National Park Service
Department of the Interior

Natural Resource Stewardship and Science

Grand Canyon National Park-Grand Canyon / Parashant National Monument Vegetation Classification and Mapping Project

Natural Resource Report NPS/GRCA/NRR—2015/913



ON THE COVER
View of pinyon - juniper and chaparral vegetation in Dragon Creek from the forests on the north rim of Grand Canyon.
NPS photo

Grand Canyon National Park-Grand Canyon / Parashant National Monument Vegetation Classification and Mapping Project

Natural Resource Report NPS/GRCA/NRR—2015/913

Michael J.C. Kearsley

National Park Service
1824 S. Thompson St.
Flagstaff, AZ 86001

Kass Green[1], Mark Tukman[2], Marion Reid[3], Mark Hall[3], Tina Ayers[4], Kyle Christie ([4,*])

[1]Kass Green & Associates
1101 High Court
Berkeley, CA 94708

[2]Tukman Geospatial LLC
2700 Bennett Ridge Road
Santa Rosa, CA 95404

[3]NatureServe
2108 55th Street, Ste. 220
Boulder, CO 80301

[4]Department of Biological Sciences
Northern Arizona University
Flagstaff, AZ 86011

(*) Current Address:
Department of Evolution and Ecology
2320 Storer Hall, one Shields Avenue
University of California
Davis, CA 95616

February 2015

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from the Natural Resource Publications Management Web site (http://www.nature.nps.gov/publications/nrpm/) on the Internet.

Please cite this publication as:

Kearsley, M. J. C., K. Green, M. Tukman, M. Reid, M. Hall, T. J. Ayers, and K. Christie. 2015. Grand Canyon National Park-Grand Canyon / Parashant National Monument vegetation classification and mapping project. Natural Resource Report NPS/GRCA/NRR—2015/913. National Park Service, Fort Collins, Colorado.

NPS 113/127833, 666/127833, February 2015

Contents

Page

Figures vii

Tables ix

Appendices xi

Acknowledgements xi

Executive Summary xiii

I. Introduction 1

The Grand Canyon National Park/Grand Canyon – Parashant National Monument Vegetation Classification and Mapping Project 1

National Park Service Vegetation Inventory Program 1

NPS Inventory and Monitoring Program Standards 2

Grand Canyon National Park History 3

Grand Canyon National Park Natural Resources 4

History of Vegetation Studies in Grand Canyon 5

Grand Canyon-Parashant National Monument History 6

Grand Canyon – Parashant National Monument Resources 6

History of Vegetation Studies at Grand Canyon – Parashant National Monument. 7

Literature Cited 7

Project Boundary 13

Project Partners and Project Agreement 13

General Process 13

II. Project Overview 13

Aerial Imagery 16

Mapping Phases 18

Interim meetings and reports 19

Literature Cited 20

Contents (continued)

Page

Preliminary Activities 23

Preliminary Associations List 23

Electronic Field Data Collection Systems 23

Biophysical Modeling 23

III. Vegetation Classification Data Collection 23

Data Sheets 25

Field Crew Training 25

Methods 26

Sampling Design 26

Classification Plots 26

Observation Plots 30

Data Quality Control 30

Results 31

Vegetation Surveys and Collections 31

Database 32

Literature Cited 33

Preliminary NVC Classification List 35

Classification and Data Analysis 35

Methods 35

Data Preparation and Screening 35

IV. Vegetation Classification 35

Multivariate Analysis 36

Plant Association Field Keys 38

Association Descriptions 41

Contents (continued)

Page

Results 41

Classification Discussion 42

Vegetation Classification Products 46

Vegetation Classification and Plant Association Descriptions 46

Literature cited 46

V. Vegetation Mapping 49

Methods 49

Introduction 49

Physical Implementation of the Vegetation Association Key 52

Image Preprocessing 52

Image Segmentation 52

Acquire and Create Independent Variable Data Sets and Calculate Zonal Statistics 56

Sample Data Collection 56

Vegetation Classes and Map Model Classes 58

Classification and Regression Tree (CART) Modeling 58

Manual Editing to Produce the Draft and Final Maps 59

Draft Map and Report Review 61

Accuracy Assessment 61

Final Map, Report and Database Delivery 63

Results 63

Vegetation Classes to Map Classes 63

Accuracy Assessment 66

Literature Cited 69

Vegetation Dynamics and Vegetation Mapping 71

Contents (continued)

Page

VI. Discussion and Conclusions 71

Lessons Learned 72

Classification versus mapping 72

Mapping Phases 72

Gradsect analysis 73

Electronic data collection 73

Field crews 74

Mapping acquisition elements 74

The Park as the Customer 74

Literature Cited 74

Figures

Page

Figure 1. Overview of the project Mapping Area. 3

Figure 2. Areas sampled in 2007. 17

Figure 3. Areas sampled in 2008. 17

Figure 4. Mapping phases. 18

Figure 5. Calculation of biophysical units. 24

Figure 6. Cost surface modeling. 25

Figure 7. Field training at the South Rim during a snow storm. 26

Figure 8. Field training moved to Flagstaff, beyond the snow storm. 26

Figure 9. Entity–relationship diagram for the final database including data collected on paper sheets in 2007 and on Palm PDAs in 2008. 32

Figure 10. Clustering output for the Mojave shrublands samples. 37

Figure 11. Cluster dendrogram of plot data representing Mormon tea dominated vegetation. 38

Figure 12. Example of a Bray-Curtis ordination of plots representing Mormon tea dominated vegetation. 39

Figure 13. Example of a Bray-Curtis ordination of plot data representing pinyon-juniper dominated vegetation. 39

Figure 14. Cluster dendrogram of plot data representing pinyon-juniper dominated vegetation. 40

Figure 15. Example of a Bray-Curtis ordination of plot data representing Mojave-Sonoran Semi-Desert Scrub dominated vegetation. 41

Figure 16. ***Baccharis emoryi - Salix*** Shrubland at Bright Angel Creek. 42

Figure 17. C***oleogyne ramosissima - Ephedra*** spp. Warm Desert Shrubland in the Inner Canyon. 42

Figure 18. Pinus edulis - ***Juniperus osteosperma / Artemisia bigelovii*** Woodland on the North Rim. 43

Figure 19. ***Abies lasiocarpa - Picea engelmannii / Juniperus communis*** Woodland (background) and ***Festuca (calligera, arizonica, brachyphylla)*** Herbaceous Vegetation (foreground) on the North Rim. 43

Figures (continued)

Page

Figure 20a. Project workflow: imagery and ancillary data. 50

Figure 20b. Project workflow. 51

Figure 21a. Phase 1 processing regions 53

Figure 21b. Phase 2 processing regions. 53

Figure 21c. Phase 3 processing regions. 54

Figure 22. Image segmentation and vegetation polygon creation. 54

Figure 23. Field data entry on the Trimble Yuma. 58

Figure 24. Field data entry form for Phases 2 & 3. 59

Figure 25. Conceptual illustration of the CART data mining and rule creation process. 60

Figure 26. Sample selection for CART and accuracy assessment. 62

Figure 27a. Final vegetation map of the Phase 1 area 64

Figure 27b. Final vegetation map of the east portion of the Phase 2 area. 64

Figure 27C. Final vegetation map of the west portion of the Phase 2 area. 65

Figure 27d. Final vegetation map of the Phase 3 area. 65

Tables

Page

Table 1. Description of mapping standards. 2

Table 2. Primary partners on the project and their roles and responsibilities 14

Table 3. Participants in the Project Planning Meeting 15

Table 4. Data sets determined to be useful in mapping and vegetation analysis by Grand Canyon staff (Makarick and Mietz, unpublished data). 16

Table 5. Major interim meetings and calls. 19

Table 6. Biophysical Unit (BPU) Key and Classes 24

Table 7. Cost metric for accessing polygons 25

Table 8. Backcountry areas sampled in 2007 with target vegetation types and target ecological, historical, physical and geologic features. 27

Table 9. Backcountry areas sampled in 2008 with target vegetation types and target physical – geologic features. 28

Table 10. General data categories and specific data components collected at classification plots. 30

Table 11. Number of plots assigned to ecological groups used in analysis. 36

Table 12. Imagery used for segmentation by processing region 55

Table 13. KGA field samples by Phase and type. 58

Table 14. Draft and final overall accuracies for Phases 1-3. 67

Table 15. Summary of producer's and user's accuracies for all three phases combined. 68

Appendices

Page

Appendix A: Project Agreement between Grand Canyon National Park and NPS Vegetation Inventory Program 77

Appendix B: Dichotomous keys to vegetation surveyed in Grand Canyon National Park and Grand Canyon - Parashant National Monument 85

Appendix C: National Vegetation Classification Standard hierarchy with vegetation Associations and Alliances surveyed in Grand Canyon National Park and Grand Canyon - Parashant National Monument 117

Appendix D: Descriptions of National Vegetation Classification Standard vegetation Associations 129

Appendix E: Vegetation Association - map class table 589

Appendix F: Table of mapping errors 599

Appendix G: Vegetation and fuels survey field data sheets 609

Acknowledgements

This project would not have been possible without the assistance and enthusiasm of many people. Financial support was provided by NPS Vegetation Inventory Program, and the authors express their gratitude to Karl Brown and Tammy Cook. Jim Von Loh assembled an awesome field crew at the start of the field sampling phase. Chris Lea (NPS-VIP) came out to assist in the field on a couple of delightful Grand Canyon days and provided much needed guidance on NVCS and validation questions. Kathryn Parker (GRCA) provided timely and valuable advice on the procurement process and Elizabeth Baerl was the absolute bomb of a Contracting Officer. Jennifer Fox (LAKE) helped with logistics, data, documents and input from the way west end of things. The report was greatly improved by reviews from John Spence (GLCA), Lisa Thomas (SCPN), Tammy Cook (NPS-VIP), and especially Mindy Trask (MOJN). Finally, this project owes most of its form and success to the vision and continuous guidance of the Grand Canyon N.P. staff who understood what a vegetation mapping project could do for their park: Lori Makarick who pushed harder than anyone to get it going, Eric Gdula who was always available for review, comments, insights, and suggestions when they were needed, and Steve Mietz, whose early vision of how such a large and complex project could succeed laid out a road map that guided our work the rest of the way.

Executive Summary

The National Park Service Vegetation Inventory Program (NPS-VIP) is an effort by the National Park Service (NPS) to classify, describe, and map existing vegetation of national park units for the Natural Resource Inventory and Monitoring (I&M) Program. Supported by the NPS-VIP, Grand Canyon National Park, NatureServe, Kass Green Associates, and Northern Arizona University have completed the classification and mapping of plant communities of Grand Canyon National Park and portions of Grand Canyon – Parashant National Monument under the administrative control of Lake Mead National Recreation Area. This classification and mapping project created an updated assessment of the distribution of vegetation last mapped over thirty years ago.

The U.S. National Vegetation Classification (USNVC) is a standardized framework for the inventory and study of vegetation in the United States. The purpose of the USNVC is to produce standards-based statistics about vegetation resources across the nation, derived from vegetation data gathered at local, regional, or national levels and analyses guided by the National Vegetation Classification Standard (NVCS). The USNVC categories represent levels of description from the very local (Associations) to the broadest, physiognomic (Formations) classes. The latest classification standard, published in 2008 by the Federal Geographic Data Committee (Federal Geographic Data Committee 2008), provides for an ongoing refinement of the NVC based on new data and new insights into how vegetation communities are organized and distributed.

Ecologists and botanists from NatureServe, Northern Arizona University and the National Park Service created the vegetation classification based on 1496 vegetation classification plots within the mapping area. Vegetation data from a USGS data set provided guidance on classification of riparian vegetation in the Colorado River Corridor which was not sampled for this project. Map calibration and accuracy assessment data identified two communities which had not been documented during the initial classification data collection. The final classification included 222 NVC Association-level plant communities. Of these, 139 represented existing Associations, 47 required the creation and description of new Associations, and four represented NVC Alliance-level communities. The 32 remaining communities were considered "Park Specials" because, although unique and outside the described boundaries of existing Alliances, they lacked sufficient information and abundance to justify creating new Associations. A dichotomous key to the vegetation Associations was created by and tested by NatureServe, Northern Arizona University and KGA personnel both in the field and using existing data sets.

The classification work done for this project demonstrated both the strengths of using a dynamic standard like the NVCS, and the challenges it presents. Many of the described Associations represented refinements of types described from more limited geographic areas. The Goodding's willow Woodland had been described from samples in New Mexico and Texas, where mesquite and ash trees were common associates, rather than the tamarisk and willow-leaf *Baccharis* which are associates in Grand Canyon. Similarly, descriptions of new Associations like the Crucifixion-thorn Grand Canyon Shrubland are likely to be revised and renamed when they are analyzed from the many other parts of the southwestern U.S. where they occur. Furthermore, during the course of this project, the botany underlying the classification was undergoing its own changes; the desert *Ceanothus* (*Ceanothus greggii*) in Arizona will be moved to Mojave *Ceanothus* (C. vestitus) and Emory *Baccharis* (*Baccharis emoryi*) has been synonymized with B. salicina. Both of these changes will eventually require updates to the USNVC as soon as the process defined by the NVCS is completed.

The vegetation was mapped in three phases based on floristic similarity and difficulties dealing with the logistical barriers presented

by extreme terrain. Phase 1 included the high elevation forests and woodlands on rims of the eastern portion of the mapping area; Phase 2 was the inner canyon areas of the eastern and central mapping area; Phase 3 was most of the rim- and canyon areas west of Parashant Canyon. Each phase was mapped and accuracy assessed as a unit. The final mapping activities involved reconciling map classes, boundaries and accuracy assessment among all phases.

An innovative combination of automated image segmentation and regression-tree analysis was used to create the vegetation map. For Phases 1 and 2, the mapping was based on 1-meter, 4-band digital aerial imagery from the 2007 USDA National Agriculture Inventory Program (NAIP), along with satellite imagery, a digital elevation model and ancillary data sets provided by Grand Canyon NP. Phase 3 used both the 2007 NAIP data and 2010 NAIP data; the latter had less shadowing in some areas. The aerial imagery was broken into almost 2 million spectrally distinct objects, or segments, using eCognition software. Nearly 60,000 of these segments were labeled to vegetation type using the vegetation key. Labeled segments were then separated into two groups: training sites for the regression tree analysis and map labeling or accuracy assessment sites. Vegetation Associations which could not be reliably distinguished using remotely-sensed data were combined into NVC Alliance or NVC Group level map classes after discussions among NPS, mappers, and classifiers. Draft maps were edited based on further field work and review by local experts to produce a final map.

The final map contained 87 map classes with a minimum mapping unit of 0.5 hectares across more than 560,000 hectares. The classes included 41 NVC Associations, 36 NVC Alliances, seven NVC Group-level classes and three classes of unvegetated surfaces (built-up, water, and bare soil/rock). Accuracy assessment (AA) was done for 1847 map segments, distributed based on map class abundances. Accuracy by map class varied between 13% (Pinyon – Juniper / Talus or Canyon Slope Scrub) and 100% (Douglas Fir / Snowberry Forest and 5 others); project-wide accuracy was 77%. Roughly one-third of the mis-identified samples were among closely– related vegetation types. Others were among classes which were found in similar habitats (e.g., constrained tributary beds) and had very similar spectral signatures.

The final products of this project, both electronic and hard-copy, are available from the NPS Inventory and Monitoring program. Materials available are a detailed report on methods and results and appendices which cover NVC plant Association descriptions, the dichotomous key to vegetation Associations, and accuracy assessment results. Also available are geospatial and tabular plot and map class data and project boundaries. Ground-based photographs for all vegetation classification plots (5 each), vegetation observation plots (2 – 3 each), and calibration plots (1-2 each) are also available. These and products from other NPS Vegetation Inventory Program projects are available at the NPS Vegetation Inventory website: *http://science.nature.nps.gov/im/inventory/veg/*.

I. Introduction

The Grand Canyon National Park/Grand Canyon – Parashant National Monument Vegetation Classification and Mapping Project

The Grand Canyon National Park/Grand Canyon-Parashant National Monument Vegetation Classification and Mapping Project was initiated by Grand Canyon National Park and supported by the National Park Service Vegetation Inventory Program (NPS-VIP). The original proposal included only Grand Canyon National Park, but the project mapping area was expanded in 2007 to include those portions of Grand Canyon-Parashant National Monument under the administrative of Lake Mead National Recreation Area. The decision allowed the NPS-VIP to take advantage of high-quality regional aerial imagery and reduce logistical and administrative costs. The project's goals were to classify, describe, and map the vegetation of this area to provide useful inventory information to park resource managers, researcher personnel and the NPS Inventory and Monitoring Program.

The classification and map products are expected to support decision-making related to many resources. Early internal scoping meetings in 2003 and 2004 identified a number of management information needs which a vegetation map would fulfill. Grand Canyon's fire management program needed data on the distribution of fuels and fuel types on the rims. The park's wildlife program was working from a Mexican Spotted Owl (*Strix occidentalis lucida)* habitat map based on a 35 year old vegetation map that had never been tested for accuracy. Recreation planners needed data on the distribution of rare vegetation types to assess impacts of emerging recreation uses like canyoneering and packrafting that were giving users access to previously unvisited areas of the park. Plans for maintenance and upgrades to facilities such as the renovation of the Trans-Canyon Pipeline needed information on the distribution of vegetation types.

National Park Service Vegetation Inventory Program

The National Park Service Vegetation Inventory Program is an effort to classify, describe, and map existing vegetation of national park units for the NPS Natural Resource Inventory and Monitoring (I&M) Program. The NPS VIP is managed by the NPS Biological Resources Management Division and provides baseline vegetation information to the NPS Natural Resource I&M Program. The U.S. Geological Survey Vegetation Characterization Program (USGS VCP) lends a cooperative role in the NPS VIP. Its original goals were similar to the goals of this project: to classify, describe, and map vegetation communities in National Park Service units across the United States. The program is an important component of the National Park Service Inventory and Monitoring Program, a long-term program to develop baseline data. The primary objective of the NPS-VIP is to produce high-quality, standardized maps of the vegetation and other land cover classes occurring within National Parks and National Park Service units. These maps and associated information are required to support a wide variety of resource assessment, park management, and conservation initiatives.

The National Park Service Inventory and Monitoring (I&M) program, its predecessors and cooperators have developed guidelines and protocols for sampling, classification, mapping, and accuracy assessment (The Nature Conservancy and Environmental Systems Research Institute 1994a,b; The Nature Conservancy et al. 1994) and serve them to the public through their website (*http://science.nature.nps.gov/im/inventory/veg/index.cfm*). These protocols were modified by the mapping area by field crews, Grand Canyon National Park personnel, classifiers and mappers when necessary to meet unique challenges. Any adjustments to these methods were done in ways that satisfied the Federal Geographic Data Committee standards for vegetation mapping products (FGDC 1998).

Table 1. Description of mapping standards.

Where not specified, details are at *http://science.nature.gov/im/inventory/veg/docs/Product_Specifications.pdf*

Name of Mapping Specification	Description
National Map Accuracy Standards (NMAS) (http://*nationalmap.gov/standards/nmas.html)*	Describe requirements for horizontal and vertical accuracy of the maps created, dependent on map scale. Because the Grand Canyon National Park/Grand Canyon-Parashant National Monument vegetation map is produced at a scale of 1:24,000, accuracy is defined as +/- 0.02 inch in the horizontal plane. There is no vertical component to the map, so no vertical accuracy component applies.
National Vegetation Classification Standard (http://*usnvc.org/)*	The National Vegetation Classification (NVC) is a central organizing framework for how all vegetation in the United States is inventoried and studied. The purpose of the NVC is to produce uniform statistics about vegetation across the nation, based on data gathered at local, regional, or national levels. The latest classification standard was published in 2008 by the Federal Geographic Data Committee (Federal Geographic Data Committee 2008) and provides the basis for ongoing refinement of the NVC.
Minimum Mapping Units	For NPS Vegetation Inventory Program projects in the lower 48 states is 0.5 hectares (1.24 acres).
GIS Data Specifications	Specified for formats, content, essential elements, and definitions of terms present in the GIS data.
Metadata Standards	Specified for formats, content, essential elements, and definitions of terms present in the GIS data.
Vegetation Map Class Accuracy (http://*ww1.usgs.gov/vip/standards/NPSVI_Accuracy_Assessment_Guidelines_ver2.pdf*)	Specified at 70% or above for all vegetation classes according to guidance in place when the project began. In 2010, a new standard was introduced (Lea and Curtis 2010) which increased map class accuracy to 80%. The original, lower standard, was applied to this project, but overall map accuracy will necessarily be higher than this standard because this specifies a lowest acceptable level of user accuracy for any map class.
Data Specifications	Specifications for non-spatial (tabular) data collection and delivery requirements are specified with minimum quality standards and organization standards to allow users to discover and use products.

The NPS-VIP also provides access to data products and project management guidelines through the same website. Guidance is provided for all steps needed to complete a classification and mapping project from scoping meetings through close-out. The data products available include all geospatial and tabular and reports from completed projects. The Vegetation Inventory Map Viewer, a web-based tool which allows access to completed vegetation inventory data without requiring geographic information system software is currently under development on the website.

NPS Inventory and Monitoring Program Standards

In order to make the maps and data generated by the NPS-VIP useful for resource management at a Service-wide level, a number of standards are applied to vegetation maps and associated data products. These standards are required by the Federal Geographic Data Committee and apply to all maps produced for the federal government. Table 1 lists the standards for horizontal accuracy, GIS data deliveries, metadata, vegetation classification, map class accuracy and data specifications.

Among these standards is the National Vegetation Classification Standard (NVCS). The NVCS is a process-based standard for classifying vegetation at local to global scales, and provides a common language for conservation and management of vegetation nationally. It is a dynamic standard by design, and underwent a major revision between the start and end of this project (Federal Geographic Data Committee 2008). The new classification hierarchy included middle levels with geographic information which improved the NVC performance. The current hierarchy includes upper (physiognomic), middle (geographic and taxonomic), and lower (taxonomic) levels. Details of this

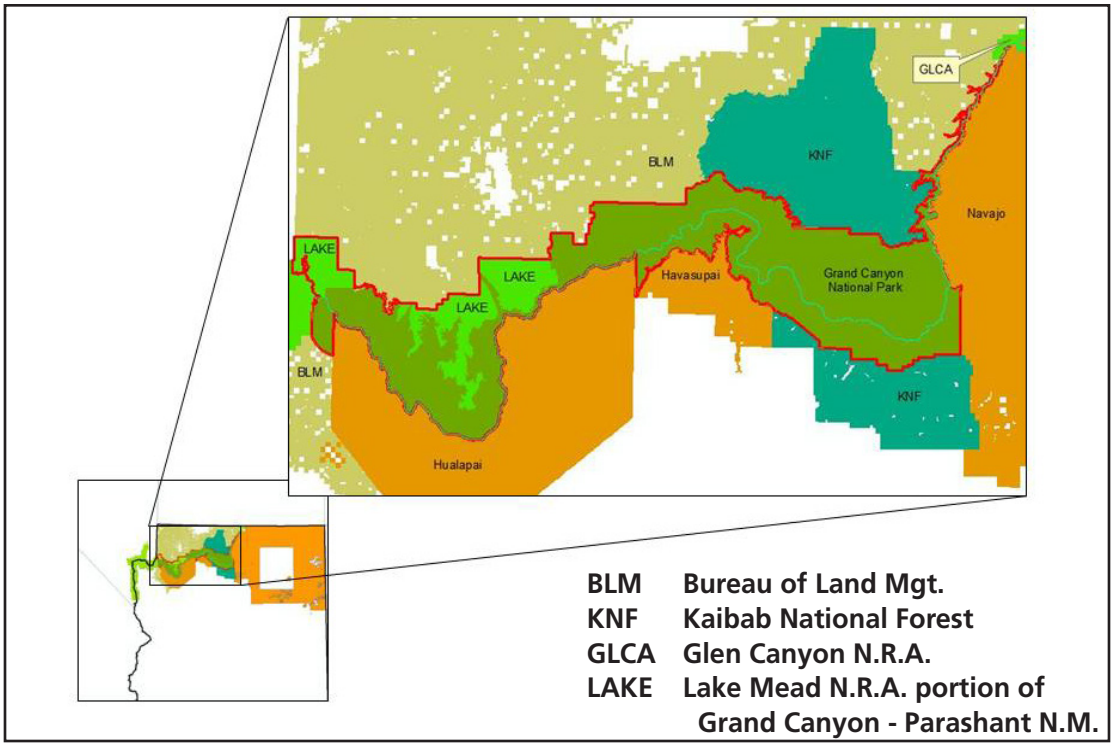


Figure 1. Overview of the project Mapping Area.

The red line indicates the mapping area boundary, Tribal areas are in orange

revision and its impact on the classification of vegetation for this project are presented in the Vegetation Classification chapter of this report

The change from Version 1 to Version 2 created several challenges for this project. The classification phase sampling took place in 2007 and 2008, and the mapping phase began in 2009, so the two phases straddled the change in the NVCS. The fate of several taxa which were important to the project (e.g. *ponderosa* pine Alliances) is still not clear because the realignment of associations into geographically-appropriate Groups caused the merging of some Associations and the movement of others to newly-created Alliances. This has hindered the smooth integration of the hierarchical structure of the NVCS into map classes.

Grand Canyon National Park History

Grand Canyon National Park is located in northern Arizona, United States (Figure 1). It is bounded by parts of the Kaibab, Kanab, and Shivwits Plateaus to the north and the Coconino Plateau and Music Mountains to the south. The Colorado River bisects the park running northeast to southwest more than 277 miles from Lees Ferry to Grand Wash Cliffs. In all, the park encompasses 1,217,403 acres.

The park is relatively isolated from development. Most of the park's boundaries are shared by public lands administered by the Bureau of Land Management and the U.S. Forest Service, or tribal lands of the Navajo, Havasupai and Hualapai nations. The Colorado River is bordered by National Park Service units both upstream (Glen Canyon National Recreation Area) and downstream (Lake Mead National Recreation Area and Parashant National Monument) of the park. The closest major metropolitan areas, Phoenix, Las Vegas and Salt Lake City, are 250 to 400 miles driving distance from the developed areas of the park.

The area was first given federal protection when President Harrison created Grand Canyon Forest Reserve in 1893. Portions of the Forest Reserve were designated as a federal game preserve by Theodore Roosevelt in 1906, two years before he set aside nearly 820,000 acres as Grand Canyon National Monument under the management of the U.S. Forest Service. Grand Canyon became a national park in February 1919, when it became the seventeenth national park. The Grand Canyon Enlargement Act increased

the area of the park to its current size with the addition of Marble Canyon National Monument in 1975.

Grand Canyon National Park Natural Resources

Grand Canyon National Park was established to protect the unsurpassed display of geology, rich archaeological history, abundant wildlife, and spectacular views. Rock units exposed in the park range in age from the 1.8 billion year-old Elves Chasm Gneiss to the Kaibab Limestone deposited 270 million years ago. Geologic faulting, volcanism, and six million years of erosion by the Colorado River in its current course are overlaid on the diversity of rock types, and have created a variety of soil types with important textural and compositional variations. Cliff-forming rocks such as the Redwall Limestone and Coconino Sandstone provide very different habitats than the slope-forming shales and softer types.

Cultural resources in the park show that humans have utilized the canyon for nearly 12,000 years. Paleo-Indian projectile point fragments, Archaic-period roasting pits, rock art panels, and artifacts occur throughout the park. The locations of maize-based horticulture and agriculture-supported settlements show the importance of the Colorado River and its tributaries to the early farmers of the canyon. Ancestral Puebloan dwellings are found on both the North and South Rims as well. For the last thousand years, ancestors of the present-day t*Ribes* made use of the resources of the canyon. The t*Ribes* that retain traditional relationships with the Grand Canyon include the Havasupai, Hopi, Hualapai, Navajo, Southern Paiute, Yavapai Apache, and Zuni.

The diversity of botanical resources of Grand Canyon arises from the combination of many factors. The park sits at the southern end of the Colorado Plateau, where many biogeographic regions converge. The Rocky Mountain, Great Basin, Mojavean, Sonoran, and Apachean provinces all contribute to the diversity of this area. Overlaying this biotic source diversity is an elevational range from less than 375 meters (1250 feet) near Grand Wash Cliffs to over 2800 meters (9200 feet) on the North Rim. In rough terms, this represents as much change in conditions as would be seen in 23 degrees of latitude. As remarkable as this gradient is, it is made more so by the proximity of these diverse habitats; plant communities nomally separated by 1200 to 1500 miles are a hundred times closer, leading to remarkable juxtapositions of conifer forests above desert communities.

These ecosystems are shaped by the effects of disturbance arising from many sources. Areas of the Grand Canyon National Park's North Rim receive four to six meters of snow per year and the spring-time runoff and / or increased spring discharge can cause significant flooding. Like many desert stream systems, the tributaries of the Colorado River are subject to flash flooding during the summer "monsoon" that scours their riparian habitats. Fires on the rims typically burn through 4,000 to 5,000 hectares (10,000 to 12,000 acres) each year of forest, woodland and herbaceous habitats. Finally, although Grand Canyon is often viewed as a "desert" park, drought disturbance has contributed to die-back of tree species in forests and woodlands of higher elevation areas, both directly through moisture stress, and indirectly via increasing susceptibility to insect outbreaks. Eight of the first twelve years of this century have been characterized as moderate to extreme drought years in northern Arizona. The net effect of all these disturbance types is the creation of greater diversity within successional mosaics whose trajectories vary with disturbance severity, soils and topographic and other physical factors.

The wildlife supported by Grand Canyon is as varied as their habitats. Deer and elk inhabit the forests of the North- and South Rims with endemic, tassel-eared squirrels. Desert bighorn sheep are found in desertscrub communities of the inner canyon, Mountain lions, coyotes, and foxes range throughout the park. The lowest elevation habitats support small mammals and reptiles whose physiology and behavior allow them to tolerate the harsh environments. Overall, it is estimated that the park supports 47 different reptiles, 90 species of mammals

including 19 species of bats, more than 350 species of birds, and as many as 20,000 species of invertebrates.

History of Vegetation Studies in Grand Canyon

Although primarily known for its geology, Grand Canyon has generated interest in its vegetation resources longer than it has been a National Park. Early European visitors to the region generally included references to desert and forest vegetation in their descriptions of their experiences in the area, whether seen from horseback (Prudden 1898), steamship (Ives 1859), or from a perch atop a floating log (Clerke 1868). The zonation of vegetation in Grand Canyon figures prominently in C. Hart Merriam's (1890) seminal work on "Life Zones" where he documented changes in Arizona's plant communities with elevation that were strikingly similar to changes with latitude. While surveying a potential train route paralleling the Colorado River, Robert Brewster Stanton (1890) captured images of vegetation throughout the length of the river corridor in photographs which have been used as a baseline in assessments of long-term change in vegetation (Webb 1996, Bowers 1997).

Longer-term trends in vegetation have been analyzed by taking advantage of the region's dry climate. The aridity allows animal middens to remain intact for thousands of years. A large deposit of sloth dung in a cave in western Grand Canyon showed that during the period extending back to 24,000 years ago, Woodland and Mesic Shrubland species such as pines, birches, and sage were abundant (Martin et al. 1961) in the western end of the park which ocotillo, cactus and creosote bush now dominate. Packrat middens, found throughout the region, provide a more widespread and longer record of vegetation change, extending the findings from sloth dung in to more recent periods. During the transition from moisture-loving species to present-day xeric shrublands (6,000 to 12,000 years bp), both kinds of species occupied the area at the same time (Cole 1985, 2010, Mead and Phillips 1981, Coats 1996).

There have been a number of plant checklists produced for the park. Pauline Mead Patraw, Grand Canyon's first female Ranger–Naturalist, produced the first formal checklist, based on collections from the park (Patraw1932, 1936). MacDougal (1947) created a second checklist for Grand Canyon by extracting data from a larger flora for the entire state of Arizona. These were updated in an annotated checklist after a systematic search through regional herbaria and field notes by the staff at the Museum of Northern Arizona (Phillips et al. 1982). Several publications have added to the flora of Grand Canyon (Ayers et al. 1995, Brian et al. 1999, 2001), the most recent of which was a direct result of surveys performed for this project (Christie et al. 2011).

Most studies of riparian vegetation in the Colorado River corridor have taken place since the completion of Glen Canyon Dam, although there are exceptions (e.g., Clover and Jotter 1941, 1944). The first post-dam vegetation description focused on the desert species (Bennett 1968). As the impacts of river regulation became more evident, the emphasis shifted to riparian species (Aitchison et al. 1974, Carothers et al. 1976). A major push for studies of changes in the riparian vegetation of the river corridor came after the high flows of the early 1980s (Anderson 1984, Stevens and Waring 1985). Long-term assessments of vegetation change in the river corridor after Glen Canyon Dam were based on remote sensing (Pucherelli 1986, Waring 1999). Restoration activities in riparian habitats, specifically the removal of tamarisk from selected tributaries, included monitoring of vegetation plots after removal (Belote et al. 2010).

In Grand Canyon National Park, fire is one of the most important organizing forces in communities above the rim. Studies on the effects of fire on forest and woodland communities have been conducted in support of its very active fire management program. A series of Fire Management Plans created since the 1980s (Grand Canyon National Park 1985, 1992, 1999, 2010) all include analyses of fire behavior differences in different vegetation types. Of particular interest have been the mid-elevation mixed conifer

forest types that cover the zone between the fire-adapted *ponderosa* pine forests and the spruce-fir forests of the highest elevation areas (White and Vankat 1993, Wolf and Mast 1997). The Ecological Restoration Institute at Northern Arizona University has studied all forest types above the rims, and maintains long-term data sets (Fulé 2000, 2002, 2004, Fulé and Laughlin 2007). The NPS Southern Colorado Plateau Network Inventory and Monitoring program also monitors mixed-conifer and pinyon-juniper communities (DeCoster, Swan et al. 2009), but these studies are motivated more by interest in long-term change than fire effects.

There have been several general vegetation studies, including both descriptions of vegetation and maps of vegetation distributions in Grand Canyon. Smaller mapping projects, focused on limited areas or vegetation types, have been performed for Fishtail Mesa (Jameson 1962, Brian 1998), the Sanup Plateau areas within the park (Baxter 1983), and North Rim forests (Rasmussen 1941, Rand 1957, Halvorson 1972, White and Vankat 1984, 2005) and meadows (Moore 1991). Vegetation in the Colorado River corridor was mapped using aerial photography and ground-truthing in the early 1980s (Phillips et al. 1982) and again two decades later (Ralston 2007). A systematic survey of park-wide forest and shrubland resources, along with maps and vegetation typing, was completed for the National Park Service Forestry Division in the early 1930s (Wagner 1934). A second, all-park vegetation survey and map were completed almost a half-century later, using a regionally-standardized vegetation classification (Warren 1982).

Grand Canyon-Parashant National Monument History

Grand Canyon – Parashant National Monument is located in northwestern Arizona (Figure 1). It encompasses 1,054,264 acres and is bounded by the western end of the north rim of Grand Canyon National Park to the south, the Nevada/Arizona border to the west, and the Hurricane Valley to the east. The Bureau of Land Management portion of the monument contains four Wilderness Areas: the southern portion of the Paiute Wilderness, the Grand Wash Cliffs Wilderness, Mount Logan Wilderness and the Mount Trumbull Wilderness.

The origins of Lake Mead National Recreation Area (N.R.A.) began after the completion of Boulder (now Hoover) Dam. Boulder Dam Recreation Area was created in 1935 to accommodate the recreational uses of the reservoir impounded by Boulder Dam. In 1964, the area around Lake Mohave and the river in between were added by the U.S. Congress to create the enlarged Lake Mead National Recreation Area.

Grand Canyon-Parashant National Monument was established by Presidential Proclamation 7265 on January 11, 2000 to protect the remote and rugged scenery. The southern end of the monument, especially the area near Kelly Point at the extreme south end of the Shivwits Plateau, contains some of the most remote and difficult to access parts of the continental United States. The monument was created from an 808,744 acre portion of the Bureau of Land Management's Arizona Strip District, 208,447 acres of National Park Service land from Lake Mead National Recreation Area(N.R.A.), and Arizona State Trust lands. It is unique among NPS National Monuments in being managed jointly by the Bureau of Land Management and the National Park Service.

Because of funding and administrative constraints on the NPS Vegetation Inventory Program, mapping activities for this project were limited to the NPS lands within Grand Canyon - Parashant National Monument. The areas mapped for this project include three parts of the Recreation Area at the far eastern end; Grand Wash Bay and the Snap Canyon area, the Whitmore Canyon area and the environs of Shivwits Plateau, including Twin Point, Tincanebitts Point, Suicide Point and Burnt Canyon point (Figure 1).

Grand Canyon – Parashant National Monument Resources

Grand Canyon – Parashant National Monument was established to protect the solitude and remote terrain found there. Much of its geology is shared with Grand Canyon, with

Grand Wash Cliffs delineating the end of the Grand Canyon of the Colorado River. The monument lies at the intersection of two physiographic provinces: the Colorado Plateau to the east and the Basin and Range Province to the west. The Colorado Plateau Province is characterized by gently sloping high plateaus eroded by tributaries of the Colorado River. These have exposed the Chinle and Moenkopi formations in addition to the same sedimentary rock layers found in Grand Canyon. These were formed in the Triassic Period (Mesozoic Era) extending the geologic record another 40 million years. The Basin and Range Province, west of the Grand Wash Cliffs, is composed of extensively faulted and folded rock layers. The rock types are mostly igneous and metamorphic in origin with vast exposures of Precambrian rocks. Faults trend mostly north-south, producing a landscape with north-trending mountain ranges separated by sediment-filled valleys.

Tertiary and Quaternary volcanic fields are common in the parts of Grand Canyon-Parashant National Monument mapped for this project. Several of the larger flows created massive lava dams across the Colorado River which backed flows up past the upstream extent of Grand Canyon (Koons 1945, Fenton et al. 2004, 2006). The gray, black, and reddish black substrates of the basaltic flows and cinder cones create distinctive habitats for the development of vegetation.

Few studies of Grand Canyon-Parashant National Monument's archaeological resources exist. However, cultural resources present document human occupation of the monument beginning 8,000 to 12,000 years ago. Early evidence includes the presence of Clovis point fragments in the Virgin River area. Ancestral Puebloan sites have been found in areas clustered around riparian habitats and other rich ecological zones. Europeans entering the area in the 18th century encountered Southern Paiute groups throughout the area.

The botanical resources within the mapped portion of Grand Canyon – Parashant National Monument have as diverse a set of influences as those in Grand Canyon National Park. The current vegetation is derived from the meeting of floras from the Mojavean, Sonoran, Great Basin, and Colorado Plateau provinces. Habitats sampled for this project cover nearly the same elevational range as in Grand Canyon, rising from 365 meters (1200 feet) above sea level at the surface of Lake Mead to the top of Mt. Trumbull (2450 meters; 8000 feet).

This floristic diversity supports a wide range of wildlife species. Populations of Merriam's turkeys, goshawks, porcupines and Kaibab squirrels are found in the high-elevation *ponderosa* stands on Mount Trumbull, many miles from the next nearest populations. Mule deer occupy habitats in and below Mt. Trumbull. Pronghorn antelope, although not common, are supported by grasslands in the intermediate elevations. In the lowest areas, desert tortoise and other reptiles are found, along with small mammals.

History of Vegetation Studies at Grand Canyon – Parashant National Monument.

Because of the areas remoteness and difficult terrain, there have been far fewer studies of vegetation in Grand Canyon – Parashant National Monument. Holland et al. (1977) published a popular guide to the flowering plants of Lake Mead National Recreation Area, and a more technical checklist of vascular species (Holland et al. 1979) and a list of threatened and endangered species (Holland et al. 1980). Moore (1993) also surveyed sensitive plant species for Lake Mead, and Van Buren and Harper (2004), and Powell (1991) updated the species list for vascular plants. Baxter (1983, 1984) and his coworkers produced a grazing study and plant survey for the Kaibab National Forest on the Sanup Plateau. The post-dam colonization of sandbars by tamarisk led to a number of studies of the extent of stands and impacts on native communities (Smith 1989, USNPS 2009).

Literature Cited

Anderson, B. W. and R. D. Ohmart. 1984. A vegetation management study for the enhancement of wildlife along the

lower Colorado River. Final Report. U.S. Bureau of Reclamation contract # 7-07-3-V0009. Center for Environmental Studies, Arizona State University, Tempe, AZ.

Ayers, T. J., R. Scott, L. E. Stevens, A. M. Phillips, and K. Warren. 1995. Additions to the flora of Grand Canyon National Park. Journal of the Arizona-Nevada Academy of Science 28:70-75.

Baxter, C., D. Brewer, R. Jorgensen, and R. Galeano. 1983. Sanup Plateau grazing impact study. Page 44 in USDA, editor. USDA USFS Southwestern Region, Kaibab National Forest, Williams, AZ.

Baxter, C., D. Brewer, R. Jorgensen, and R. Galeano. 1984. Range and soils evaluation of the Sanup Plateau.in U. F. Service, editor. Williams Ranger District, Kaibab National Forest, Williams, Ariz.

Belote, T. R., L. J. Makarick, M. J. Kearsley, and C. L. Lauver. 2010. Tamarisk removal in Grand Canyon National Park: changing the native - non-native relationship as a restoration goal. Ecological Restoration 28:229-239.

Bennett, P. S. 1969. Some notes on the vegetation of the Inner Gorge, Grand Canyon. Pages 25-34 in Four Corners Geological Society, editor. Geology & Natural History of the Fifth Field Conference Powell Centennial River Expedition 1969 Grand Canyon Region. Four Corners Geological Society, Durango, Colorado.

Bowers, J. E., R. H. Webb, and E. A. Pierson. 1997. Succession of desert plants on debris flow terraces, Grand Canyon, Arizona, U.S.A. Journal of arid environments 36:67-86.

Brian, N., W. C. Hodgson, and A. M. Phillips. 1999. Additions to the flora of the Grand Canyon region--II. Journal of the Arizona-Nevada Academy of Science 32:117-127.

Brian, N. J. 2001. Additions to the flora of the Grand Canyon region -- III. Journal of the Arizona-Nevada Academy of Science 33:151-153.

Brian, N. J. and P. G. Rowlands. 1998. A resurvey of the vegetation and soils of Fishtail Mesa, Grand Canyon National Park, Arizona. Grand Canyon National Park, Grand Canyon, Ariz.

Carothers, S. W., S. W. Aitchison, M. M. Karpiscak, and G. A. Ruffner. 1976. An ecological survey of the riparian zones of the Colorado River between Lees Ferry and the Grand Cliffs: Final Report. Grand Canyon National Park. Museum of Northern Arizona, Flagstaff, AZ.

Christie, K., G. Rink, and T. J. Ayers. 2011. Additions to the flora of Grand Canyon National Park resulting from National Vegetation Mapping Program fieldwork. *Canotia* 7:1-13.

Clerke, J. 1868. A terrible voyage. Lippincott's Magazine 2:588-594.

Clover, E. U. and L. Jotter. 1941. Cacti of the Canyon of the Colorado and Tributaries. Bulletin of the Torrey Botanical Club 68:409-419.

Clover, E. U. and L. Jotter. 1944. Floristic studies in the Canyon of the Colorado and Tributaries. The American Midland Naturalist 32:591-642.

Coats, L. L. 1996. Middle to late Wisconsinan vegetation change at Little Nankoweap, Grand Canyon National Park, Arizona. M.Sc. Northern Arizona University, Flagstaff, AZ.

Cole, K. L. 1985. Past rates of change, species richness, and a model of vegetational inertia in the Grand Canyon, Arizona. The American Naturalist 125:289-303.

DeCoster, J. K. and M. C. Swan. 2009. Integrated upland vegetation and soils monitoring for Grand Canyon National Park : 2007 and 2008 report. Natural

Resource Data Series NPS/SCPN/NRDS 2009/018. Southern Colorado Plateau Network, Flagstaff, Ariz.

Federal Geographic Data Committee. 1998. National Vegetation Classification Standard. Federal Geographic Data Committee Secretariat, Reston, VA.

Federal Geographic Data Committee. 2008. National Vegetation Classification Standard, Version 2 FGDC-STD-005-2008 (version 2).

Federal Geographic Data Committee Secretariat, U.S. Geological Survey, Reston, VA.

Fenton, C. R., R. J. Poreda, B. P. Nash, R. H. Webb, and T. E. Cerling. 2004. Geochemical discrimination of five Pleistocene lava-dam outburst-flood deposits, western Grand Canyon, Arizona. Journal of Geology 112: 91-110.

Fenton, C. R., R. H. Webb, and T. E. Cerling. 2006. Peak discharge of a Pleistocene lava-dam outburst in Grand Canyon, Arizona, USA. Quaternary Research 65: 324-335.

Fulé, P. Z. and D. C. Laughlin. 2007. Wildland fire effects on forest structure over an altitudinal gradient, Grand Canyon National Park, USA. Journal of Applied Ecology 44:136 -146.

Grand Canyon National Park. 1985. Grand Canyon National Park fire management plan: an amendment to the natural resources management plan. U.S. Dept. of the Interior, National Park Service, Grand Canyon National Park, Grand Canyon, Ariz.

Grand Canyon National Park. 2002. Research on wildfire hazard reduction in *ponderosa* pine ecosystems at Grand Canyon National Park, Coconino County, Arizona. U.S. Dept. of the Interior, National Park Service, Grand Canyon National Park, Grand Canyon, Ariz.

Grand Canyon National Park. 2009. Fire management plan, Grand Canyon National Park, Arizona final environmental impact statement and assessment of effect. U.S. Dept. of the Interior, National Park Service, Grand Canyon National Park, Grand Canyon, Ariz.

Holland, J. S., R. K. Grater, D. H. Huntzinger, E. Jackson, Lake Mead National Recreation Area., and Southwest Parks and Monuments Association. 1977. Flowering plants of the Lake Mead region. Southwest Parks and Monuments Association, Globe, Ariz.

Holland, J. S., W. E. Niles, and P. J. Leary. 1979. Vascular plants of the Lake Mead National Recreation Area. Lake Mead Technical Report No. 3. Cooperative National Park Resources Studies Unit, University of Nevada, Las Vegas, Dept. of Biological Sciences, Las Vegas, Nev.

Holland, J. S., W. E. Niles, and D. R. Schramm. 1980. A guide to the threatened and endangered vascular plants of the Lake Mead National Recreation Area. Lake Mead Technical Report no. 4. Cooperative National Park Resources Studies Unit, Department of Biological Sciences, University of Nevada Las Vegas, Las Vegas, NV.

Ives, J. C. 1859. The Colorado expedition: the Colorado of the West and the country bordering it--the Grand Cañon. Journal of the American Geographical and Statistical Society 1:41-45.

Jameson, D. A., J. A. Williams, and E. W. Wilton. 1962. Vegetation and soils of Fishtail Mesa, Arizona. Ecology 43:403-410.

Kerns, B. K. 1999. Phytolith assemblages and soil characteristics from a southwestern *ponderosa* pine-bunchgrass community. Northern Arizona University, Flagstaff, Arizona.

Koons, E. D. 1945. Geology of the Uinkaret

Plateau, northern Arizona. Geological Society of America Bulletin 56:151-180.

Lea, C. and A. C. Curtis. 2010. Thematic accuracy assessment procedures: National Park Service vegetation inventory, version 2.0. Natural Resource Report. NPS/2010/NRR—2010/204. Natural Resource Program Center. Fort Collins, Colorado. Published Report-2124829.

MacDougall, W. B. 1947. Checklist of plants of Grand Canyon National Park. 3rd edition. Grand Canyon Natural History Association, Grand Canyon, Ariz.

Martin, P. S., B. E. Sabels, and D. Shutler, Jr. 1961. Rampart Cave coprolite and ecology of the Shasta ground sloth. American Journal of Science 259:102-127.

Mead, J. I. and A. M. Phillips. 1981. The late Pleistocene and Holocene fauna and flora of Vulture Cave, Grand Canyon, Arizona. The Southwestern Naturalist 26: 257-288.

Merriam, C. H. and L. H. Stejneger. 1890. Results of a biological survey of the San Francisco Mountain region and desert of the Little Colorado, Arizona. U.S. Government Printing Office, Washington, D.C.

Moore, B. C. 1993. Lake Mead National Recreation Area : sensitive plant, animal & community staff field guide. The Barrick Museum of Natural History, Las Vegas, Nev.

Moore, M. M. 1991. Tree encroachment on meadows of the North Rim of Grand Canyon National Park : literature review. Northern Arizona University, Flagstaff, Ariz.

Patraw, P. M. 1932. Preliminary check-list of plants of Grand Canyon National Park. United States, Department of the Interior, National Park Service, Grand Canyon National Park, Grand Canyon, Ariz.

Patraw, P. M. and A. C. Hawbecker. 1936. Check-list of plants of Grand Canyon National Park. Rev. edition. Grand Canyon National History Association, Grand Canyon, Ariz.

Phillips, B. G., A. M. Phillips, and M. A. Schmidt-Bernzott. 1987. Annotated checklist of vascular plants of Grand Canyon National Park. Grand Canyon Natural History Association, Flagstaff, AZ.

Powell, E. 2001. Checklist of vascular plants of Lake Mead National Recreation Area. U. S. Dept. of the Interior, National Park Service, Las Vegas, NV.

Prudden, T. M. 1898. Under the spell of the Grand Cañon. Harper's Monthly 57:377-392.

Pucherelli, M. J. 1986. Evaluation of riparian vegetation trends in the Grand Canyon using multitemporal remote sensing techniques. Final Report GCES/18/87. NTIS PB88-183470. U.S. Department of the Interior, Bureau of Reclamation, Glen Canyon Environmental Studies Salt Lake City, UT.

Ralston, B. E. 2007. A vegetation database for the Colorado River ecosystem from Glen Canyon Dam to the western boundary of Grand Canyon National Park, Arizona. U.S. Department of the Interior, U.S. Geologic Survey, Grand Canyon Monitoring and Research Center., Flagstaff, Ariz.

Rand, P. J. 1957. The plant communities of Grand Canyon National Park, Arizona. Proceedings of the Minnesota Academy of Science 25-26:88-90.

Rasmussen, D. I. 1941. Biotic communities of Kaibab plateau, Arizona. Ph D. University of Illinois.

Smith, S. D. 1989. The ecology of saltcedar (*Tamarix* chinensis) in Death Valley

National Monument and Lake Mead National Recreation Area : an assessment of techniques and monitoring for saltcedar control in the park system. Cooperative National Park Resource Studies Unit, University of Nevada Las Vegas, Las Vegas, NV.

Stanton, R. B. 1890. Through the Grand Cañon of the Colorado. Scribner's Magazine 8:591-613.

Stevens, L. E. and G. L. Waring. 1986. Effects of post-dam flooding on riparian substrates, vegetation, and invertebrate populations in the Colorado River corridor in Grand Canyon, Arizona. Final Report. Contract Number PB88-183488. Glen Canyon Environmental Studies, Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, UT.

The Nature Conservancy and Environmental Systems Research Institute. 1994a. Field methods for vegetation mapping USGS/ NPS Vegetation Mapping Program Pages vi, 106. U.S. Department of Interior, National Biological Survey and National Park Service, Washington, DC.

The Nature Conservancy and Environmental Systems Research Institute. 1994b. NBS / NPS Vegetation Mapping Program: Standardized National Vegetation Classification Standard. U.S. Department of the Interior, National Biological Survey and National Park Service, Washington, DC.

The Nature Conservancy, Environmental Systems Research Institute, and National Center for Geographical Information and Analysis. 1994. NBS / NPS Vegetation Mapping Program: Accuracy Assessment Procedures. U.S. Department of the Interior, National Biological Survey and National Park Service, Washington, D.C.

U.S. National Park Service, U.S. Forest Service, and U.S. Bureau of Land Management. 2009. Vegetation monitoring and analysis at Lake Mead National Recreation Area : project compendium 2006-2009. Cooperative National Park Resources Studies Unit, University of Nevada Las Vegas, Las Vegas, Nev.

Van Buren, R. and K.T. Harper. 2004. Two-year annual monitoring report. 2003 and 2004. *Astragalus ampullarioides*, Shivwits milkvetch. Utah Valley State College, Orem, UT.

Wagner, C. A. 1936. Master Plan - Vegetation Type Map Grand Canyon. Pages Vegetation type map, standard from the Cal Dept. of Forestry, applied to Grand Canyon. Division, editor. Department of the Interior, National Park Service, San Francisco, CA.

Waring, G. L. 1995. Current and historical riparian vegetation trends in Grand Canyon, using multitemporal remote sensing analyses of GIS sites U.S. Department of Interior, Bureau of Reclamation, Glen Canyon Environmental Studies Office., Flagstaff, AZ.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982. Vegetation of Grand Canyon National Park. University of Arizona, Tucson.

Webb, R. H. 1996. Grand Canyon : a century of change : rephotography of the 1889-1890 Stanton Expedition. University of Arizona Press, Tucson.

White, M. A. and J. L. Vankat. 1993. Middle and high elevation coniferous forest communities of the North Rim region of Grand Canyon National Park, Arizona, USA. Vegetatio 109:161-174.

II. Project Overview

This section of the report serves to describe, in general terms, the overall progress of the project through all phases of work. The section also includes a description of the partners who contributed significantly to the project and what their responsibilities were. The discussion then covers the decision to use digital aerial imagery rather than aerial photography or satellite imagery. Later sections provide greater detail on each project task; Chapter 4 describes vegetation sampling, Chapter 5 covers methods and results of the vegetation classification, and Chapter 6 covers both the mapping and accuracy assessment tasks.

Project Boundary

The project boundary includes all lands within Grand Canyon National Park and those portions of Grand Canyon – Parashant National Monument under the administrative jurisdiction of Lake Mead National Recreation Area (Figure 1). The Grand Canyon National Park portion of the project area covers 1,958,802 km^2 (1,217,403 acres). The Grand Canyon–Parashant National Monument portion covers 341,577 km^2 (212,292 acres). The imagery analyzed included a 0.4 km (0.25 mile) boundary around the project area. However, because these areas are not part of the mapping area of interest, they were not included in accuracy assessment nor are they considered a formal part of the products developed for this project.

Project Partners and Project Agreement

Because of the size of the project area and the magnitude of the logistical, botanical and administrative challenges presented by an undertaking of this size, a project agreement was created between Grand Canyon National Park and the NPS-VIP (then called the "NPS Vegetation Mapping Program") to clearly define roles and responsibilities, and to prevent important tasks from being overlooked. The text of the original agreement and the modifications made to it is attached to this report as Appendix A.

Table 2 lists the primary partners on this project and summarizes their respective roles and responsibilities.

General Process

Vegetation mapping projects consist of three primary tasks: sampling vegetation to cover as much of the ecological variation as possible, classifying vegetation into distinct and standardized units, and mapping the distribution of these units across the project area. These tasks were completed more or less in order with some overlap between components. Once sampling was begun, the project took just over five years with the dedicated cooperation of many participants. The size, remoteness, difficulty and wilderness character of the project area, the inclusion of multiple National Park Service units, and the application of novel technology all contributed to making this an exciting project.

Extensive discussions between Grand Canyon National Park and the NPS-VIP related to initiating the project began prior to a scoping meeting in 2000. Topics included the project scope, field sampling methods, wilderness character issues, access and logistics, roles and responsibilities, and the possibilities for incorporating new technologies to move the project forward as rapidly as possible. A project agreement was drawn up to assign project responsibilities for each step (Appendix A). The NPS-VIP contracted with an environmental consulting firm, (e^2M), to produce a project workplan to serve as a guide on the timing, scope and expected costs of all phases of the project (von Loh 2006).

These discussions culminated with a major planning meeting held in Flagstaff, AZ in October 2006 on the campus of Northern Arizona University. Participants included representatives from Grand Canyon National Park, NPS Biological Resources Management Division, the NPS Southern Colorado Plateau Network, NPS Inventory and Monitoring Program, U.S. Geological Survey Biological Resources Division, and several cooperators and contractors (Table 3.). It

Table 2. Primary partners on the project and their roles and responsibilities	
Primary partners	**Roles and responsibilities**
Grand Canyon National Park	• Overall project leadership. Provides project management and day-to-day administrative functions. • Compilation of final data products for delivery to USGS – NPS Vegetation Inventory Program, including reports, data, photographs, vegetation descriptions and keys, spatial data and metadata • Arranges funding for 10 – 15% of total project budget through funding Vegetation Mapping Coordinator position and activities. • Provides liaison between project activities and Tribal stakeholders • Provides lead on project-specific contracting and agreements via providing CO, COR and ATR services for field crews, data entry, description writing, field key testing, remote sensing, mapping and accuracy assessment. • Provides logistical and safety support for field work
NPS Vegetation Inventory Program and NPS Inventory and Monitoring Program	• Arrange funding for 85 – 90% of the cost of the project • Lead for acquisition of sampling design, field equipment, vegetation classification and remote sensing services • Assist in RFP process through review of scope of work, products, schedule of deliverables, and as a technical expert in proposal review • Review classification and mapping classes to ensure consistency with national program and Federal Geographic Data Committee standards. • Provide guidance on incorporation of new National Vegetation Classification Standard and National Vegetation Mapping Program directions. • Primary responsibility for services relative to National Vegetation Classification Standard through agreements with NatureServe.
Grand Canyon – Parashant National Monument	• Reviews and advises on work plans and project products • Provides logistical and safety support as necessary • Provides information relevant to mapping activities.
Northern Arizona University	• Project lead for field sampling and database entry • Project lead for electronic data collection solution design and support • Provides botanical expertise in writing local vegetation descriptions and testing of field keys
NatureServe	• Project lead for vegetation classification • Vegetation data analyses and development of vegetation classification, including descriptions of vegetation classes and placement of classes in current National Vegetation Classification Standard hierarchy • Development of the vegetation field key • Provide training for vegetation plot sampling, and annual reviews of field samples • Provide documentation of methods and results of vegetation classification
Kass Green & Associates (d.b.a. Alta Vista Company)	• Project lead for vegetation mapping and accuracy assessment • Development of map classification • Interprets imagery via automated image segmentation and semi-automated segment classification • Design and execution of map calibration and calibration sampling • Design and execution of accuracy assessment • Develop spatial database products of vegetation sampling plot locations, calibration site locations, accuracy assessment site locations, vegetation map and project boundary • Supports all database products with FGDC – compliant metadata • Provides documentation of methods and results of mapping and accuracy assessment activities.
Other Project Partners	• Engineering-Environmental Management (e^2M) provided interim project management, remote sensing, sampling analysis, field equipment surveys, and field data collection services at the outset of the project. • CoganTech, Inc. (CTI) provided spatial analyses, including gradsect analyses and testing of sampling plans during project planning. • Utah State University provided database services after field work was completed. • USGS / Grand Canyon Monitoring and Research Center provided imagery and data from the Colorado River Corridor riparian communities. • US Bureau of Reclamation assisted with initial planning for aerial imagery acquisition and acquiring contractors for that purpose.

Table 3. Participants in the Project Planning Meeting	
Affiliation	**Name**
National Park Service Grand Canyon National Park • Biological Resources Management Division • Inventory and Monitoring Program • Southern Colorado Plateau Network	Jan Balsom, Eric Gdula, Lori Makarick, Steve Mietz, Mary Rasmussen Karl Brown Chris Lea Chris Lauver
U.S. Geological Survey • Grand Canyon Monitoring and Research Center	Barbara Ralston
Supporting contractors and cooperators • NatureServe • Engineering-Environmental Management (e2M) • CoganTech, Inc. • Northern Arizona University	Marion Reid Jim von Loh, Margaret Foderaro Dan Cogan Mike Kearsley

should be noted that this meeting preceded the addition of Grand Canyon-Parashant National Monument lands to the project area and did not include representatives from the monument. The meeting resulted in a reaffirmation of roles, the scope of the NPS-VIP and this project, a summarization of the project agreement and workplan, and a discussion the project timeline, logistics and staffing.

Before sending crews into the field to sample vegetation, tests and reviews were conducted of several methods and technologies. Automated image segmentation was performed at the far west end of the park (Cogan 2006) to test its potential usefulness to this project. A gradsect analysis was conducted for all of Grand Canyon National park which was designed to be used to guide sampling plans (Cogan 2007). A field equipment group comprised of NPS and e^2M contractor staff evaluated electronic field data collection equipment for use by vegetation sampling crews (von Loh and Foderaro 2006).

Grand Canyon personnel reviewed legacy data sets from the numerous studies of vegetation within the park (see Chapter 2: Introduction) to determine whether any could reliably contribute to the vegetation classification. Data sets were placed into one of three categories. Data sets were deemed useful for both classification and mapping if they included both woody and herbaceous species and measures of abundance. Other data sets were judged useful for mapping but not for classification if they contained data on only dominant species, or had abundance measures which could not be easily interpreted. Most data sets were not detailed enough to be useful for either classification or mapping. Data sets in the first two categories required reformatting to be made useful (Table 4).

Administration of field crew work involved a contract and cooperative agreements. In February 2007, eight botanists with substantial experience with Colorado Plateau botany were retained through a contract between the National Vegetation Inventory Program and e^2M environmental consultants. After the first four field sessions, responsibility for field crew services became the responsibility of Northern Arizona University via a cooperative agreement. In 2008, a Cooperative Agreement with Northern Arizona University was used for all vegetation sampling expertise.

Because of timing and weather patterns, field sampling in 2007 and 2008 were conducted in different parts of the mapping area. With a dry winter in 2006-2007 and a late start to sampling, 2007 sampling was focused on higher elevation forests, woodlands and meadows (Figure 2). In 2008, most sampling was done below the rim (Figure 3). Data entry began in the winter of 2007

Table 4. Data sets determined to be useful in mapping and vegetation analysis by Grand Canyon staff (Makarick and Mietz, unpublished data).

Data Set	Class*	Comments
River vegetation map (Ralston et al. 2007)	I	USGS vegetation map based on May 2002 aerial imagery
Fire effects monitoring plots (Grand Canyon Fire Effects staff, unpublished data)	I	North- and south rim forest and woodlands, 1989 - 2006
Thompson Canyon (White and Vankat 1993)	I, III	Mixed conifer and spruce – fir vegetation repeat surveys from 1984 and 2005
Branch of Forestry Resample (Vankat 2011a, b)	I	Resample of forest and woodland plots in the 1935 Wagner et al. vegetation map
Ecological Restoration Institute (Fulé 2004, 2005, Fulé and Laughlin 2007)	I	Forest plots surveyed for restoration research 1997 - 2005
Vegetation mapping plots (Warren et al. 1982)	II	Plots surveyed in all parts of Grand Canyon N.P. for vegetation mapping
Fishtail Mesa plots (Brian and Rowlands 1998)	II	Vegetation plots surveyed in 1956 and 1996 in eight transects on Fishtail Mesa
Backcountry inventory plots (Unpublished data)	I, II	Paired campsite / non-campsite plots in desertscrub, pinyon-juniper and riparian areas
Tamarisk management data (Belote et al. 2012)	I	Plot and transect surveys in a limited number of tributaries being treated

*Utility class: 1 = adequate for classification and mapping, II = adequate for photo interpretation and accuracy assessment; III, IV, V = not useful for mapping or analysis.

and continued through 2008, although the electronic data collection system available in 2008 eliminated the need for entering almost all of the 2008 data.

Vegetation classification took place between 2008 and 2010. Analysis proceeded from the higher elevation plots to the lower elevation areas, in keeping with the sequence that had been developed for the mapping. NatureServe conducted a series of analyses which classified the plot data into existing vegetation Associations, provisional vegetation Associations, or "Park Specials," depending on whether the type had been documented elsewhere and the relative commonness of the type in the mapping area. Three products resulted from the analysis: a descriptions document, containing local and global descriptions of all vegetation Associations encountered, a table placing the Associations in the NVC hierarchy, and a dichotomous field key to the vegetation Associations. Northern Arizona University field crew members provided valuable assistance to the descriptions and key, and Kass Green & Associates produced a separate field key to high elevation vegetation because they were mapping while the classification and key-writing concluded. In total, 223 vegetation Associations were described from the project area data.

Mapping was performed using an innovative combination of automated image segmentation and partially supervised segment classification. Imagery acquired from the U.S. Department of Agriculture's National Agricultural Inventory Program (NAIP) in 2007 and 2010 was found to be sufficiently detailed (1-meter pixels) and minimal flaws, including shadowing and image smearing, to be used. With reviews from Grand Canyon personnel and in-house experts, Kass Green & Associates performed computerized image segmentation using eCognition software. These image segments were assigned to map classes using Classification and Regression Tree (CART) analysis, an automated process that took advantage of the wide array of ancillary data such as slope, aspect, elevation, fire history, geology, soils, and hydrology in addition to reflectance properties. The results of CART analysis in preliminary maps were adjusted with additional calibration data and editing to produce the final map.

Aerial Imagery

Aerial imagery is at the heart of large mapping projects like this one. An aerial view of the project area provides mappers with the basic information – color, texture and relationship to adjacent areas – mappers need to differentiate land cover classes from each other.

After extensive discussions in 2005 and 2006, it was decided to acquire project-specific digital aerial imagery for the project area. Satellite imagery would have been too coarse, and printed aerial photographs

require far too much processing to be workable on such a large project. In late July of 2007, Grand Canyon personnel learned of the U.S. Department of Agriculture's National Agricultural Inventory Program (NAIP) imagery for Arizona. The project area was included in the 1-meter pixel, four-band digital imagery taken in mid-July at the point of maximum "green-up" for the year. An examination of the imagery, using 200 random locations throughout the project area, showed that the level of shadowing and smearing were low enough to be acceptable for mapping. Funding which had been programmed for an Interagency Agreement with the Bureau of Reclamation's Remote Sensing and GIS Office for imagery procurement was reprogrammed to support field crews for the remainder of the 2007 field season.

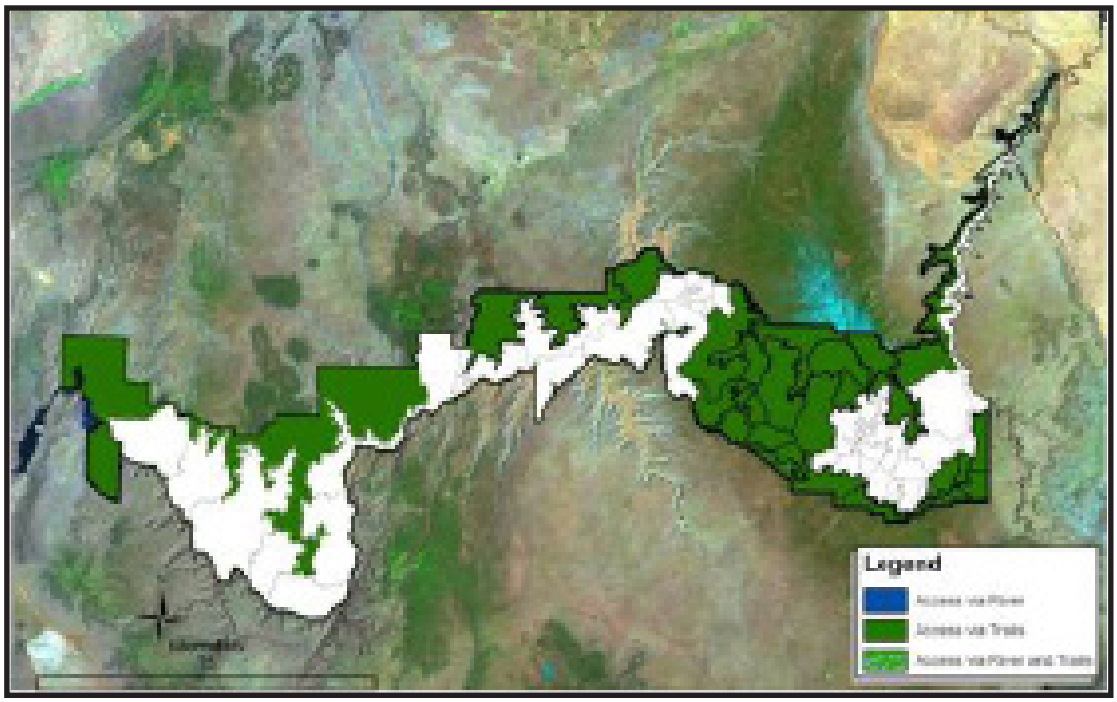


Figure 2. Areas sampled in 2007.

All surveys were accessed from roads and trails.

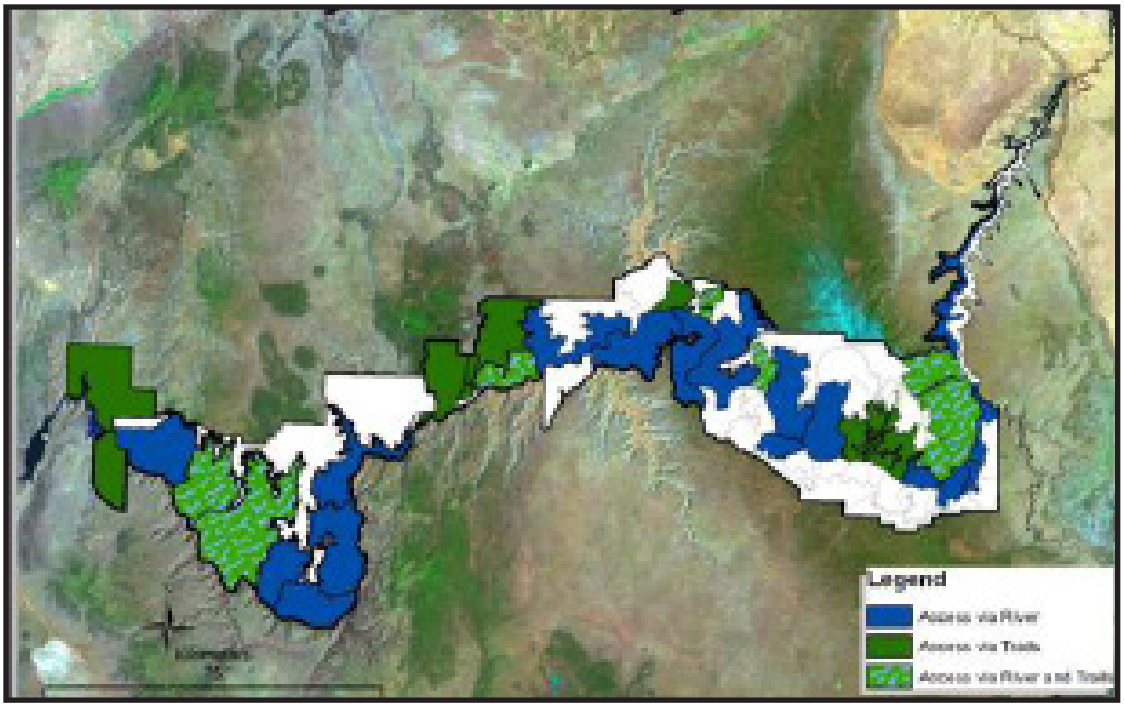


Figure 3. Areas sampled in 2008.

Access to backcountry areas was achieved via a combination of roads and trails from the rims and up drainages from river trips.

Mapping Phases

Because the mapping area was large, diverse, and challenging, and because of funding uncertainties, mapping was planned as three separate phases, each lasting one year (Figure 4). The project area was divided up based on floristic, logistical and management considerations. Each phase covered an area that had some floristic coherence so that most or all of each vegetation type would be sampled in one phase to the greatest extent possible. Areas of similar vegetation might be split into two phases if sampling all at once would add a lot of logistical costs. For example, smaller areas of *ponderosa* pine forests on Mt. Trumbull were not mapped in first phase because they were much smaller than and so far from similar forests surrounding the developed areas of the park.

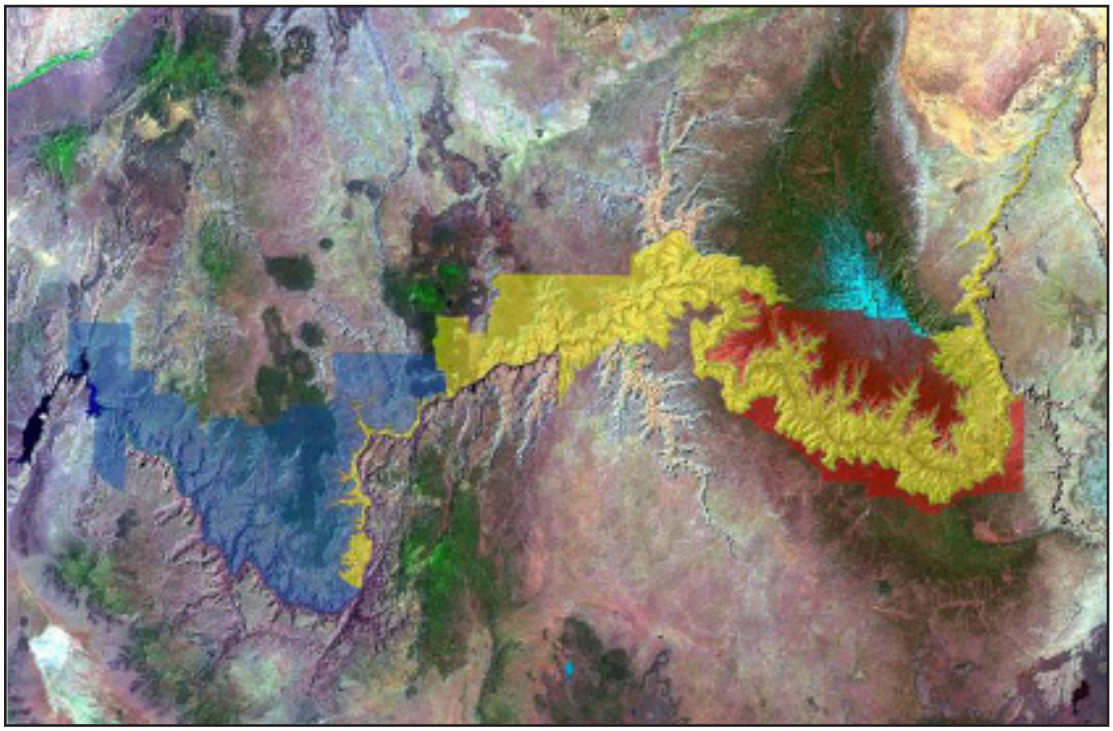


Figure 4. Mapping phases.

Phase 1 (red) included the rim areas down to the Redwall limestone. Phase 2 (yellow) covered the inner canyon from Lees Ferry to Diamond Creek, plus western area rims. Phase 3 (blue) included Lake Mead N.R.A. and Grand Canyon N.P. downstream of Diamond Creek.

Phase 1 covered areas of eastern Grand Canyon National Park from the top of the rims down to the bottom of the Redwall Limestone (Figure 4), containing most of the forest and woodland communities in the project area. These areas were the first to be mapped because they are the most heavily visited and most intensively managed parts of the mapping area. The Redwall Limestone was chosen as a natural, easily recognized boundary because it almost always forms sheer cliffs from 120 – 180 meters (400 – 600 feet) thick, separating rims from inner canyon areas.

Phase 2 included areas below the Redwall limestone from the northeast boundary of the park at Lees Ferry to the area around Two Hundred and Twentymile Canyon. It also covered rim areas around Kanab Point and Tuckup Point, Tuweap and Mount Emma. In areas west of Tuweap, the boundary followed the bottom of the Redwall Limestone again. Because many of the Phase 2 areas would have to be accessed from the Colorado River rather than the rims, the western phase boundary was placed just above Diamond Creek, the first point at which it would be possible to take a river trip out after it launched at Lees Ferry, some 364 kilometers (226 miles) upstream.

Phase 3 included all the rim areas of Grand Canyon–Parashant National Monument within the mapping area (Shivwits Plateau, Suicide Point, Twin Point, Tincanebitts Point, and Fort Garret Point) plus the inner canyon areas of Lower Granite Gorge, and the broad expanses of the Sanup Plateau and the Esplanade area surrounding Whitmore Canyon.

The rim portions of this phase were accessible primarily from the west; St. George, Utah, where Monument Headquarters is located, was the main point of access. Inner canyon areas were mostly accessed from a river trip which launched at Diamond Creek and took out at South Cove on Lake Mead. In addition, Phase 3 work required that all three phases be seamlessly combined and that the USGS Colorado River riparian areas map (Ralston 2007) be stitched in as well.

In order to make each phase's maps useful immediately, validation and accuracy assessment were performed as each map was completed and submitted separately. The validation step was introduced by the National Vegetation Inventory Program after the Project Agreement and to avoid having to accept maps with excessively low accuracy. When a vegetation map class was found in significant amounts in two phases, the decision could be made to postpone the accuracy assessment for that class until the later phase was completed. For example, many *Pinus edulis – Juniperus osteosperma* (pinyon-juniper) map classes occurred both above- and below the rim, so accuracy assessment on Phase 1 areas of these classes was pushed into Phase 2.

Interim meetings and reports

Many interim meetings were held during this project to discuss progress and plan strategies for project activities. Table 5 lists the major meetings and conference calls. In addition to these formal meetings, more informal meetings and conference calls were organized throughout the project period.

Beginning in 2010, project partners collaborated through monthly check-in calls, ad-hoc discussions of issues as they arose, progress meetings and planning meetings. Open communication was key to the success of the project, and the use of on-line collaboration tools from simple conference calls to screen-sharing software made the timely completion of the project possible.

Interim reports were submitted at various times. Northern Arizona University's Biology Department submitted reports documenting the results of vegetation sampling activities, vegetation key testing and local vegetation description writing (Christie et al 2010). The Ecosystem Restoration Institute at Northern Arizona University submitted a report which covered the creation, testing and deployment of the electronic field data collection solution programmed by their technical staff (Curran and Fule 2009). Working drafts of the vegetation descriptions document, vegetation hierarchy, and field key to vegetation Associations were created by NatureServe (NatureServe 2010). Kass Green & Associates provided interim mapping reports at the conclusion of each of the first two phases (Kass Green & Associates 2010, 2011), along with a draft of the report on the final phase of the mapping (Green and Tukman 2012).

Table 5. Major interim meetings and calls.

Date	Location	Purpose
Oct. 2007	Flagstaff, AZ	Progress meeting to discuss 2007 field season accomplishments
Jan 2008	Denver, CO	Budget and planning for 2008 field season, Data entry progress
Jun 2008	Call	Data entry progress, classification plans, mapping acquisition instruments
Feb 2008	Meadview, AZ	Planning and progress meeting combined with summer 2008 field sampling training.
Jul 2008	Call	Mapping expertise and acquisition instruments, plans for submitting request for interest via FedBizOpps
Dec 2008	Call	Discussion of data entry and database completion, strategies for vegetation classification, strategies for submitting request for proposals for vegetation mapping
April 2009	Grand Canyon N.P.	Pre-solicitation meeting with interested vendors to discuss methods, standards and schedules for vegetation mapping.
June 2009	Flagstaff, AZ	Source selection panel meeting to determine vegetation mapping contract awardee

Literature Cited

Ayers, T. J. and K. Christie. 2010. 2007 - 2008 Field Crew Support, Data Management, and Review Meetings for GRCA Vegetation Mapping. Final Report. Task Agreement J2340070031 / Cooperative Agreement H1200-004-0002. Northern Arizona University, Colorado Plateau Cooperative Ecosystems Study Unit., Flagstaff, AZ.

Belote, T. R., L. J. Makarick, M. J. Kearsley, and C. L. Lauver. 2010. Tamarisk removal in Grand Canyon National Park: changing the native - non-native relationship as a restoration goal. Ecological Restoration 28:229-239.

Brian, N. J. and P. G. Rowlands. 1998. A resurvey of the vegetation and soils of Fishtail Mesa, Grand Canyon National Park, Arizona. Grand Canyon National Park, Grand Canyon, Ariz.

Fule, P. 2004. Changes in canopy fuels and potential fire behavior 1880-2004 : Grand Canyon, Arizona. Elsevier Science, New York.

Fule, P. 2005. Pine-oak forest dynamics five years after ecological restoration treatments, Arizona, USA. Forest Ecology and Management 218:129-145.

Fule, P. Z. and D. C. Laughlin. 2007. Wildland fire effects on forest structure over an altitudinal gradient, Grand Canyon National Park, USA. Journal of Applied Ecology 44:136 -146.

Cogan, D., J. V. Loh, S. Spratlen, and M. Foderaro. 2006. Gradsect analysis Grand Canyon National Park. e2M Engineering - Environmental Management, Englewood, CO.

Green, K. and M. Tukman. 2010. Grand Canyon vegetation mapping : Phase 1 final report. Kass Green and Associates, Berkeley, CA.

Green, K. and M. Tukman. 2011. Grand Canyon vegetation mapping : Phase 2 final report. Kass Green and Associates, Berkeley, CA.

Green, K. and M. Tukman. 2012. Grand Canyon Vegetation Mapping. Phase 3 Final Report. Kass Green and Associates, Berkeley, CA.

Ralston, B. E. 2007. A vegetation database for the Colorado River ecosystem from Glen Canyon Dam to the western boundary of Grand Canyon National Park, Arizona. U.S. Department of the Interior, U.S. Geologic Survey, Grand Canyon Monitoring and Research Center, Flagstaff, Ariz.

Vankat, J. L. 2011a. Post-1935 changes in forest vegetation of Grand Canyon National Park,Arizona, USA: Part1 – *ponderosa* pine forest. Forest Ecology and Management 261:309-325.

Vankat, J. L. 2011b. Post - 1935 changes in forest vegetation of Grand Canyon National Park, Arizona, USA: Part2 — Mixed conifer, spruce-fir, and quaking aspen forests. Forest Ecology and Management 261:326-341.

Von Loh, J. 2006a. Work Plan, Volume 1. Vegetation Classification and Mapping Project. e2M Engineering - Environmental Management, Englewood, CO.

Von Loh, J. 2006b. Work Plan, Volume 2. Vegetation Classification and Mapping Project. e2M Engineering - Environmental Management, Engelwood, CO.

Von Loh, J., S. Spratlen, and M. Foderaro. 2007. Electronic Field Equipment Grand Canyon National Park Summary Report. e2M Engineering - Environmental Management, Englewood, CO.

Warren, P. L., K. L. Reichardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982. Vegetation of Grand Canyon National Park. Technical Report No. 9. University of Arizona Cooperative National Park

Resources Studies Unit, Tucson, AZ.

White, M. A. and J. L. Vankat. 1993. Middle and high elevation coniferous forest communities of the North Rim region of Grand Canyon National Park, Arizona, USA. Vegetatio 109:161-174.

III. Vegetation Classification Data Collection

This section of the report will describe project activities related to collecting data used in the classification stage. It desc*Ribes* pre-fieldwork activities, sampling strategies used, plot survey methods, and database construction. Early work through the first three sessions of field data collection was coordinated by e^2M, Inc. (environmental engineering Management, Incorporated) through a contract designed to get crews organized and trained as quickly as possible. The rest of the classification data activities were performed through a series of Cooperative Ecosystem Studies Unit task agreements between Grand Canyon National Park and Northern Arizona University. The arrangement made full use of the regional botanical expertise and programming abilities their staff possessed. Final reports from e2M and Northern Arizona University form the basis of this chapter.

Preliminary Activities

Preliminary Associations List

During the scoping process, the need for a list of potential vegetation Associations was identified as a priority. The list would provide field crews with a list of standard choices from which to determine the vegetation type being sampled. Furthermore, the standard list would simplify the process of the actual vegetation classification because classifiers would be given a head start on placing plots into vegetation types. Details of the process used to generate the list are described in the Vegetation Classification chapter of this report.

Electronic Field Data Collection Systems

In early discussions about this project, electronic data collection was identified as a priority because of the anticipated complexity and size of the data set. In the end, electronic data collection was used during three phases of the work: classification data collection, map calibration, and accuracy assessment. Each had very specific and different data requirements and structure. An early attempt at a single solution for all phases (von Loh et al. 2007) involving Thales (Magellan) Mobile Mappers running ArcPad 6.x failed due to programming limitations and the complexity of the project. Instead, two entirely different systems were created for this project: a inexpensive and technologically simple system for collecting detailed botanical, structural and environmental data for vegetation classifiers, and a technologically sophisticated system for the simple vegetation data and precise geographic information for mapping and accuracy assessment.

The first system was programmed and assembled through an Assistance Agreement with Northern Arizona University's Ecosystem Restoration Institute (ERI). It was similar to one in use at ERI for collecting forest floristics and structure data in support of long-term studies of fire impacts. Inexpensive Palm Tungsten2 Personal Digital Assistants (PDAs) for each crew replaced the single, powerful Mobile Mapper, and all crew members could collect subsets of the data independently. Data forms were programmed in PenDragon® Forms for the PDAs. The programming included built-in error-checking for most variables using range limits, pick lists and character counts. The application was office- and field-tested five times before the first sampling session in 2008. It was released to the field crews during training in February of 2008.

The second system was created during the mapping and accuracy assessment phase and is described in Chapter 6 of this document. Field forms were created in MS Visual Basic to run on field computers in ESRI ArcMap. The application collected data on only the common and dominant plants within imagery segments in order to classify them into vegetation Associations via a key.

Biophysical Modeling

The purpose of vegetation data sampling was to collect data to allow the classification of all vegetation in the mapping area into National Vegetation Classification Standard – compliant plant Associations. The sampling had to be sufficiently broad to include all the

Table 6. Biophysical Unit (BPU) Key and Classes		
Hydrology	**Solar**	**Vegetation**
1000 = Riparian	100 = Full Shade (0 – 1 hr daylight)	1 = Barren
2000 = Uplands	200 = Partial Sun (2 – 4 hrs daylight)	2 = Cold Desert Scrub
	300 = Partial Shade (5 – 7 hrs daylight)	3 = Mixed Conifer
	400 = Full Sun (8 – 9 hrs daylight)	4 = Pinyon Pine / Juniper
		5 = Ponderosa Pine
		6 = Riparian
		7 = Spruce – Fir
		8 = Warm Desert Scrub
		0 = No Vegetation Data (areas in environs)

vegetation type present, but also of sufficient depth to allow the full range of composition present within these Associations to be accounted for. The imposition of time and budgetary constraints created a need for efficiency.

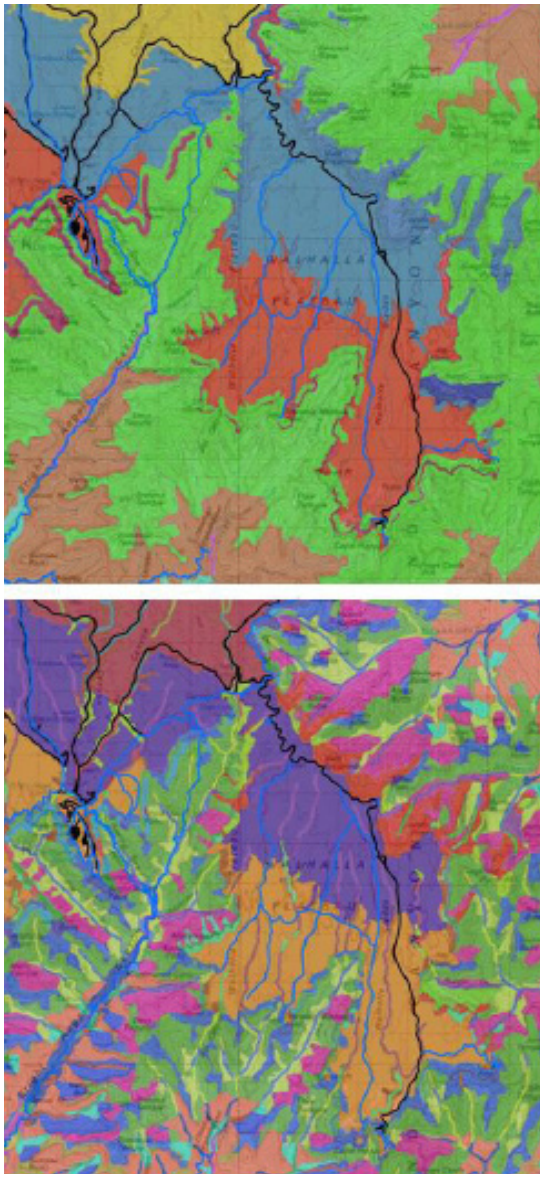


Figure 5. Calculation of biophysical units.

Upper: Vegetation classes in biophysical unit modeling: yellow = spruce-fir, blue = mixed conifer, red = Ponderosa Pine, green = cold desert, orange = warm desert, blue = riparian. Lower: Biophysical units including vegetation, solar input and riparian status. Roads are in black, trails are in blue. From Cogan et al. 2006

In order to direct classification sampling in a way that maximizes the breadth of environmental variability encountered while minimizing costs, the NPS-VIP in 2007 suggested the use of gradsect analysis and cost surfaces when planning for samples in large and very large parks (Nature Conservancy 1997). A gradsect analysis divides the mapping area into biophysical units (BPUs) which represent similar ranges of important environmental variables such as elevation, surface geology, soils and slope aspect (Austin and Heyligers 1989, 1991). A cost surface ranks the difficulty of reaching a particular area.

A gradsect analysis was performed and combined with a cost surface for the mapping area (von Loh et al 2006). Biophysical units were created based on classes of hydrology, solar, and vegetation formations listed in the 1982 Grand Canyon vegetation map (Table 6; Figure 5). Areas representing consistent biophysical unit values were delineated in polygons, and the resulting map of biophysical units was exported as a shapefile. Once the biophysical units were delineated, a "cost to access" was generated using slope values (at polygon centers) and distance from polygon centers to the nearest road or trail. The presence of cliffs or canyon on that path moved the cost for a biophysical unit to the highest cost class. The cost metric for accessing other polygons was calculated as the product of the slope scale value and the distance scale value (Table 7, figure 6).

Table 7. Cost metric for accessing polygons		
Cost Surface Calculations		
Slope Cost	**Distance Cost**	**Surface Soils**
100 = Easy (0° - 10°)	10 = 0 – 1 km	1 = Easy (0 – 2000)
200 = Moderate (11° - 20°)	20 = 1 – 2 km	2 = Moderate (2001 – 10000)
300 = Steep (21° - 30°)	30 = 2 – 3 km	3 = Strenuous (10001 – 20000)
400 = Impassable (> 30°)	40 = 3 – 4 km	4 = Impassable (> 20000)
	50 > 4 km	

Data Sheets

Although plans for data collection for this project called for electronic solutions, hand-written data sheets were used for most of 2007 and as backup in 2008. Sets of data sheets which had been used by other NPS units was assembled in 2006. Data sheets covering four subjects were available: Classification plot locality and environment, classification plot species and strata, observation point locality and species cover, and fuels.

As with mapping projects in previous parks, the sheets were modified to meet this project's own requirements. One area was added to the observation point data sheets to include information on the presence and, if appropriate, treatment of noxious exotic plant species. A second area was carved out of the same sheet to record information about the presence and abundance of special status species, even if no other plot data was collected. Based on feedback from field crews, the sheets continued to be modified for other reasons such as streamlining work flow and allowing separation of plot tasks into logically coherent groups. The data sheets in their final form are included in Appendix G of this report.

Field Crew Training

Field crews were given extensive training in 2007 in protocols and equipment with an emphasis on electronic data collection, standard operating procedures for safety and check-ins, and sampling methods. In March of 2007, field crews met for four days with NPS and NatureServe personnel to go over protocols in addition to training with digital cameras, high-end recreational GPS units, photo processing software, data collection methods and requirements, and the first of two electronic field data collection application (Magellan Mobile Mappers). After a day and a half of lectures and training in

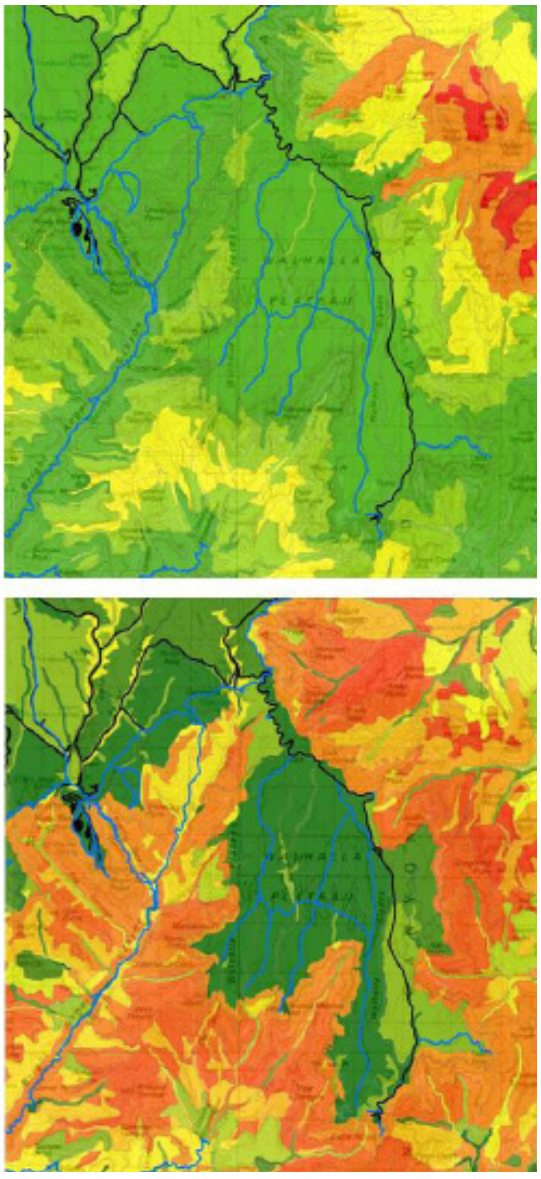


Figure 6. Cost surface modeling.

Upper: Distance cost Dark green = 0 – 1km, light green = 1 2km, yellow = 2 – 3 km, orange = 3 – 4 km, red > 4 km.
Lower: Final cost classes including distance cost, slope cost and cliff costs. Roads are in black, trails are in blue. From Cogan et al. 2006

Flagstaff, crews moved to Grand Canyon Village for field training. Several inches of fresh snow drove the crews back to Flagstaff where training concluded (Figures 7 and 8).

In 2008, the training was conducted in February and relocated to a lower elevation site by "the Hook" portion of Grand Canyon National Park outside Meadview, AZ. National Park Service and NatureServe personnel reviewed results from 2007, including vegetation types which had been adequately sampled and those which had not. Field training was performed on the new electronic data collection system. The time spent during that week also allowed crews to review safety, permitting, and compliance procedures.



Figure 7. Field training at the South Rim during a snow storm.



Figure 8. Field training moved to Flagstaff, beyond the snow storm.

Methods

Sampling Design

In 2007, two methods for efficiently distributing samples across the landscape were used. For the first two sessions, samples were to be allocated by using biophysical units from the gradsect analysis (von Loh et al. 2006). Mobile Mappers used real-time tracking of position relative to the biophysical units in the area to locate samples. When programming of the units to record vegetation data failed, this approach was abandoned. The second approach was similar in that plots were surveyed in different physical and biological settings, but relied instead on "rally points" in targeted vegetation types generated in the GIS. Data in the park's GIS, including aerial imagery from 2005, fire history maps, geological maps, topographic maps, soil maps and old vegetation maps were used to identify unique localities where vegetation should be sampled. Coordinates for points were generated and transferred to the crews' handheld GPS units. Crews were given discretion to survey interesting or unusual vegetation where they found it, while surveys at these rally points was performed. Small maps which showed rally points on both aerial imagery and 1:24,000 scale topographic maps were created for the crews to make navigation easier. Table 8 desc*Ribes* the areas surveyed in 2007 and the vegetation types that were the targets.

In 2008, rally points were again generated as necessary for forest and woodland areas. However, most surveys were conducted in inner canyon settings where crews could see patterns in the distribution of vegetation, geology and topography from the ground. There, field crews were given the latitude to create opportunistic sampling plot locations based upon their understanding of local vegetation patterns, the homogeneity of the landscape, and how frequently a vegetation type had been sampled already. Discussions with the crews before each session described why areas were chosen and which types of vegetation to look for. On three separate river trips, tributaries and intervening areas were targeted because they represented unique geological, topographic and biophysical settings. Land-based sessions were similarly targeted towards vegetation types and physical settings. Table 9 summarizes the rationale behind areas surveyed in 2008.

Classification Plots

Sample data collection consisted of three steps: establishment, plot survey and vegetation survey. This section will give an abbrevi-

Table 8. Backcountry areas sampled in 2007 with target vegetation types and target ecological, historical, physical and geologic features.

Session	Backcountry Area	Vegetation Types	Targets
1	Grand Wash Cliffs / The Hook	Mojave desertscrub , especially Joshua tree communities Management disclimax riparian (reservoir shoreline)	Test and training with Mobile Mapper electronic data collection and database synchronization application Young (Holocene / Miocene) alluvial deposits Young (Pleistocene) sedimentary /conglomerates
2	a. Tanner and Hance b. Ruby and Bass	a. Great Basin desertscrub and dry wash riparian (mesquite / acacia) b. Great Basin desertscrub	a. Precambrian sedimentary (Dox), Cambrian sedimentary (Bright Angel shale) and Permian sedimentary (Supai group) layers b. Precambrian sedimentary (Bass limestone), and metamorphics (Shinumo quartzite, Vishnu schist
3	a. Badger, Soap and Rider b. South and Cedar Mountain c. Kanab Creek	a. Great Basin desertscrub Dry wash riparian (Acacia / Mesquite) b. Great Basin desertscrub Dry wash riparian (Acacia / Mesquite), Great Basin Pinyon / Juniper woodlands c. Esplanade communities, tributary riparian	a. Deeply incised tributaries in Kaibab limestone and Coconino sandstone layers of Marble Canyon b. Marble Canyon tributaries and rim areas in southeast portions of the park c. Permian sedimentary (Supai group) layers
4	a. Tuckup Point b. Kanab Point	a. Great Basin pinyon – juniper communities b. Great Basin pinyon – juniper communities	a. Limestone Rims on north rim b. Limestone rims on north side of canyon
5	a. Widforss and Outlet b. Ken Patrick and Walhalla Plateau eastern boundary	a. Great Basin pinyon – juniper communities, rim-area ponderosa pine communities b. Great Basin pinyon – juniper communities, rim-area ponderosa pine	a. Drainages and rim areas on high-elevation limestone b. Drainages and rim areas on high-elevation limestone
6	a. Powell Plateau Blacktail, Fire Point, and Swamp Point b. Outlet and developed areas	a. Great Basin desertscrub Tributary riparian Ponderosa herbaceous woodland areas. b. Ponderosa pine woodlands and rim wooded shrublands	a. Permian sedimentary (Esplanade and Supai members) layers and isolated communities on Powell b. Drainages and rim areas on high-elevation limestone
7	Point Sublime and Swamp Ridge	Ponderosa pine woodlands Lower elevation mixed conifer Rim wooded shrublands Seep and spring vegetation	Drainages and rim areas on high-elevation limestone
8	Walhalla Plateau	Ponderosa pine woodlands with and without recent fire activity Lower elevation mixed conifer Rim wooded shrublands Seep and spring vegetation	Drainages and rim areas on high-elevation limestone, springs and seeps
9	Robbers Roost	Ponderosa pine woodlands Lower elevation mixed conifer Rim wooded shrublands Seep and spring vegetation	Drainages and rim areas on high-elevation limestone, springs and seeps
10	Swamp Ridge and Robbers Roost	Higher elevation ponderosa pine woodlands with and without recent fire activity Higher elevation mixed conifer Seep and spring vegetation	Drainages and rim areas on high-elevation limestone, springs and seeps
11	Thompson Canyon, north end	Higher elevation ponderosa pine woodlands with and without recent fire activity Higher elevation mixed conifer Seep and spring vegetation	Drainages and rim areas on high-elevation limestone, springs and seeps
12	a. Cape Solitude, Cedar Mountain, Tusayan Ruin, and Long Jim b. Eremita mesa, Pasture Wash, Signal Hill, and South Rim	a. Low elevation ponderosa pine wood lands Great Basin pinyon – juniper woodlands springs and seeps b. Low elevation ponderosa pine, Great Basin pinyon – juniper woodlands, springs and seeps	a. Drainages and rim areas on south rim limestones. b. Drainages and rim areas on south rim limestones.
13	a. Garnet and Bass b. Bass, Ruby, and Slate	a. Great Basin desertscrub Dry wash riparian (mesquite / acacia) Seeps and springs. b. Great Basin desertscrub Dry wash riparian (mesquite / acacia) Seeps and springs	a. Permian sedimentary (Esplanade, Supai and Hermit) layers in western b. Cambrian sedimentary (Bright Angel shale, Tapeats sandstone) and Precambrian metamorphic (Vishnu schist)

Table 9. Backcountry areas sampled in 2008 with target vegetation types and target physical – geologic features. Because of the extended time spent during river trips, the total days in the field on by these nine sessions listed below are equivalent to 13 eight-day land sessions.

Session	Backcountry Area	Vegetation Types	Targets
Training	Hook	Mojave desertscrub Dry wash mesquite / acacia riparian	Test and training with Palm-based electronic data collection and database synchronization application Young (Holocene / Miocene) alluvial deposits Young (Pleistocene) sedimentary /conglomerates
1	a. Trinity Creek	a. Desert riparian, dry wash riparian (mesquite / acacia) and transition desertscrub	a. Cambrian sedimentary (Bright Angel shale) and Precambrian metamorphics (Vishnu schist)
	b. North Bass	b. Great Basin desertscrub	b. Precambrian sedimentary (Bass limestone), and metamorphics (Shinumo quartzite)
	c. Fossil	c. Disjunct Canotia stands Great Basin desertscrub	c. Permian sedimentary (Supai group) and Aeolian dune areas
	d. The Dome	d. Great Basin – Mojave transitional desertscrub	d. Cambrian sedimentary (Muav limestone)
	e. Trail Canyon	e. Mojave desertscrub	e. Precambrian metamorphics (Vishnu Schist, Shinumo quartzite)
2	Parashant / Grand Wash Bay	Mojave desertscrub Management disclimax riparian	Recent surficial deposits (Tertiary and Quaternary gravels, alluvial and aeolian deposits.
3	a. South Canyon	a. Great Basin desertscrub Great Basin dry wash riparian (acacia / mesquite)	a. Permian sedimentary (Supai group) and Mississippian sedimentary (Redwall limestone) layers
	b. Saddle Canyon	b. Great Basin desertscrub Tributary riparian	b. Permian sedimentary (Supai group) and Mississippian sedimentary (Redwall limestone) layers
	c. Nankoweap	c. Great Basin desertscrub Seep and spring vegetation Great Basin Pinyon / Juniper woodlands	c. Permian sedimentary (Supai group and Hermit shales), Mississippian sedimentary (Redwall limestone), Cambrian sedimentary (Bright Angel shale) and Pre-Cambrian sedimentary (Nankoweap, Galeros, and Kwagunt formations) layers
	d. Chuar	d. Great Basin desertscrub, springs Pinyon / Juniper	d. Precambrian sedimentary (Kwagunt and Galeros formations) layers
	e. Cardenas and Unkar	e. Great Basin desertscrub, springs Pinyon / Juniper	e. Precambrian sedimentary (Dox formation) and intrusive (Diabase dikes) layers, plus Tertiary gravels.
	f. Slate Creek, and Trinity Creek	f. Great Basin desertscrub, Seep and spring vegetation, Great Basin P/J woodlands, Tributary riparian	f. Cambrian sedimentary (Bright Angel shale, Tapeats sandstone) layers
	g. Scorpion Ridge	g. Peucephyllum woodland patches Great Basin desertscrub	g. Precambrian intrusive (Diabase) and sedimentary layers (Hakatai shales, Shinumo quartzite, Dox formation).
	h. Blacktail	h. Great Basin desertscrub, seep and spring vegetation, Great Basin Pinyon / Juniper woodlands, tributary riparian	h. Precambrian intrusives (Diabase sill), and sedimentary layers (Hakatai shales, Shinumo quartzite).
	i. Olo	i. Great Basin desertscrub, seep and spring vegetation, Great Basin Pinyon / Juniper woodlands, tributary riparian	i. Permian sedimentary layers (Esplanade sandstone, Supai group)
	j. Boysag	j. Halophyllic vegetation Seep and spring vegetation	j. Salty sedimentary (Muav limestone) layer.
	k. Parashant	k. Western Great Basin desertscrub, Western Great Basin Pinyon / Juniper woodlands	k. Permian sedimentary (Esplanade), Mississippian sedimentary (Surprise Canyon and Redwall limestones), Devonian sedimentary (Temple Butte limestone) layers.
	l. Diamond Creek and Separation	l. Mojave desertscrub, Mojave Pinyon / Juniper woodlands, tributary riparian	l. Cambrian sedimentary (Tapeats sandstone) layers of the western Tonto
	m. Surprise	m. Mojave desertscrub, tributary riparian, seep and spring vegetation	m. Cambrian sedimentary (Tapeats sandstone) layers of the western Tonto
4	a. Nankoweap, Chuar and Unkar	a. "Mountain brush" communities and well shaded Great Basin desertscrub	a. Deeply incised upper reaches of Marble Canyon tributaries. Areas infrequently visited by trained botanists.
	b. Tuweep / Toroweap	b. Transition and Mojave desertscrub Western Pinyon / Juniper woodlands	b. Quaternary pyroclastics (cinder cones), basalt flows, alluvial and flood plain deposits.
	c. The Dome	c. Transition and Mojave desertscrub Seep and spring vegetation Abundant annuals	c. Permian (Esplanade) sandstone, western end of Grand Canyon

Table 9. continued.

Session	Backcountry Area	Vegetation Types	Targets
5	a. Clear Creek and lower Bright Angel b. Phantom Creek c. Transept Canyon and upper Bright Angel	a. Great Basin desertscrub Tributary Riparian b. Great Basin desertscrub, Tributary Riparian, Seep and spring vegetation c. Great Basin desertscrub Tributary Riparian Seep and spring vegetation	a. Proterozoic metamorphic (Vishnu schist) and Precambrian sedimentary (Dox and Hakatai formation) and Cambrian sedimentary (Bright Angel) layers b. Permian (Esplanade) sandstone and Precambrian sedimentary (Hakatai and Bright Angel) layers c. Precambrian sedimentary (Hakatai and Dox formations, Shinumo quartzite) and intrusive (Diabase sill and dike)
6	a. North Bass b. Esplanade and Surprise Valley	a. Great Basin desertscrub, Tributary Riparian, Seep and spring vegetation b. Great Basin desertscrub, Tributary Riparian, Seep and spring vegetation	a. Cambrian sedimentary (Bright Angel and Tapeats) and Precambrian sedimentary (Dox, Shinumo quartzite, Bass limestn.) layers b. Permian sedimentary layers (Esplanade sandstone and Supai group) and landslide formation (Deer Creek slump)
7	a. Surprise b. Burnt Point	a. Mojave desertscrub, Tributary Riparian, Mojave Pinyon / Juniper woodland b. Mojave desertscrub, Tributary Riparian, Mojave Pinyon / Juniper woodland	a. Permian sedimentary layers (Esplanade sandstone and Supai group) in western Grand Canyon b. Permian sedimentary layers (Esplanade sandstone and Supai group) in western Grand Canyon
8	a. Fishtail b. Esplanade and Surprise Valley c. Diamond Creek	a. Great Basin desertscrub and pinyon / juniper woodland, Scrub oak woodlands b. Great Basin desertscrub Scrub oak woodlands c. Mojave desertscrub, Mojave desert grasslands, The great unknown Sanup Plateau vegetation	a. Permian sedimentary layers (Esplanade sandstone and Supai group) in central Grand Canyon b. Permian sedimentary layers (Esplanade sandstone and Supai group) and landslide formation (Deer Creek slump) c. Permian sedimentary layers (Esplanade sandstone and Supai group) in western Grand Canyon
9	Separation, Burnt Point, and Snap	Mojave desertscrub Mojave desert grasslands The great unknown Sanup Plateau vegetation	Permian sedimentary layers (Esplanade sandstone and Supai group) in western Grand Canyon

ated description of methods used to accomplish these steps.

Establishing the location of the plot required the crew to find points where target vegetation was homogeneous and representative of the vegetation in that area. Representativeness included both the species composition and the stratification of species in to structure. For example, a stand with 30% cover of white fir seedlings under a mature canopy of *ponderosa* pine is very different than a stand with both species in the canopy. Plots had to be more than 30 meters from boundaries with other vegetation types to avoid sampling transitions between two contiguous vegetation types.

Classification plots were almost all 20 *x* 20 meter squares with diagonals pointing north-south and east-west. Measuring tapes were run across the central point to the plot corners using a compass to determine direction. Although the National Vegetation Characterization Program (The Nature Conservancy 1994) recommended sampling dwarf-shrubland and herbaceous vegetation in 10 *x* 10 meter plots, the experience of crews in the field was that it took no longer to survey the larger plots, and standardizing the plot size made the sampling effort equal across all vegetation types. Exceptions to this rule were made for unusually shaped areas such as riparian fringes and dry wash vegetation in constrained canyons where plots were laid out as extended rectangles covering 400 m2.

Plot surveys included recording location information and environmental descriptions (Table 10). Plots were identified with a unique code based on NPS unit name (GRCA) and a 5-digit number whose first digit was zero, the second was the crew number (1 through 4, linked to GPS unit numbers), and a 3-digit number unique to the plot (0 through 499 in 2007, 500 through 999 in 2008). Crew 1 would have surveyed plots named GRCA.01009 and GRCA.01223 in 2007 and plots GRCA.01544 and GRCA.01632 in 2008. Plot location information included both general terms such as "North Rim" and site names like "Horseshoe Mesa," as well as specifics like GPS northing,

Table 10. General data categories and specific data components collected at classification plots.

Plot Data Category	Data Components
Location Information	Plot code, park name, site name, state, county, quad name, quad code, GPS unit, GPS file ID, UTM coordinates, UTM zone, GPS error, 3D differential, survey date, surveyor names, directions to plot, plot dimensions, photograph documentation
Environmental Description	Elevation, slope, aspect, topographic position, landform, geology, Cowardin wetland type, hydrologic regime, floodplain width and gradient, distance to water, standing water depth, ground cover, soil texture, soil drainage, evidence of disturbance and animal use
Vegetation Description	Height and cover of all strata, cover by species, physiognomic type, provisional association name, plot representativeness
Fuels Model Factors	Downed wood tally, litter and duff depth, dead fuel depth, sound and rotten wood, herbaceous fuel type, herbaceous fuel height, percent live herbaceous fuel, shrub fuel type, shrub waxiness, litter and woody fuel source and cover

easting and coordinate system, and estimated positional error. Crews were required to record how they navigated to the plot so that future surveyors could relocate it, and the plots representativeness relative to other areas around it. Plot environmental data included elevation, slope, aspect, topographic position, and surface cover of bedrock, rock, sand, crust, litter, etc.

Vegetation surveys included both general descriptions of the vegetation in the plot and the identities of and ocular estimates of cover for all species found in the plot. Physiognomic characters of the vegetation (broadleaf or needle-leaved, deciduous or evergreen) were recorded. All species present were recorded and placed in strata according to NPS standards. Tree species could occur in more than one stratum; white fir (*Abies concolor*) typically occurred in the canopy (T2) or subcanopy (T3) layers and in the seedling (H4) layer. At the conclusion of the vegetation survey, crews made a preliminary assignment of the plot to one of the vegetation Associations in the list provided during training. Five photographs were taken for each classification plot, one in each of the cardinal directions, and one from outside of the plot looking in towards the plot center (for relocation purposes).

Fuel model type, total ground cover, Brown's Transects (Brown 1974; 1 transect for woodland plots, 2 transects for forested plots), and litter and duff measurements were gathered on all woodland and forested plots above the rim.

Observation Plots

Observation plot data were recorded when crews determined that there was a need to demonstrate the extent of a particular vegetation type without collecting full plot data. Crews also recorded observation plots when they encountered an unusual vegetation type or a pattern in vegetation that they believed would be useful during the mapping phase. Observation point names were similar to classification plot names, except that the first digit was a "9" rather than a zero, so that Crew 1 would have surveyed observation points GRCA.91023 and GRCA.91075 in 2007 and GRCA.91532 in 2008. Observation point data included location information similar to classification plot data, but the vegetation data consisted only of the identity and cover information for common and dominant species. A preliminary assignment to a vegetation Association was also made. Three photographs were typically taken of each observation plot, two of the plot, and one from outside looking in towards the center of the plot.

Data Quality Control

Data from the 2007 sampling season were collected almost exclusively on paper datasheets. These were entered manually into a MS Access database which was adapted from one used in the NPS Northern Colorado Plateau Network. Northern Arizona University students and field staff entered data for all plots sampled in 2007, including those sampled prior to NAU/CPCESU's involvement in project fieldwork. Data from the 2008 sampling season were uploaded

digitally from the Palm OS PDAs into a MS Access database.

All data were subjected to a thorough quality control process before being forwarded to Grand Canyon personnel and NatureServe for classification work. All plot data sheets were checked against their records after data entry. The integrity of the entered data was also verified through numerous queries in MS Access. These queries ensured that no duplicate plot numbers existed, that all plots were appropriated named, that all state, county, and park codes were properly entered, that all compass directions and site names were spelled correctly, and that all park site names appeared on topographic maps. Surveyor names were converted into a standard naming convention consisting of the first letter of the first name, followed by the full last name and all plot dimension and shape fields were verified. The accuracy of the type, orientation, time, and photographer fields were verified. Photographer names were converted into the standard naming convention.

Queries checked that elevation, slope, and aspect values fell within appropriate value ranges. Queries also required that all plots which were classified in the Cowardin (1979) system as Palustrine also had corresponding hydrological descriptions. A spell-check was completed for all comments fields. Omissions in geology and landform fields were corrected. Queries ensured that the total percent cover for substrates values equaled an appropriate value.

Additional queries maintained the integrity of the vegetation descriptions by identifying omissions or contradictions in the phenology, leaf type, and physiognomy fields. All "mixed" leaf types required additional descriptions. Provisional community names were spell-checked. The spelling and nomenclature of all species names was verified and updated to reflect the current USDA PLANTS database. Queries ensured that species were recorded in the appropriate strata and that all cover estimates fell within reasonable parameters.

Results

Vegetation Surveys and Collections

Overall, field crews worked the equivalent of 25 eight-day field sessions between the summers of 2007 and 2008. A total of 1496 vegetation classification plots were surveyed, 378 of which included the collection of fuels data. Crews also collected data from 700 observation points, 566 in 2007 and 135 in 2008.

During field surveys, 1425 plant specimen collections were made by field crews in Grand Canyon National Park and Grand Canyon-Parashant National Monument. Of these, four-hundred and seventy-five (475) collections were made in 2007, while 950 collections were made in 2008. The difference resulted from the focus on forested systems in the first year and a more broad set of habitats in 2008. The collections made included twenty-five (25) new records for Grand Canyon National Park, including two (2) new records for the state of Arizona, 12 rarely collected or otherwise unusual taxa, and 26 special status plants were vouchered during fieldwork. A complete treatment of the significant collections can be found in Christie et al. 2011.

From the 1425 plant collections made during this project, 1350 herbarium specimens were processed and prepared for delivery to the Grand Canyon National Park herbarium following standard plant collecting protocols. The remaining 75 collections made from Grand Canyon - Parashant National Monument were similarly delivered to Lake Mead National Recreation Area. When available, duplicate collections were stored at the Deaver Herbarium at Northern Arizona University.

Each collection was pressed, dried, frozen, identified, assigned an NPS accession number, given a label with pertinent locality and ecological data, and mounted to archival-quality herbarium paper. All herbarium specimens and associated databases were delivered to the Grand Canyon National Park herbarium in numerical order following accession number. Plant collection informa-

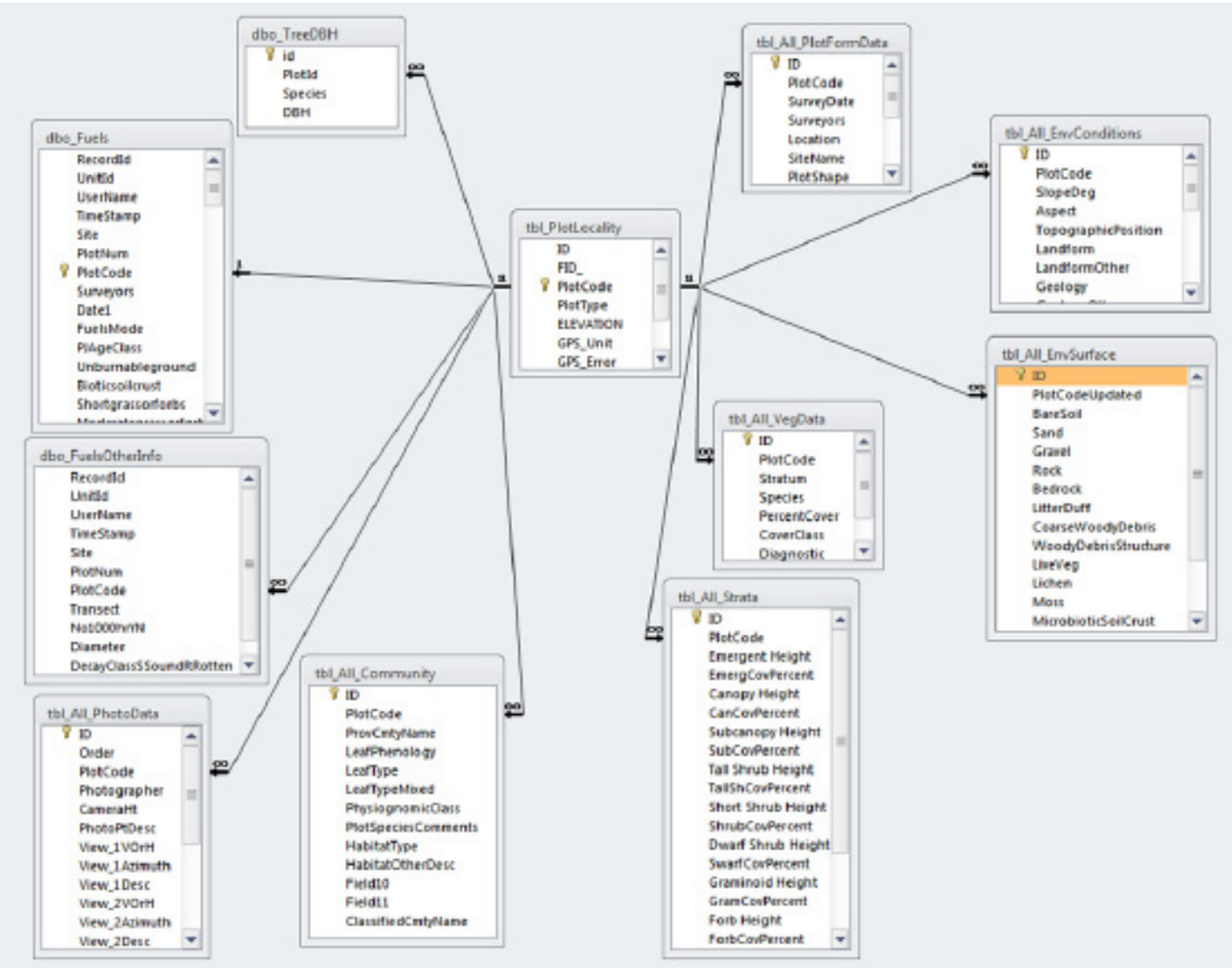
tion, including collectors, repository, and accession numbers, are given in the NAU final report (Christie et al. 2010). All collection information can be accessed via SEINet (www.swbiodiversity.org/seinet/).

Database

At the end of the vegetation surveys, data resided in separate databases, reflecting the differences between manual- and electronic data collection used in 2007 and 2008. Data from 2007 were contained in the MS Access database created for surveys in the Northern Colorado Plateau Network vegetation mapping projects. The 2008 data were in a different MS Access database structured to collect the same information from the PenDragon Forms application on Palm PDAs. These were combined into a single database before being forwarded to NatureServe for analysis. Entity-relationship diagrams from the two databases were examined to determine where the equivalent fields were located. Tables were exported to spreadsheets and rearranged so that a single table would contain all the records from both years for a set of variables.

Quality control measures had to be performed to adjust data from the two databases to a common format. For example, 2007 data from the Northern Colorado Plateau Network recorded plot codes in the form "GRCA.0XXXX" whereas the Pendragon application recorded them as "GRCA0XXXX" without the punctuation in the middle. Differences in field lengths

Figure 9. Entity–relationship diagram for the final database including data collected on paper sheets in 2007 and on Palm PDAs in 2008.



were standardized and binary fields that contained “Yes” or “No” values in one year and “0” or “1” in the other were standardized to a common response. Figure 9 contains the entity-relationship diagram for the final database.

Literature Cited

Austin, M. P. and P. Heyligers. 1989. Vegetation survey design for conservation: gradsect sampling of forests in northeastern New South Wales. Biological Conservation 50:13 - 32.

Austin, M. P. and P. Heyligers. 1991. New approach to vegetation survey design: Gradsect Sampling. Pages 31-36 in C. R. Margules and M. P. Austin, editors. Nature Conservation: Cost-Effective Biological Surveys and Data Analysis. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.

Ayers, T. J. and K. Christie. 2010. 2007 - 2008 Field Crew Support, Data Management, and Review Meetings for GRCA Vegetation Mapping. Final Report. Task Agreement J2340070031 / Cooperative Agreement H1200-004-0002. Northern Arizona University, Colorado Plateau Cooperative Ecosystems Study Unit., Flagstaff, AZ.

Brown, J.K. 1974. Handbook for inventorying downed woody material. USDA Forest Service General Technical Report INT-16. Intermountain Forest and Range Experiment Station. Ogden, UT.

Christie, K., G. Rink, and T. J. Ayers. 2011. Additions to the flora of Grand Canyon National Park resulting from National Vegetation Mapping Program fieldwork. *Canotia* 7:1-13.

Cogan, D., J. V. Loh, S. Spratlen, and M. Foderaro. 2006. Gradsect analysis Grand Canyon National Park. e2M Engineering - Environmental Management, Englewood, CO.

Cowardin, L.M., V. Carter, Golet, F.C., and LaRoe, E.T. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Services. Washington, D.C.

The Nature Conservancy and Environmental Systems Research Institute. 1994. Field methods for vegetation mapping. Department of Interior, National Biological Survey and National Park Service, Washington, DC.

Von Loh, J., D. Cogan, S. Spratlen, and M. Foderaro. 2006. Final Report Gradsect Analysis Grand Canyon National Park. Pages vi, 15. e2M Engineering - Environmental Management, Englewood, CO.

Von Loh, J., S. Spratlen, and M. Foderaro. 2007. Electronic Field Equipment Grand Canyon National Park Summary Report. Pages vi, 16, attachments. e2M Engineering - Environmental Management.

IV. Vegetation Classification

At the heart of any vegetation mapping is the classification of vegetation. It defines the units from which the map is to be built. The standards for NPS-VIP maps require that maps are based on the processes outlined in the U.S. National Vegetation Classification Standard (Federal Geographic Data Committee Vegetation Subcommittee 2008). In this section, the methods used to classify the vegetation of Grand Canyon National Park and the mapped portions of Lake Mead National Recreation Area are described.

Preliminary NVC Classification List

During the scoping process and work plan development for this project, a need was identified for a list of vegetation types (plant Associations or comparable classes) that might occur within the mapping area. Such a list would be useful for a number of reasons:

- To provide a rough estimate of the number of Associations to be expected to eventually become map classes
- To allow estimates of the running number of plots in each type which had been sampled
- To provide field crews with guidance on types likely to be encountered
- To aid in the design of field inventory work.

The process of creating the list required many steps and sources. During the development of the work plan (von Loh and Spratlen 2006), ecology staff at e²M consulted a plant species list generated by Grand Canyon National Park Vegetation Program staff and a previous classification of vegetation done for Grand Canyon (Warren et al. 1982). They also derived potential vegetation types from vegetation maps from nearby NPS units, including Arches N.P., Canyonlands N.P., Sunset Crater N.M., Walnut Canyon N.M., Wupatki N.M., Petrified Forest N.M., Mesa Verde N.P., and Canyon de Chelly (Coles et al. 2009, Hansen 2004, Hansen et al. 2004a,b, Thomas 2009a,b, Thomas et al 2010) as well as samples collected in the northern part of Glen Canyon N.R.A. The Nature Serve Explorer (NatureServe 2006) was also queried for plant Associations known to occur in Arizona by e²M staff. The final list was included as an Appendix in the final project Work Plan (von Loh and Spratlen 2006).

Classification and Data Analysis

Two primary datasets were used for the vegetation classification for this project. These included 1508 classification plots collected during the 2007 and 2008 field seasons. These consisted of 1025 taxa and were classified using standard quantitative techniques including cluster analysis, ordination, summary statistics and indicator species analysis.

The second dataset consisted of 461 plots and 180 taxa collected by the Grand Canyon Monitoring and Research Center (GCMRC; see Table 4). These data, although useful to inform and compliment the classification, did not contain data considered compatible with classification plots collected in 2007 and 2008 and were not quantitatively analyzed. Each sample from the GCMRC dataset was reviewed and assigned to an NVC Association if possible. Several possible new Associations were identified in the GCMRC data. In a later step, the GCMRC Associations were compared to types defined through the plot data analysis to ensure that identical types across the two datasets were identified and consolidated into one Association represented by the 2 different datasets.

Methods

Data Preparation and *Screening*

Of the 1497 complete classification plots collected in the 2007 and 2008 seasons, 1470 were used in the data analysis. Plots that were excluded were those considered unclassifiable due to insufficient species data or those which represented burned or disturbed sites.

Prior to data analysis, standard screening and preparations were performed to facilitate the interpretation of results. In large datasets such as this, data transcription errors and data entry errors are problematic

and common, the most frequent of which are duplicate species records, synonymy of scientific names, species records without plant symbols or missing cover data. Using field data records, standard taxonomic information and database queries, species records were updated wherever possible.

After species records were considered complete, additional data deletions and transformations were performed to inform the analysis. Species records were deleted that were determined to not be informative in the analysis or that would create unnecessary confusion. These records included any unknown species, species identified only to genus or family, and ubiquitous exotic species (e.g. *Bromus tectorum, Bromus rubens*) that would otherwise cause unrelated plots to group together. Species recorded in only one plot were also eliminated to reduce the outlier effect in clusters and ordinations. Woody species recorded in more than one height class were converted into one total cover value using an algorithm written in Microsoft Access. The data was exported in list format from the Plots database, and then imported directly into a matrix for analysis using PC-Ord (McCune and Mefford 1999) after species names and cover classes had been formatted to meet PC-Ord requirements.

Due to the level of variation and volume of plot data, 3 data subsets were assembled based on elevation zones to later be used to assign a priori groups for analysis. These groups included plots from <1500 m, 1300 – 2700 m, and >2500 m elevation. Elevation zones were based on general floristic trends with those plots from <1500 m mostly representing Mojave and Sonoran elements, 1300 – 2700 m plots mostly representing Colorado Plateau shrub and pinyon – juniper communities, and >2500 m plots mostly representing Colorado Plateau forest and woodland communities. The overlap in elevation zones meant some plots were assigned to 2 different analytical groups, which was intentional to ensure vegetation types would not be split across an artificial elevation break.

Cluster analyses using raw cover scores were performed on all three elevation zone subsets to assign a priori ecological groups (Figure 10, Table 11). These groups generally correspond to the Macrogroup level of the NVC. Plots considered to represent ruderal or non-native dominated vegetation were removed from the analysis and assigned to the appropriate Associations where possible. As analysis progressed, some smaller scale groups were selected for further study including plots representing Mormon tea, Colorado Plateau pinyon – juniper and Great Basin pinyon - juniper communities.

Table 11. Number of plots assigned to ecological groups used in analysis.

Ecological Group	Plot totals
Blackbrush Shrublands	136
Grasslands	151
Mojave Shrublands	214
Mountain Brush and Chaparral	147
Palustrine Vegetation	100
Pinyon - Juniper	235
Sagebrush	81
Sonoran Shrublands	212
Spruce - Fir - Ponderosa Pine - Aspen Woodlands	194
Total	**1470**

Multivariate Analysis

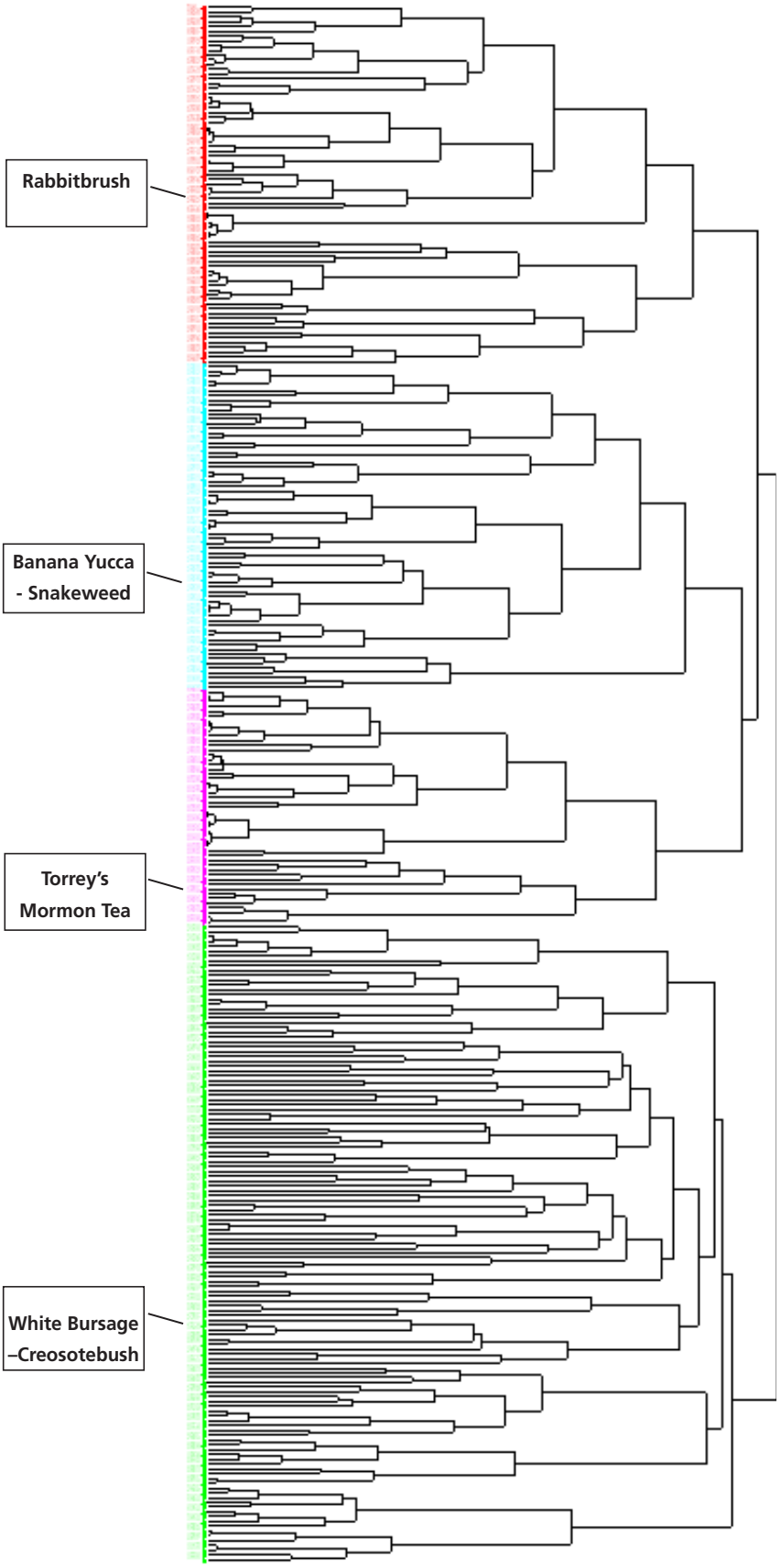
Once plots were assigned to floristically similar groups, vegetation classification was accomplished through a multivariate analysis of the plot data using standard techniques including cluster analysis, ordination, and indicator species analysis. Cluster analysis was used to find natural groupings of plots in the data based on shared species abundances. The result of a cluster analysis is a diagram, called a dendrogram, in which the dissimilarity between two plots is represented by the height of the line which connects them. Ordination analysis provided a visual representation of the species-based dissimilarities between plots. In an ordination diagram, points representing plots which are similar to each other are placed close together and those that are dissimilar are plotted relatively far apart. Indicator species analysis (ISA; Dufréne and Legendre 1997) identifies species which are characteristic of a priori groups of

plots. An ideal indicator species for a group is one which reaches its maximum abundance in that group, is found in most or all plots in that group, and is rare in plots not in that group. Each species is assigned an indicator score for each group, ranging from 0 (no indication) to 100 (perfect indication). The highest score achieved by a species in any group then becomes it's indicator score.

Species cover data were exported in list format from the Access database and then imported into PC-Ord (McCune and Mefford, 1999). Cluster analysis was performed using Lance-Williams Flexible-Beta linkage method (beta value = -0.25) and the Bray-Curtis dissimilarity measure. Ordination was performed using non-metric multidimensional scaling using Sorenson (Bray-Curtis) distance measure. A secondary grouping matrix was created to graph the distribution of groups in ordinations and clusters. Indicator species analysis and cluster summary queries were used to interpret the groups revealed by cluster analysis and ordinations in an ecologically meaningful fashion. The analysis employed a randomization (Monte Carlo) technique to estimate the statistical significance (p-value) of the species scores. One commonly used method is to retain only those indicator species which have a $p \leq 0.05$, *and* an indicator value ≥ 25 (Dufrêne and Legendre 1997).

Cluster analysis and ordinations were first performed using raw cover values. However, significant differences in total cover between plots were frequent in the data, often the result of plots being collected from sparsely vegetated areas or differences in perceived cover values among field personnel. In groups where this was common, cover values relativized by site totals were used to equalize the weight of plots with highly variable cover scores that were otherwise floristically similar. In other analyses, cover values revitalized by species maxima were used to increase the influence of less common species. These techniques were especially useful to document differences among groups which separated poorly in analyses using raw values due to the presence of ubiquitous species.

Figure 10. Clustering output for the Mojave shrublands samples. Four subsets were further analyzed individually. Each horizontal line in the cluster represents a plot.



Ordinations and cluster analysis results proved informative, but only at certain resolutions depending on the complexity and size of the dataset. In some analyses, plots clustered definitively at the NVC Alliance level (Figures 11, 12) such as with Mormon tea dominated vegetation which represented a smaller subset of data and more pronounced species dominance. Less definitive was the clustering and ordination of pinyon – juniper dominated vegetation which separated clearly at the NVC Group level (Figures 13, 14), but analysis at the Association level proved less informative. The subset of data representing Mojave and Sonoran shrublands proved the most difficult to interpret and plots did not separate clearly even at the NVC Group level (Figure 15) presumably due to classification issues within the NVC hierarchy as well as the presence of common species prevalent between both groups.

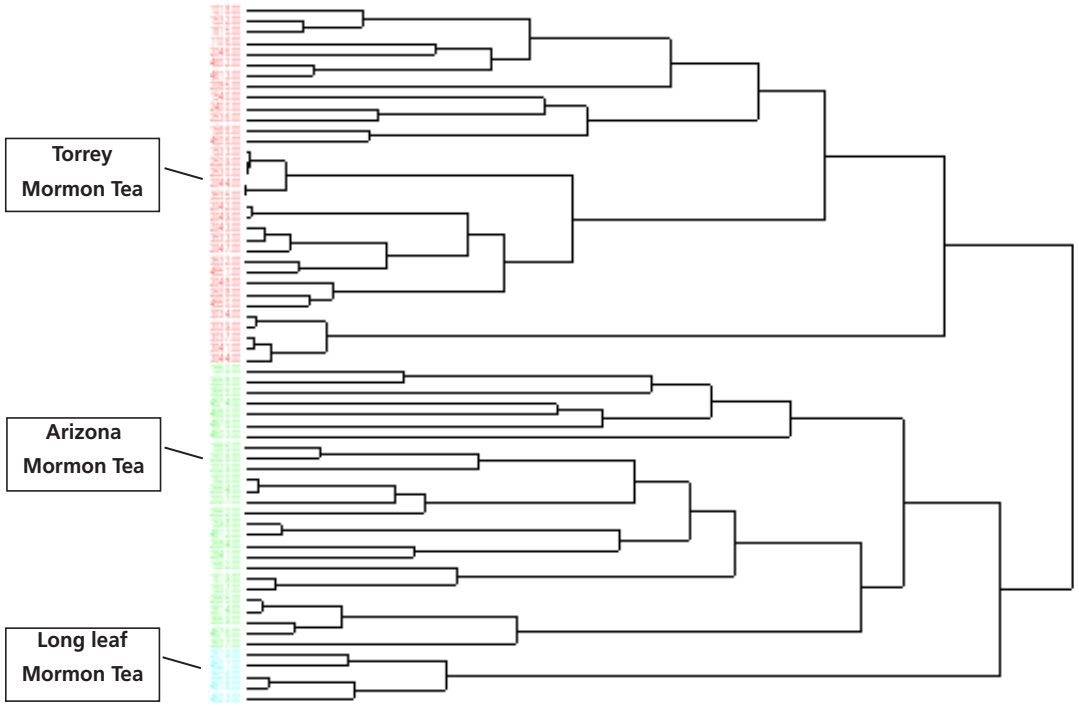
When groups identified by the analysis could not be parsed further with these methods, individual plots were inspected and assigned to Associations or Alliances based on species composition, cover and environmental data. Many of these Associations matched well documented concepts in the NVC and were attributed to them. Others were considered to intersect more narrowly defined NVC Associations and the concepts were expanded to include those plots from this project. Other Associations from this project represent new concepts which were not currently documented in the NVC. These new concepts were subjected to literature review to determine if standard, provisional or park special status was warranted.

Plant Association Field Keys

A dichotomous field key to the project area plant Associations was developed and is presented in Appendix B. The key was designed to assist users (including resource managers, interpreters and biologists) in identifying vegetation Associations on the ground. Every effort was made to limit ambiguity in choosing an appropriate vegetation type. The key includes the potential for keying to one Association through multiple physiognomic groups (e.g., shrub herbaceous types or woodlands versus forests). Small stands of unique vegetation known as "park specials" were incorporated into the key.

The field key has two levels. The first level focused on determining the physiognomy of the vegetation, i.e., forest, woodland, tall

Figure 11. Cluster dendrogram of plot data representing Mormon tea dominated vegetation.



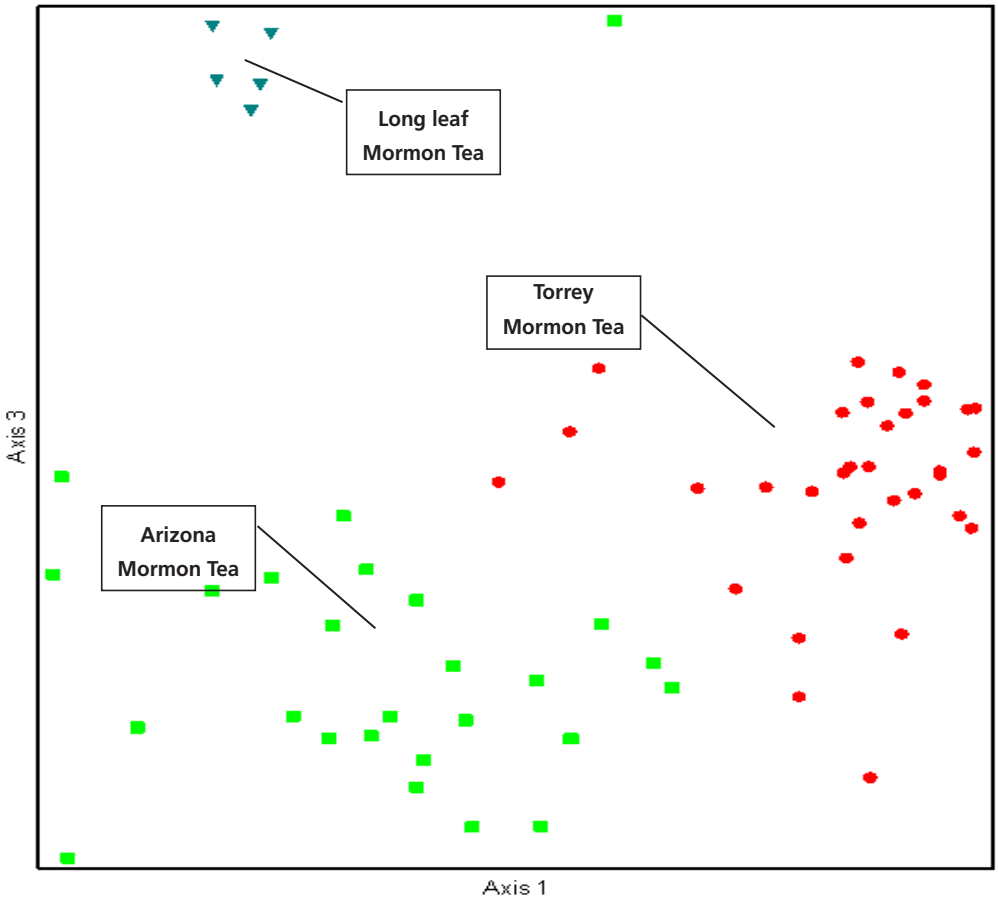


Figure 12. Example of a Bray-Curtis ordination of plots representing Mormon tea dominated vegetation.

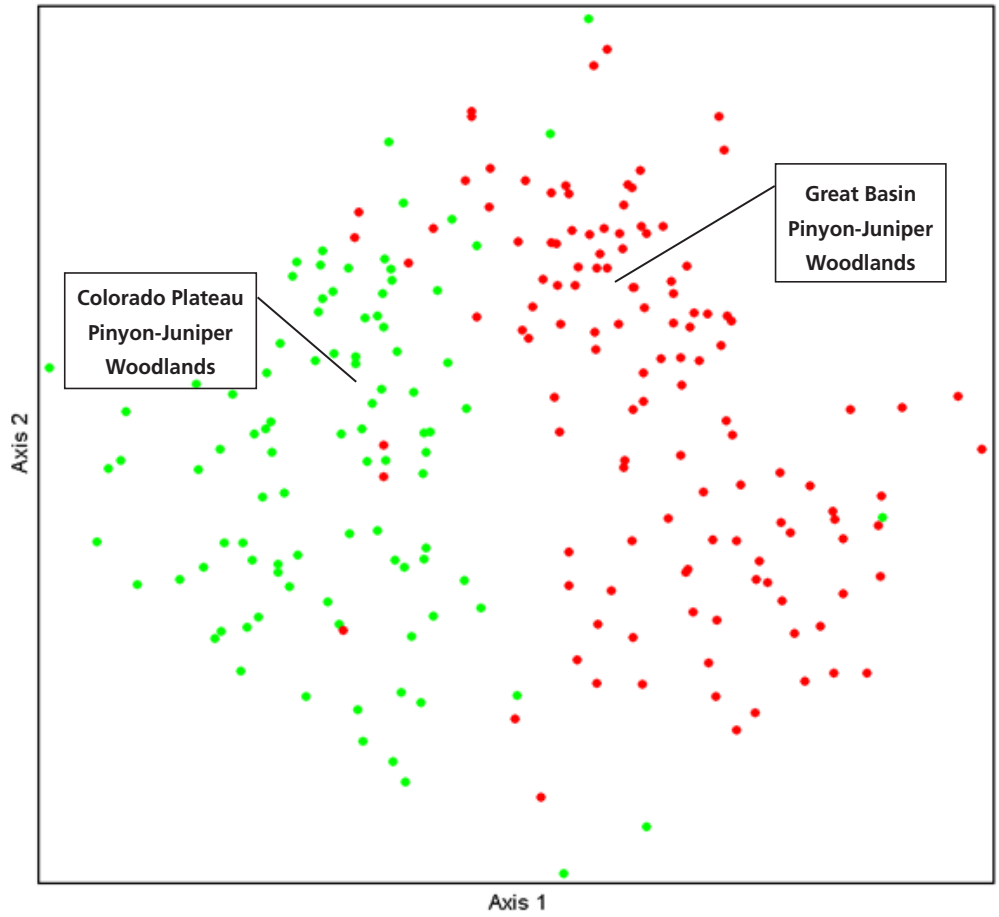
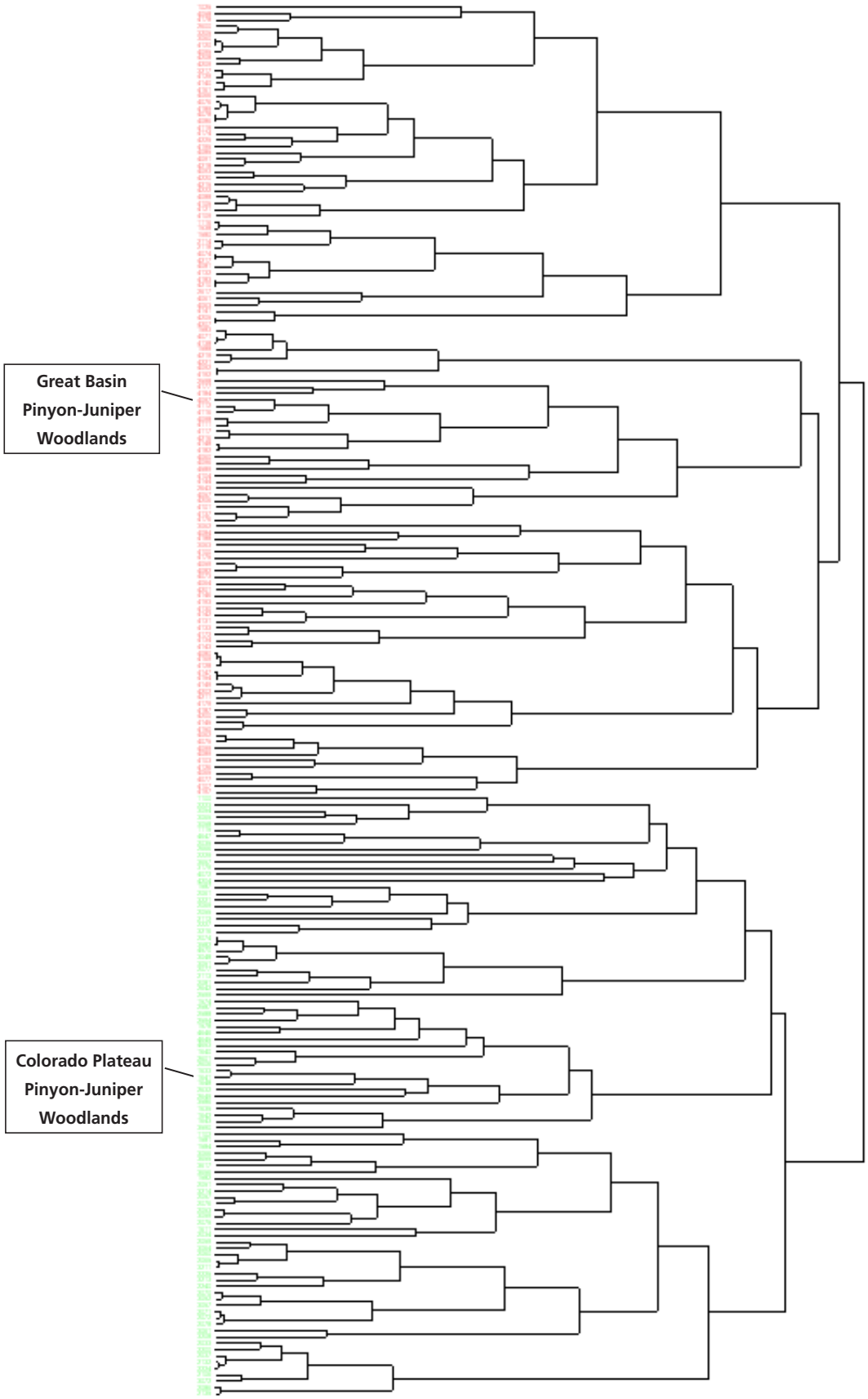


Figure 13. Example of a Bray-Curtis ordination of plot data representing pinyon-juniper dominated vegetation.

Figure 14. Cluster dendrogram of plot data representing pinyon-juniper dominated vegetation.



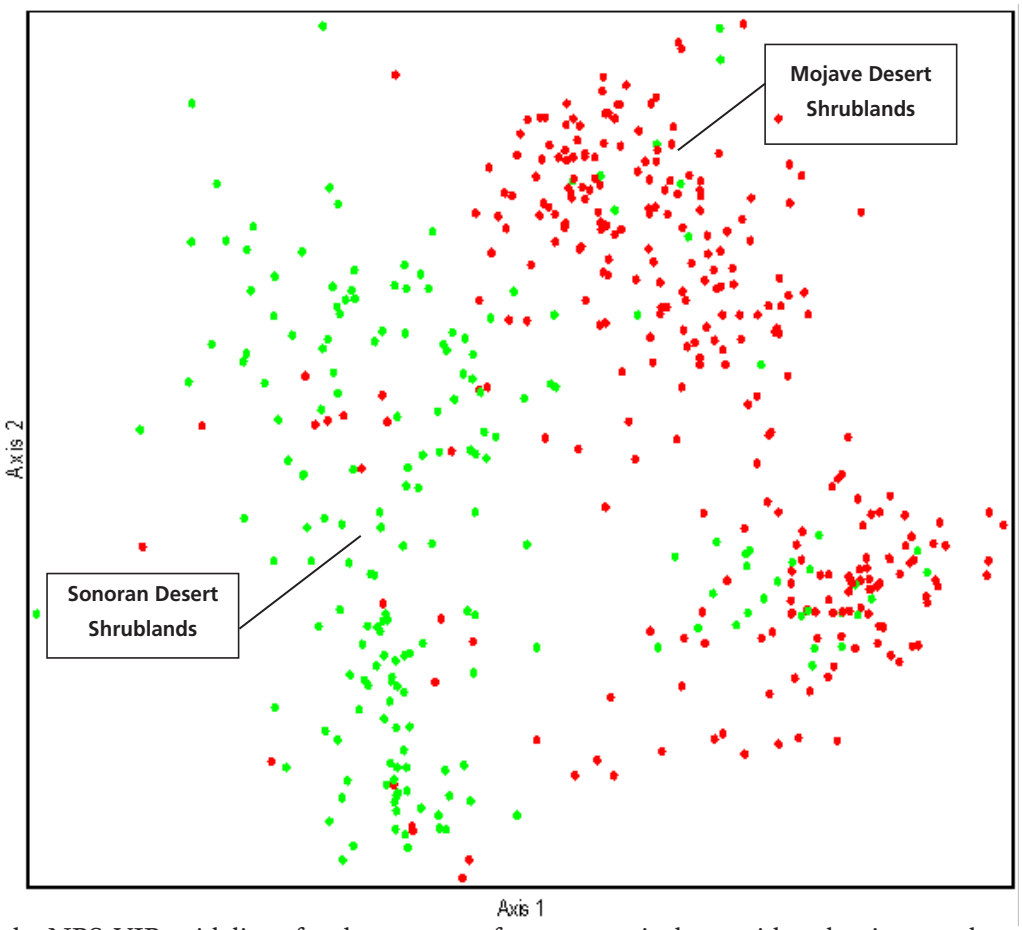


Figure 15. Example of a Bray-Curtis ordination of plot data representing Mojave-Sonoran Semi-Desert Scrub dominated vegetation.

the NPS-VIP guidelines for the content of plant Association descriptions. Only Associations represented by more than 2 plots had descriptions written, unless one of three criteria was met. First, a description based on one or two samples could be attempted if the Association had been described elsewhere by other authors based on several samples. Second, a description could be written if the type were confirmed as distinctive and repeatable based on subsequent field reconnaissance or imagery signature. Or third, a description could be written if ecologists with extensive local knowledge were sure the plot(s) represented a widely distributed type that was relatively unknown in the literature and had been under-sampled for this project.

Local Association descriptions were written by Kyle Christie, based on species abundance summaries (mean and range of common species by Association), ground cover summaries, and summaries of data on slope, aspect, elevation, and other environmental conditions recorded during the sampling. Guidance from NatureServe required that tentatively considered unique to the mapping area, and lack sufficient documentation in the literature to justify creating new Associations. Types with only one plot may have been rare in the mapping area, or were simply under sampled as a result of difficult access or limitations of the sampling design.

The vegetation of Grand Canyon National Park and Grand Canyon – Parashant National Monument can be characterized by several elevation life zones. Riparian communities (Figure 16) along the Colorado River and its tributaries are composed of willow species, arrowweed, western honey mesquite, catclaw *Acacia*, and exotic tamarisk. Hanging gardens, springs and seeps occur scattered throughout and predominant species include water birch, hackberry, sawgrass, and redbud.

Above the river corridor Mojave and Sonoran warm desert scrub communities (Figure 17) dominate the landscape. Most of the woody species are drought-deciduous or evergreen, and many have adaptations to drought and heat stress such as thorns or

succulence such as cacti and *Yucca*s. Communities are most commonly composed of creosote bush, white bursage, brittle brush, blackbrush, catclaw *Acacia*, ocotillo, mariola, western honey mesquite, four-wing saltbush, big sagebrush, several species of *Yucca*, and rubber rabbitbrush.

Above the desert scrub, communities transition into shrublands and woodlands (Figure 18) composed of species which have affinities to cooler desert environments. The shrublands tend to be dominated by deciduous broadleaf species and woodlands by pinyon and juniper. Predominant species include one and two leaf pinyon, one seeded juniper, Gambel oak, New Mexico locust, mountain mahogany, big sagebrush, snakeweed, Mormon tea, Utah *Agave*, banana and narrowleaf *Yucca*, snakeweed, winterfat, Indian ricegrass, dropseed, and needlegrass.

On the north and south rims, forests and woodlands predominate (Figure 19). At the lower elevations *ponderosa* pine is the dominant canopy species. At the higher elevations, canopy composition transitions into forests and woodlands dominated by Engelmann spruce, blue spruce, Douglas fir, white fir, aspen, and mountain ash.

Classification Discussion

Grand Canyon National Park and Grand Canyon – Parashant National Monument are a biogeographic crossroads. The floristic patterns and species assemblages found in this area are highly diverse and controlled by many interacting factors such as elevation, surficial geology and soil characteristics, grazing or fire disturbance, mass wasting events, and rainfall patterns. There are floristic elements from the Rocky Mountains, Colorado Plateau and Great Basin, Madrean, and Mojave-Sonoran deserts. Transitions from one to another are abrupt in some areas of the Canyon (driven by steep elevation gradients), or can be gradual and subtle transitions, such as along the Tonto Plateau from east to west. Disturbance events, such as historic grazing, fire, rock fall, unstable colluvial slopes, or flooding, add to the complexity of species assemblage and successional patterns. In addition, invasive exotic species have begun to contribute to shifts in species assemblages and fire regimes, especially in lower elevation parts of the project area.

The size of the project area combined with the biogeographic complexity, natural



Figure 16. *Baccharis emoryi - Salix* Shrubland at Bright Angel Creek.



Figure 17. *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland in the Inner Canyon.

dynamics and invasive exotics made the analysis and classification of some floristic groups difficult. This was compounded in a few cases by two data collection issues:

1. Low cover estimates by the field crews collecting plot data
   A. The first year of field data collection (2007) for classification plots was preceded by a very dry winter and spring. The precipitation gauge at the South Rim recorded monthly totals between 20% and 60% for each month between October 2006 and May 2007. This resulted in reduced green-up of many shrubs and herbaceous species, which in turn resulted in low canopy cover during the data collection.
   B. The field crews in general tended to under-estimate canopy cover across all life forms, but in particular tree canopy cover was often lower than would be expected upon review of the plot photos or compared to the imagery.
2. There were taxonomic issues for some genera, where the crews either were uncertain of the species or had difficulty keying the species found in the plots. Many of these were resolved during the subsequent work in the herbarium with collected specimens, but others remained unresolved in the dataset used for the classification.
   A. On the North Rim there are areas of montane grasslands, dominated by fescue (*Festuca*) species. They



Figure 18. Pinus edulis - *Juniperus osteosperma* / *Artemisia bigelovii* Woodland on the North Rim.



Figure 19. *Abies lasiocarpa - Picea engelmannii* / *Juniperus communis* Woodland (background) and *Festuca (calligera, arizonica, brachyphylla)* Herbaceous Vegetation (foreground) on the North Rim.

were keyed or named in the plots variously to *F. calligera*, *F. ovina*, or just the *Festuca* genus. *F. ovina* is an introduced taxon from Europe, that is typically found at subalpine to alpine elevations. *F. ovina* is not reported to occur in Arizona at all (USDA NRCS Plants Database, Accessed 2008 and 2012, http://plants.usda.gov/java/). *Festuca arizonica* and F. *brachyphylla* are the 2 species that would be expected to occur on the North Rim plateaus, but neither of them was identified as such by the field crews. Review by Kyle Christie of specimens and field forms concluded the taxonomy of the fescues needs work. In the end, we combined all the fescue-dominated plots into one plant Association, the *Festuca* (*arizonica*, *brachyphylla*) Herbaceous Vegetation.

B. Sagebrush species (*Artemisia spp.*) are an important shrub component of the vegetation surevyed for this project, occuring both as sagebrush shrubland communities, and as an under-growth component of pinyon-juniper or *ponderosa* woodlands, as well as associated with oaks and in other shrubland communities. The *A. tridentata* group is particularly common and widespread. There are several subspecies of *A. tridentata*, and the NVC utilizes those sub-taxa in defining sagebrush Associations (the subspecies of *A. tridentata* are considered to be significantly different in the biophysical parameters with which they are associated). From the start of the data collection, it was unclear which subspecies occured, and the crews often did not attempt to key out the subspecies of *A. tridentata*. Hence, some plots had the subspecies listed (only *ssp. vaseyana* was ever listed), but many other plots were only to *A. tridentata*. Mountain big sage is not reported to occur in Arizona at all (USDA, NRCS 2008). All plots that we classified to a big sage plant Association were named just to the species level, such as: *Artemisia tridentata* / *Bouteloua gracilis* Shrubland, *Artemisia tridentata - Purshia stansburiana* Shrubland, or *Artemisia tridentata - Ephedra spp*. Shrubland.

C. There were several species of *Ephedra* associated with varying environmental and disturbance parameters, and they are very common. Warren et al. (1982) made no attempt to distinguish across these species, and we found similar difficulties in our classification. While the *Ephedra* species can generally be classified into "warm semi-desert" versus "cool semi-desert" communities, it was uncommon to find clear floristic associates with any one of the individual species. Several *Ephedra* Associations are defined, such as *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland, *Ephedra trifurca* Badlands Shrubland, or *Ephedra torreyana - Opuntia basilaris* Shrubland, but in other cases we combined *Ephedra spp*. into an Association with other shrubs (e.g. *Coleogyne ramosissima - Ephedra spp*. Warm Desert Shrubland, *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland, *Artemisia tridentata - Ephedra spp*. Shrubland, or *Gutierrezia (sarothrae, microcephala) - Ephedra spp. - Agave utahensis* Shrubland).

3. Some particularly difficult portions of the classification included the Pinyon – Juniper woodlands and the transitions to adjacent shrubland vegetation types; blackbrush shrublands; Sonoran – Mojave shrublands; colluvial and talus slope vegetation; and mesquite woodlands. Below some discussion is provided of the classification issues for each of these.

4. The Pinyon – Juniper woodlands which dominate much of the mid-elevation zone of this project are considered to be floristically affiliated with two different ecoregions: 1) the Colorado Plateau in which two-leaf pinyon (*Pinus edulis)* is a dominant and 2) the Great Basin in

which single-leaf pinyon (*Pinus monophylla)* is dominant. However, when pinyon is absent in communities considered to be strictly juniper (*Juniperus osteosperma*) dominated, the presence of shrub and herbaceous species common to both ecoregions resulted in plots from both groups clustering together during analysis. Therefore, data relativization to emphasize rarer species and indicator species analysis was used to determine species that were indicative of each group for classification. In general, *Juniperus osteosperma* woodlands in the Great Basin tended to have *Pinus monophylla* present in most of the plots, so the final classification names include *P. monophylla* (e.g. *Juniperus osteosperma - (Pinus monophylla) / Arctostaphylos pungens* Woodland or *Juniperus osteosperma - (Pinus monophylla) / Ceanothus greggii* Woodland). Conversely, there are several *J. osteosperma* woodland Associations in the Colorado Plateau woodland Group, where *Pinus edulis* is rarely present, so several *J. osteosperma* Associations were defined (e.g. *Juniperus osteosperma / Artemisia tridentata* Woodland).

5. A second issue with pinyon-juniper woodlands was the transition zones from woodlands to shrublands, or along the predominantly slick-rock areas of the Esplanade and other "middle-elevation" areas. These transitions and slick-rock settings frequently had relatively low cover of the pinyon-juniper, often well under 15% according to the plot data, but the shrub cover was often equally low or patchy. The difficulty was in determining whether these communities should be classified as pinyon-juniper woodlands, or as shrublands wherein the pinyon-juniper is "accidental" in its presence. In other words: is this pattern of species occurrence something that is repeated in the landscape, and associated with some recurring environmental parameters such as elevation and substrate? In some cases review of the photos for the plot showed that the field crew under-estimated the cover of the pinyon-juniper, or that, while cover of the trees was very low they were mature large trees consistently present in the vicinity of the plot. The quantitative analysis tended to group the plots with a pinyon-juniper component together, even when the tree cover was quite low. In the end, every plot with low total tree cover (<25%) and any amount of pinyon or juniper was reviewed individually, both the species data and the photos for the plot. In a number of cases, plots with cover of trees down to as low as 5% were classified into a Association.
6. Communities dominated by blackbrush (*Coleogyne ramosissima*), like Pinyon - Juniper Woodlands, can have species with affininities to either warm- or cool semi-desert environments, with no clear boundary within the mapping area. At higher elevations, blackbrush is associated with Colorado Plateau elements such as cliff rose (*Purshia stansburiana*) and big sagebrush (*Artemisia tridentata*). At lower elevations, blackbrush is associated with Mojave and Sonoran elements such as Joshua tree (*Yucca brevifolia*), wooly bursage (*Ambrosia eriocentra*) and Mormon tea (*Ephedra spp.*). Although plots located well within the interior of either semi-desert environment tended to represent well defined communities that could be somewhat clearly classified, those which were located in transitional zones between the two environments could be extremely difficult to define. In the end, several blackbrush Associations were classified, and placed into one of the warm semi-desert (Mojave or Sonoran) scrub groups (e.g. *Coleogyne ramosissima - Ephedra spp.* Warm Desert Shrubland, *Yucca brevifolia / Coleogyne ramosissima* Wooded Shrubland, *Ambrosia eriocentra - (Coleogyne ramosissima)* Shrubland or *Larrea tridentata - Coleogyne ramosissima* Shrubland), but only one Association was defined within the Colorado Plateau Blackbrush-Mormon-tea Shrubland Group (e.g. *Coleogyne ramosissima* Shrubland).
7. Another type of vegetation that has presented difficulties here and in other classification projects is that of colluvial slopes. These environments may

be composed of woody plants, including both trees and shrubs, herbaceous plants, and/or nonvascular plants and maybe very diverse floristically and so it is difficult to determine indicator species. Furthermore, determining a representative site to sample in a sparse environment such as these can be conceptually challenging. In the end, classifiers used their best expert judgment in making calls.

8. The analysis of vegetation types with *Acacia* (*Acacia greggii*) and mesquite (*Prosopis glandulosa)*was complicated due to the bimodal distribution of the species in the environment. These species most commonly occurs in close proximity to water sources such as washes, but here were also found forming communities on slopes and sparse shale uplands. This was problematic during the analysis as the plots representing the less common upland mesquite Associations clustered with the plots representing the more common riparian vegetation. To determine Association assignment for these plots it was necessary to review plot locations and photos to assess topographic position.
9. The most challenging task of the classification was the analysis and classification of the Mojave-Sonoran Semi-Desert Scrub Macrogroup which is the largest, most widespread and perhaps most conceptually difficult of all. The project area corresponds to the easternmost portions of the Sonoran and Mojave ecoregions and forms a vast vegetation transitional zone within the park where warm and cool desert species mix to form communities that are often difficult to define. Sampled areas were often comprised of numerous common species in various combinations and species cover across most areas tended to be very low, often without a clear dominance by any one or two species. Furthermore, vegetation in this zone had not been incorporated in the National Vegetation Classification revision which was done concurrently with this project. Therefore, many new Associations needed to be created for ecological groups which were still under development.

Vegetation Classification Products

Vegetation Classification and Plant Association Descriptions

The primary products of the vegetation classification work described in this chapter are the descriptions of vegetation Associations, the field key to vegetation Associations, and the placement of the Associations in the NVC hierarchy. The descriptions of the Associations recognized within the NVC and encountered in one or more plots are included in Appendix D: Descriptions to Plant Associations of Grand Canyon National Park. Most descriptions include diagnostic and abundant species, cover by strata and species, and lists of similar "concepts" along with narrative local descriptions. When Associations are known to occur outside the project area, a global descriptions is included if one is available, along with literature sources used for that descriptions.

A dichotomous key to the vegetation Associations is also included with this report as Appendix B. Because vegetation cannot always be mapped accurately at the Association level (see discussion in the Vegetation Mapping and Accuracy Assessment chapter), the key does not correspond directly to map classes. A separate table describing the assignment of Associations to map classes is included as Appendix E of this report.

The arrangement of the Alliances and Associations sampled in this project in the full NVC hierarchy is included as Appendix C to this report. Although the revised NVCS was published while this project was underway, the hierarchy here reflects the most recent standard. Because the Alliance level is still being constructed at the time of this report, it is not included.

Literature cited

Coles, J., A. Tendick, G. Manis, A. Wight, G. Wakefield, J. Von Loh, A. Evenden. 2009. Vegetation classification and mapping project report, Arches National Park. Natural Resource Technical Report NPS/NCPN/NRTR-2009/253. National

Park Service Natural Resource Program Center, Fort Collins, CO

Dufrêne, M. and P. Legendre. 1997. Species assemblages and indicator species: The need for a flexible asymmetrical approach. Ecological Monographs 67: 3: 345-66.

Federal Geographic Data Committee - Vegetation Subcommittee. 2008. National Vegetation Classification Standard (Version 2). FGDC-STD-005-2008. Available: http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation.

Hansen, M. 2004. USGS-NPS National Vegetation Mapping Program: Wupatki National Monument, Arizona, vegetation classification and distribution Final Report. U.S. Geological Survey, Southwest Biological Sciences Center. Flagstaff, AZ.

Hansen, M., J. Coles, K. Thomas, D. COgan, M. Reid, J. Von Loh, K. Schultz. 2004a. USGS-NPS National Vegetation Mapping Program: Walnut Canyon National Monument, Arizona, vegetation classification and distribution Final Report. U.S. Geological Survey, Southwest Biological Sciences Center. Flagstaff, AZ.

Hansen, M., J. Coles, K. Thomas, D. COgan, M. Reid, J. Von Loh, K. Schultz. 2004a. USGS-NPS National Vegetation Mapping Program: Sunset Crater Volcano National Monument, Arizona, vegetation classification and distribution Final Report. U.S. Geological Survey, Southwest Biological Sciences Center. Flagstaff, AZ.

McCune, B., and M.J. Mefford. 1999. PC-ORD. Multivariate analysis of Ecological Data, Version 4. MjM Software Design, Gleneden Beach, Oregon.

Thomas, L. 2009a. Geospatial Vegetation Information for the Canyon de Chelly Vegetation Inventory Project. Accessed: https://irma.nps.gov/App/Reference/Profile/2167357.

Thomas, L. 2009a. Field data for the Canyon de Chelly Vegetation Inventory Project. Accessed: https://irma.nps.gov/App/Reference/Profile/2167355.

Thomas, L., M.L. Teague, L. Ogden, K. Schultz, T. Fancher, W. Waltermire, and A. Cully. 2010. Vegetation classsification and distribution mapping report: Canyon de Chelly National Monument. U.S. Department of the Interior, National Park Service, Natural Resource Program Center. Ft. Collins, CO.

USDA 2008. The PLANTS Database (http://plants.usda.gov) National Plant Data Team, Greensboro, NC. Accessed in 2008 and 2012.

Warren, P.L., Reichert, K.L., Mouat, D.A., Brown, B.T., Johnson, R.R. 1982. Vegetation of Grand Canyon National Park. Technical Report No. 9. Cooperative National Park Resources Studies Unit Contribution No. 017/16. Tucson, AZ.

V. Vegetation Mapping

Methods

Introduction

In 2009, Kass Green & Associates (KGA) was chosen by the NPS to map the vegetation of Grand Canyon National Park and the Lake Mead National Recreation Area – administered portions of the Grand Canyon Parashant National Monument using a National Vegetation Classification Standard (NVCS) compliant classification. Mapping tools and techniques used included remotely sensed digital airborne NAIP imagery, image segmentation, ancillary data, GIS biophysical modeling, photo interpretation, and field visits. This section of the report summarizes the methods used by KGA to map the vegetation of the project area.

Using remotely sensed data and ancillary information to map vegetation type is effective only because a high correlation exists between variation in the imagery and ancillary data, and variation in vegetation as specified by the classification scheme. Hopefully, when the vegetation on the ground changes, the spectral response of the imagery and the classes of the ancillary data also change. Using remotely sensed data and ancillary information to map land cover and land use requires an understanding of what causes the variation on the ground and how the imagery and ancillary information represent to those variations. Therefore, vegetation mapping requires completion of three basic steps:

- Developing a classification scheme to specify the type of land cover and land use characteristics to be detected and mapped,
- Controlling all variation in the imagery and ancillary information that is not related to variation in the classification scheme, and
- Capturing and classifying all the variation that is related to the variation in the classification scheme.

Since the early last century these steps have been completed through the manual photo interpretation of remotely sensed data to delineate and identify vegetation by relying on seven indicators of vegetation type; color, tone, texture, location, context, height, and shape of the feature of interest (Spurr, 1948). While a mainstay for decades, manual interpretation can be extremely time consuming, costly, and inconsistent. Semi-automated classification involves data exploration to establish relationships between the imagery, ancillary information, and features on the ground. Semi-automated methods can be more cost effective and consistent than manual interpretation by allowing computer data analysis to label the easily identified features, thereby focusing the skilled remote sensing analysts' efforts on difficult and complex features. This project employed semi-automated techniques.

Innovations over the last decade have resulted in the development of the semi-automated classification method of object oriented classification. Object oriented image classification classifies image objects (polygons) instead of single pixels, allowing for the incorporation of not only texture, tone, and color, but also shape and context into the creation of vegetation data. Object oriented classification closely mimics manual interpretation by creating vegetation polygons, yet brings substantial increase to the speed of map production, consistency, accuracy, and detail. While powerful in the classification of medium resolution data (e.g. Landsat), object oriented classification is pivotal for semi-automated classification of high resolution airborne imagery, (such as NAIP imagery) because of the mixture of shadow and illuminated features in the imagery and the need to group pixels together to map vegetation classes instead of individual vegetation features such as individual trees.

This project's semi automated techniques included object oriented image segmentation, classification and regression tree (CART) analysis, local expertise, field data collection, manual image interpretation and editing, and GIS biophysical modeling Figures 20a and 20b present a graphical representation of the workflow for the project. This section of the

Figure 20a. Project workflow: imagery and ancillary data.

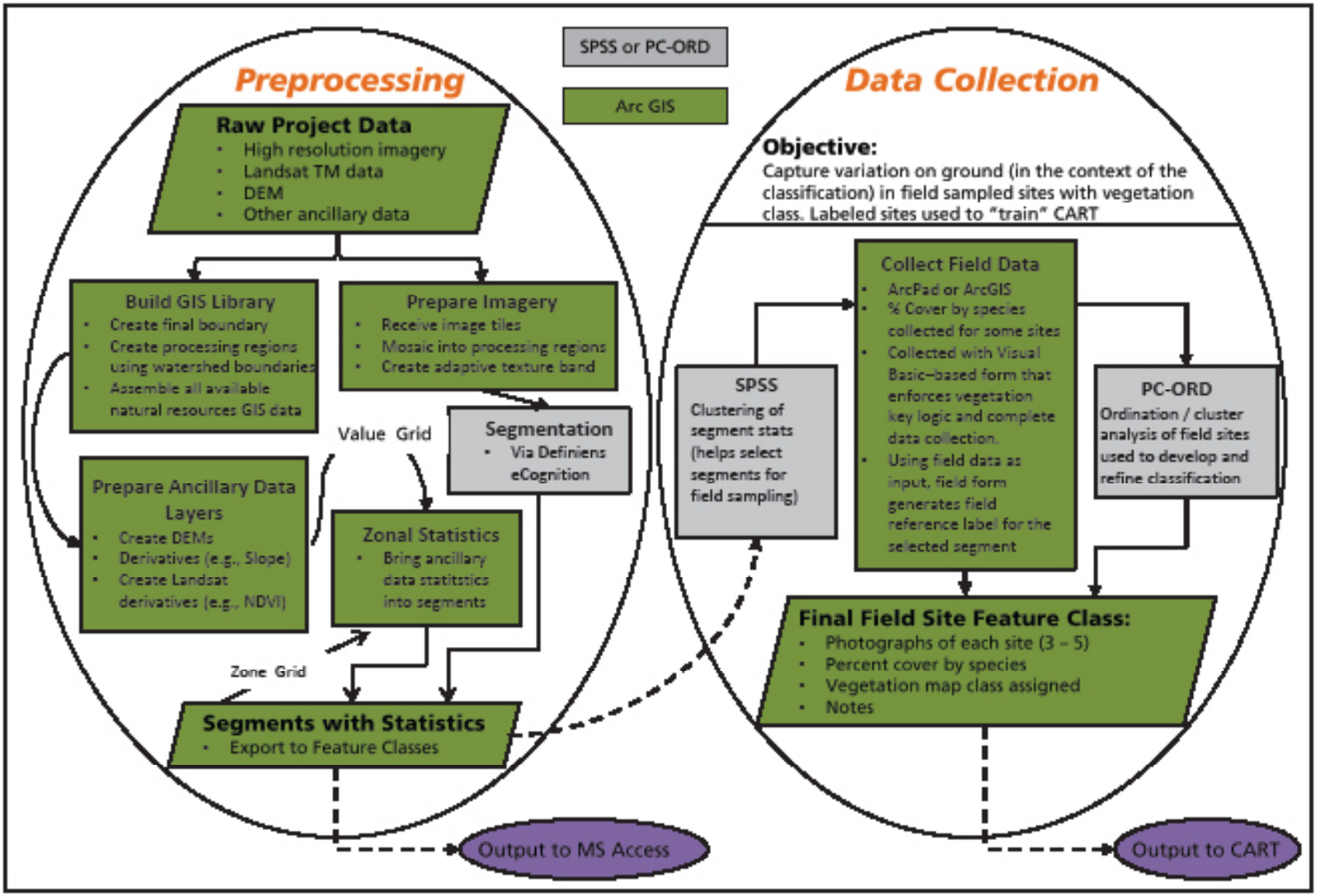
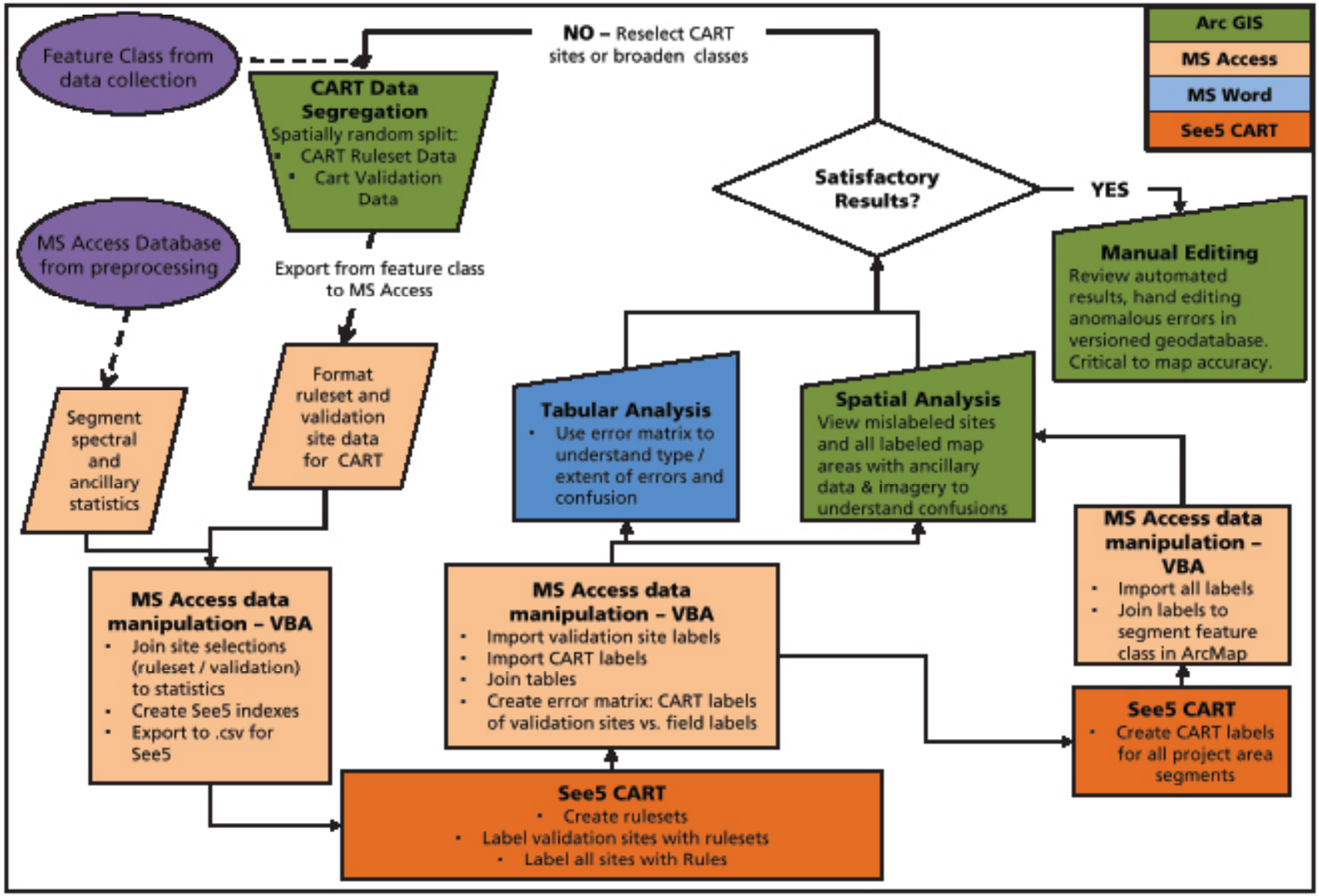


Figure 20b. Project workflow.



report details those methods.

Physical Implementation of the Vegetation *Association Key*

The most important step in any mapping project is the development of the map classification key which organizes vegetation into discrete classes that meet the goals of the eventual map users. The fundamental requirement of any classification key is that it consist of both labels and rules (i.e. definitions) that are mutually exclusive, totally exhaustive, and hierarchical.

The National Park Service (NPS) retained NatureServe to develop the vegetation classification descriptions and key for the project area based on analysis of 1497 detailed classification samples collected in the field during 2007 and 2008. Because the vegetation key was not delivered in time for Phase 1 mapping in 2009, KGA developed an ad hoc vegetation key to create the draft map of the Phase 1 mapping area (see Figure 4). In July of 2010, NatureServe delivered a draft vegetation key (NatureServe, 2010) which was used in Phases 2 & 3 of the vegetation mapping project. Both keys are included in Appendix B of this report.

KGA programmed both the KGA Phase 1 and the NatureServe key rules in Python. The resulting program is called the "Autolabeler". It enables

- field data entry in ArcGIS on Trimble Yuma field computers,
- automated labeling to the association level in the field and the office of both KGA and NPS field sample segments from field estimates of percent cover by species, and
- evaluation and analysis of NatureServe derived plot labels versus the labels created automatically.

Following programming of the key, all NatureServe manually derived sample labels were compared to those generated by the Python key and discrepancies were investigated which either affected the NatureServe key rules or the Python script. The physical implementation of both the KGA and NatureServe keys can be found in Appendix B of this report.

Image Preprocessing

Four image data sets were available to the project:

- National Agriculture Image Program (NAIP) 2010 DMC 4 band, 8 bit Digital Ortho Quarter Quads (DOQQs) for the entire project area with significant shadowing and some mis-registration in portions of this dataset.
- NAIP 2007 ADS40 4 band, 8 bit DOQQs for the entire project area with severe shadows in the canyons,
- 2005 true color, film based digital DOQQs of the project area which were flown to minimize shadows, and
- 2005 and May 2009 ADS40 4 band imagery of the Colorado River corridor which was flown to minimize shadows.

This project relied on both the 2007 and 2010 imagery for image segmentation and classification. For manual interpretation all of the available image sets were used interchangeably throughout the project. Often one image data set would reveal clues to vegetation that were hidden, in shadow, or somehow obscured in the other image data set.

Both sets of 2007 and 2010 imagery were preprocessed to remove or neutralize any spurious image variation. The most illuminated image set of each processing region was used. Finally, the imagery was divided into processing regions based on the project area's physiography and land forms. Figures 21 a, b, and c show the processing regions for each Phase of the project. All image preprocessing was done in ArcGIS (Environmental Systems Research Institute 2009).

Image Segmentation

KGA employed Trimble's (formally Definiens) eCognition software (Trimble Geospatial Imaging, Inc. 2007) to segment the NAIP imagery into spectrally unique objects. Similar to the manual delineation of polygons in photo interpretation, segmentation algorithms delineate digital imagery into

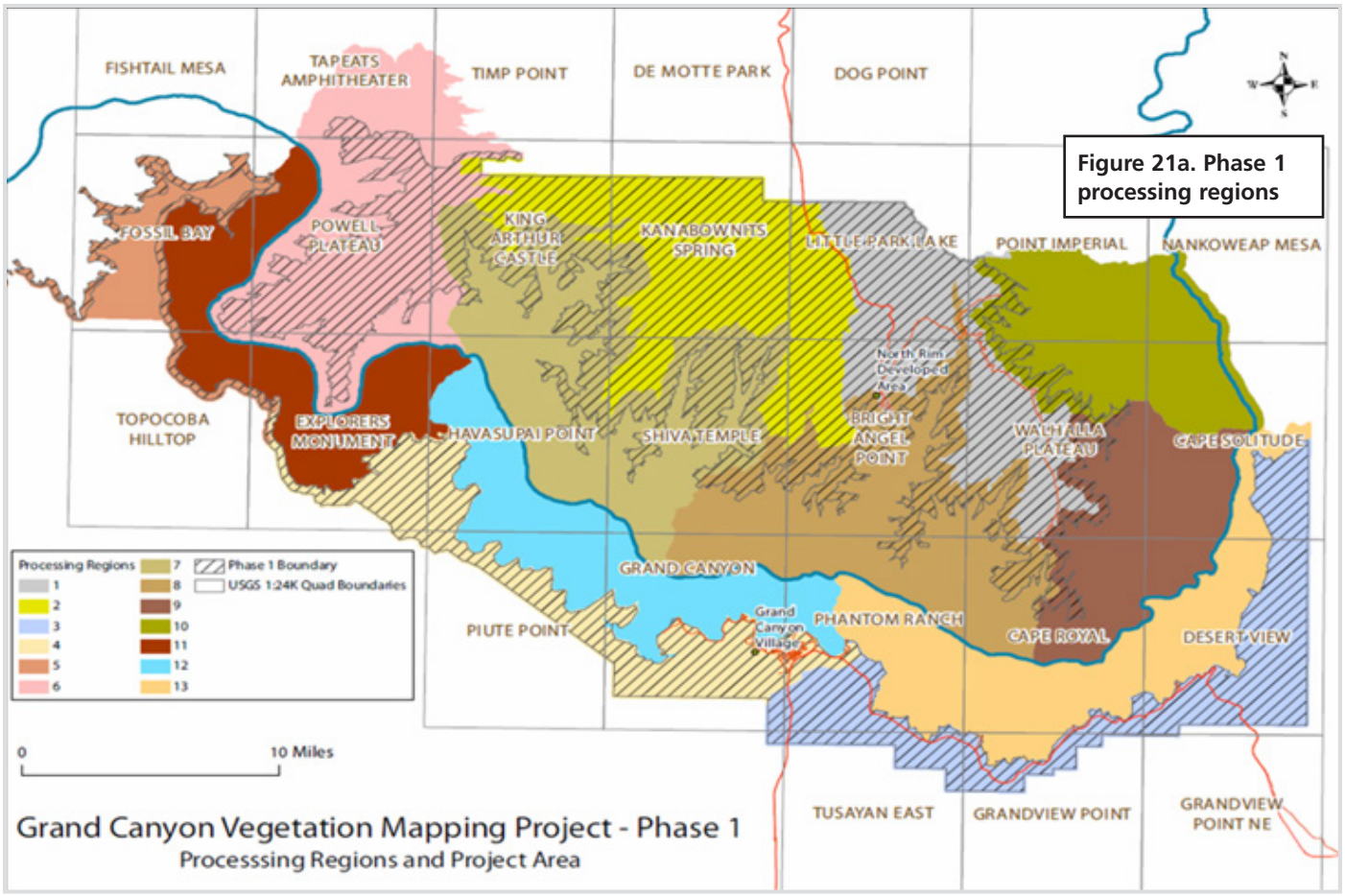


Figure 21a. Phase 1 processing regions

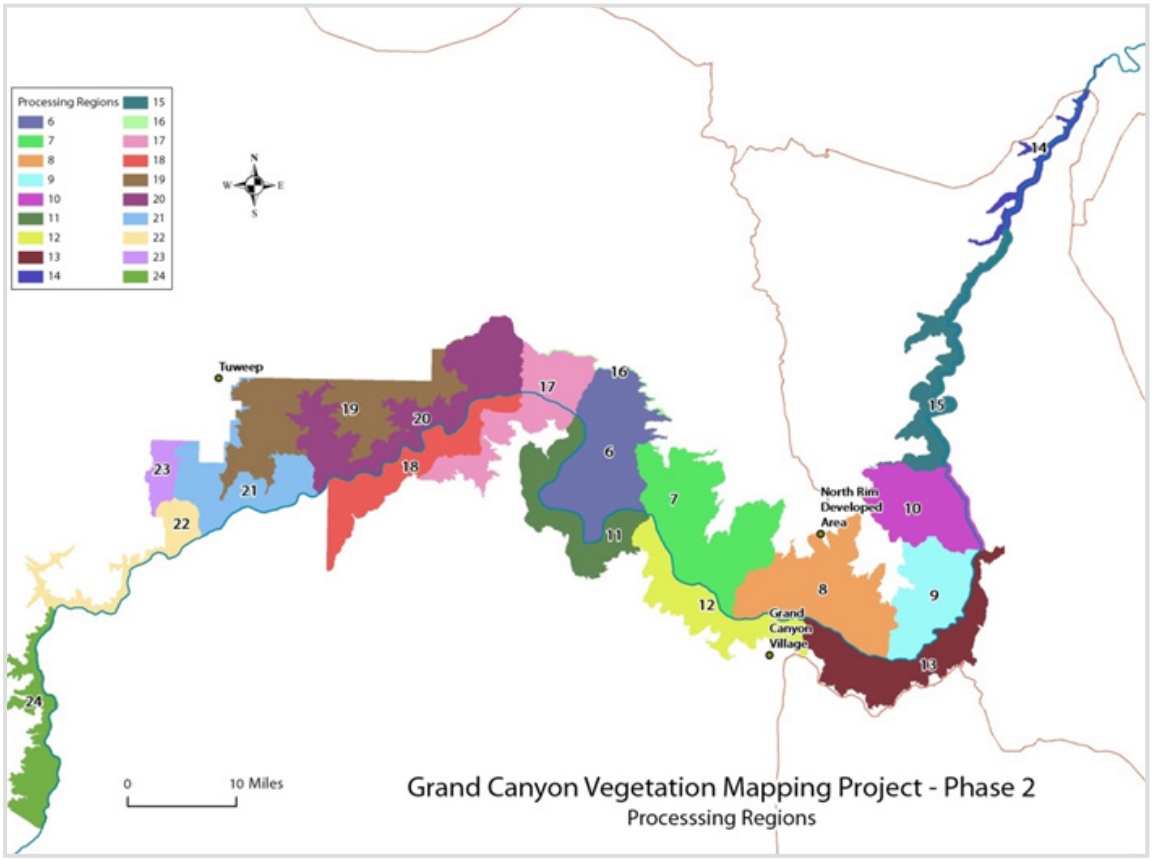


Figure 21b. Phase 2 processing regions.

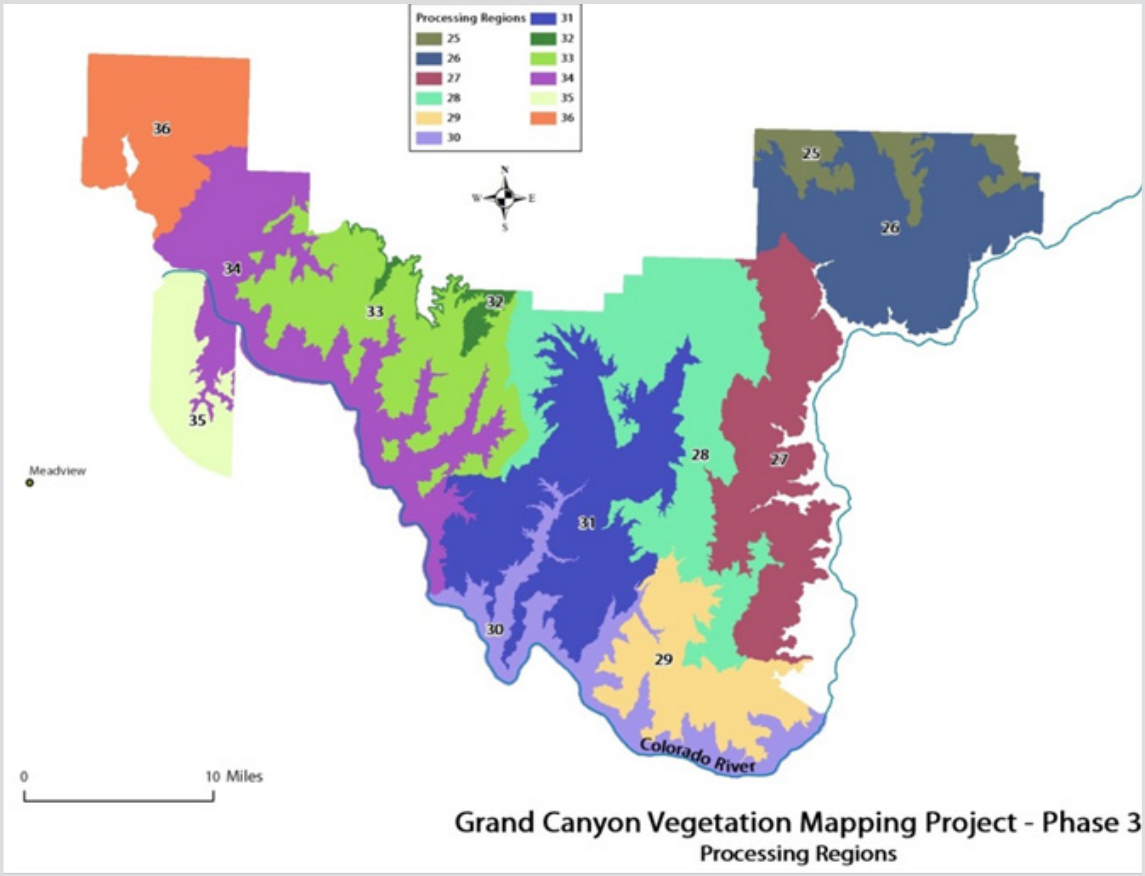


Figure 21c. Phase 3 processing regions.

groups of pixels, called objects or segments, which have more spectral variation *between* than *within* segments, based on a user defined set of inputs. Automated segmentation improves on manual delineation by forcing consistency and increasing detail in the delineation process. Image segments are always more detailed and numerous than final map polygons because the segmentation process is based on spectral reflectance and scale parameter inputs which can segment out multiple areas of the same vegetation class which are adjacent. At the end of the mapping process, delineations between adjacent segments with the same vegetation label are dissolved to create vegetation polygons as illustrated in Figure 22 for a portion of the project area near Lake Mead.

Segments were generated by processing region (see Figures 21 a-c). Phase 1 relied upon the 2007 NAIP imagery for segmentation as



Figure 22. Image segmentation and vegetation polygon creation.

Left: False color infra-red imagery with segments delineated in yellow.
Right: The resulting vegetation map of the same area with segments of the same vegetation classes merged.

the 2010 imagery was not available during the Phase 1 timeframe. In Phases 2 & 3 most processing regions were segmented using the 2010 NAIP imagery. However, in the regions where the 2010 NAIP was heavily shadowed mis-registered, the 2007 imagery was used instead. Table 12 lists the image source for segmentation of each processing region.

Various segmentation parameters were used depending on the date and location of the imagery (e.g. above or below the rim). Details on segmentation parameters can be found in the final reports for each Phase (Green and Tukman, 2010, 2011, 2013).

Draft versions of the segmentation were sent to Grand Canyon National Park personnel

Table 12. Imagery used for segmentation by processing region

Processing Region	NAIP Imagery used for segmentation	Reason why 2007 imagery was used instead of 2010
1	2007	2010 NAIP not available for Phase 1
2	2007	2010 NAIP not available for Phase 1
3	2007	2010 NAIP not available for Phase 1
4	2007	2010 NAIP not available for Phase 1
5	2007	2010 NAIP not available for Phase 1
6	2007	Heavy shadows in the 2010 imagery
7	2010	NA
8	2010	NA
9	2010	NA
10	2010	NA
11	2007	Heavy shadows in the 2010 imagery
12	2010	NA
13	2010	NA
14	2010	NA
15	2010	NA
16	2010	NA
17	2010	NA
18	2010	NA
19	2010	NA
20	2010	NA
21	2010	NA
22	2007	Mis-registration of 2010 imagery
23	2010	NA
24	2007	Mis-registration of 2010 imagery
25	2010	NA
26	2010	NA
27	2010	NA
28	2007	Heavy shadows in the 2010 imagery
29	2010	NA
30	2007	Heavy shadows in the 2010 imagery
31	2010	NA
32	2007	Heavy shadows in the 2010 imagery
33	2007	Heavy shadows in the 2010 imagery
34	2007	Heavy shadows in the 2010 imagery
35	2007	Heavy shadows in the 2010 imagery
36	2010	NA

for review and were edited in response to their comments. Most of the segment editing was focused on riparian corridors and vegetation in the many intermittent washes in the inner canyon parts of the project area.

Acquire and Create Independent Variable Data Sets and Calculate Zonal Statistics

Since the beginnings of photo interpretation over 100 years ago, the key indicators of vegetation type have been the color, tone, texture, location, context, height and shape of the feature of interest (Spurr, 1948). While many of these indicators can be derived from remotely sensed data (i.e. color, tone, texture, shape, and height), others such as location and context must be derived from ancillary data. Data ancillary to the imagery are critical to vegetation map creation because they often can capture causes of variation in vegetation type that are not captured by the imagery.

The NPS supplied the KGA Team with well over 10 gigabytes of imagery and ancillary data. KGA also acquired multiple data sets and created several ancillary data layers. Measures of each segment's color, tone, and texture were derived from the 2007 and 2010 NAIP imagery and multi-temporal Landsat TM imagery. Measures of shape were obtained from the eCognition segment shape outputs. Location information was acquired from ancillary data layers such as digital elevation models, fire history and intensity maps, stream coverages, virtual flow polygons, and geologic formations among others. In addition, several contextual models were built within ArcGIS, including landform (NatureServe, undated), solar radiance, proximity to streams, horizontal distance from the rim, vertical distance from the rim, and proximity to the Colorado River centerline. Lists of Independent variables developed for this project from the imagery, segments, and ancillary data may be found in the final reports for each Phase (Green and Tukman, 2010, 2011, 2013).

Once the independent variable layers were created or acquired, they were reviewed and co-registered. Verification and co-registration of ancillary data and imagery is an important task which insures that the independent variables being sampled are, in fact, associated with the vegetation class of interest.

Next, each independent variable layer was intersected with the segment layer in ArcGIS and segment zonal statistics for each layer (usually the mean and the standard deviation) were created for each variable for each segment. A relational database of each sample segment's dependent variable (i.e. vegetation type) and independent variables (from either eCognition or ArcGIS) was created in Microsoft Access.

Other ancillary data depicting the vegetation of the project area from earlier or smaller scale projects were also acquired but only for use in map review and not in the Classification and Regression Tree (CART) analysis (see Section H, below). Legacy vegetation data included field plots from Warren's 1982 map of the Grand Canyon National Park, Warren's 1982 map of the Grand Canyon National Park vegetation (Warren et al. 1982), field data and plot data used to make the USGS Riparian map (Ralston et al., 2008), and a survey of vegetation and soils on Fishtail Mesa (Brian and Rowlands, 1998).

Sample Data Collection

Field sampling is the most effective way to understand how remotely sensed and ancillary data may be used to map vegetation because it provides an understanding of

- the causes of vegetation variability, and
- the relationship between vegetation variability and that of the imagery and ancillary data layers.

Field data was collected throughout the project for vegetation classification, use in Classification and Regression Tree (CART) modeling, and accuracy assessment. Field data collection started with NPS classification and observation samples and ended with KGA calibration and accuracy assessment samples.

For KGA mapping and accuracy assessment, NPS classification and observation plots (discussed in Chapter 4) were transformed into sample segments where possible using photo interpretation. All KGA samples were collected as segments. The result was a combined set of KGA and NPS sample segments.

Park Service Classification and Observation Plots

NPS classification and observation field plots were collected by NPS cooperators in 2007 and 2008. These data are of two types: classification plots and observation plots. Comprehensive documentation of NPS methods for collecting classification and observation plot plots can be found in Chapter 4 of this report and in Ayers et al. (2010).

NatureServe provided a vegetation association label for each NPS classification plot. KGA used the NatureServe labels of the classification plots to check and calibrate the classification rules implemented by the Autolabeller (see section B above). Because observation plots were not labeled by NatureServe, KGA ran the observation plot data through the autolabeler to create a vegetation association label for each observation plot.

The classification and observation plots were then intersected with the segments. The NAIP imagery of each segment containing a classification or observation plot was then manually reviewed by the KGA botanists who determined whether or not the plot label was appropriate for the segment. Analysts rejected NatureServe plot labels as segment labels if the segment represented a different vegetation association than indicated by the plot label (e.g. when the plot desc*Ribes* vegetation occurring in a small island of the segment which is smaller than the minimum mapping unit or when the plot is mis-registered relative to the imagery).

KGA Sample Segments

KGA sample segments were collected on multiple field trips throughout the 3 years of the project (Figures 21a, b, and c). (Green and Tukman, 2010, 2011, and 2012). In Phase 1 KGA field data collection was limited to samples similar to NPS observation samples in that they require estimation and data entry of percent overstory cover by each vegetative species. While valuable, this type of intensive detailed sample is time consuming and acquires more information than necessary for vegetation mapping. Therefore in Phases 2 and 3, a second type of field sample was added (Segment Labels) which consisted of segments which were labeled to vegetation association without data on the percent cover of each overstory species.

Guidelines for the selection of field sample segments were:

- *Informational homogeneity* – The sample must represent one and only one vegetation class. Segments including more than one vegetation class were edited to represent only one class.
- *Spectral homogeneity* – The sample should have more between than within segment spectral response
- *Minimum size* – Samples should be larger than the minimum mapping unit of 0.5 hectares.
- *Project-wide distribution* – For each class, field personnel attempted to distribute the sites evenly across that class's distribution in the project area.
- *Spectral uniqueness* – Samples were collected of vegetation with spectrally unique characteristics.

Segment Label sampling was conducted whenever and wherever the field personnel were in the project area. These Segment Label samples were also collected along the entire river corridor over the course of two river trips and in every area hiked by the field crew in Phases 2 and 3.

The focus of the calibration trips was to capture as much field verified information as possible and to collect samples in vegetation classes that were under represented in the NPS plots and/or were spectrally interesting. Field personnel labeled segments at every opportunity resulting in the labeled segments constituting the largest type of KGA field sample (see Table 13).

During Phase 1, field sample data were collected on laptops loaded with ArcGIS, the NAIP imagery, the segments and ancillary data layers. For Phases 2 & 3, field sample data were collected on Trimble Yuma field computers (Figure 23). Segment labeling was implemented by selecting segments from the processing region segment coverage and choosing the vegetation association from a pull down menu in the attribute table. Detailed field sample data was entered using the field forms created for Phase 1 and Phases 2 & 3 (see Figure 24). The form automatically provides quality control and calculates the vegetation association of the sample segment using the Autolabeler program. The form also provides the option of selecting one or two alternative acceptable vegetation class label(s) when multiple Associations were possible based on the vegetation key.



Figure 23. Field data entry on the Trimble Yuma.

Table 13. KGA field samples by Phase and type.

Sample Type	Phase 1	Phase 2	Phase 3
Detailed	727	314	159
Segment Label		15,901	12,593

Vegetation Classes and Map Model Classes

Ideally, when the vegetation association changes, the response of the remotely sensed data and the classes of the ancillary data also change, resulting in a one to one relationship between the associations and map classes. However, because vegetation associations are often distinguished from one another by sub canopy and/or scarce indicator species, it is often impossible to map to the association level, resulting in the need to collapse associations into less detailed map model classes. Therefore, a critical step in each Phase of the project was the translation of the NatureServe ecological association descriptions and key into map model classes which could be mapped from remotely sensed data and ancillary information.

Following the calibration trips for each Phase, the mapping team, NatureServe, and NPS park personnel worked together to develop the map model classes. For each NatureServe association a determination was made regarding if the association was

- abundant and distinguishable using the imagery and/or ancillary data so as to be mapable using CART modeling coupled with manual editing,
- indistinguishable from the imagery and ancillary data and, therefore, needing to be collapsed upward to the alliance or group level, or
- too rare to be mapped using CART modeling coupled with manual editing, in which case it would appear on the final map only in places where it was found during the NPS and KGA field data collection.

The final set of map labels included both map model labels and field sample labels. All segments containing KGA or NPS field samples which were not being held out for accuracy assessment were labeled with their field-determined labels. All others segments were labeled with their map model class.

A table which relates the NatureServe NVCS Associations to the map model classes is attached to this report as Appendix E.

Classification and Regression Tree (CART) Modeling

The vegetation maps were created using a combination of CART modeling and manual editing. CART analysis builds "tree" diagrams for predicting variables from categorical and continuous data (Breiman et al., 1984). It "mines" the sample data and builds rules which are if-then statements in hierar-

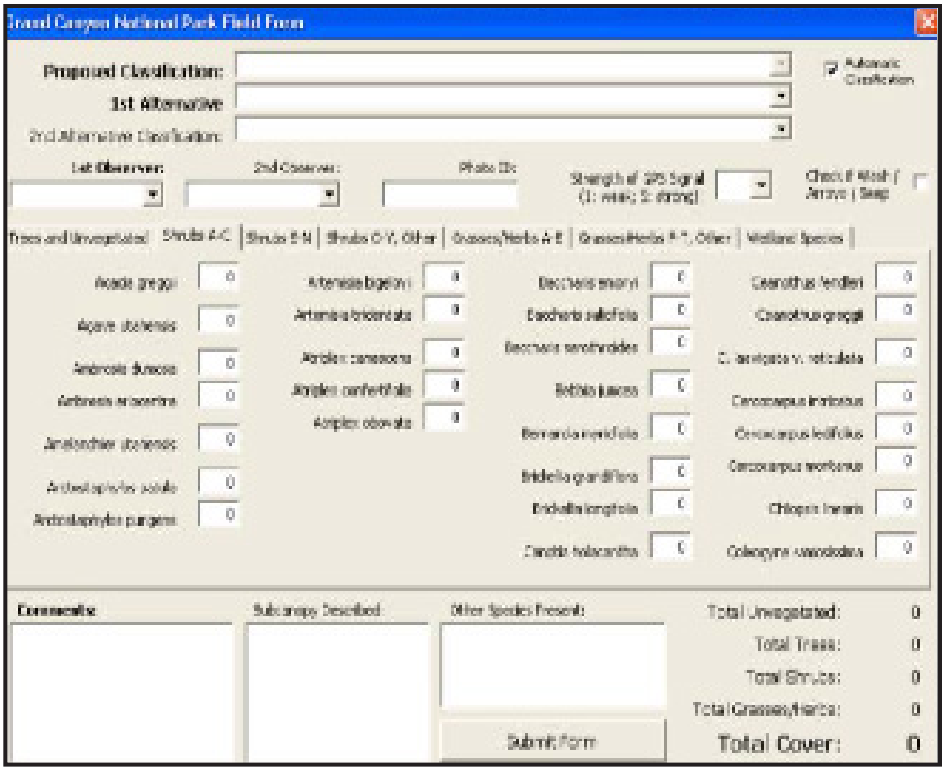


Figure 24. Field data entry form for Phases 2 & 3.

chical "trees" that condition the prediction of vegetation classes. CART is powerful because

- it can accept both continuous and categorical data inputs,
- the results are easy to interpret,
- unlike a maximum likelihood classifier, no assumptions are required concerning the distributions of the independent variables,
- it identifies simple and complex relationships between variables that other techniques might not uncover, and
- it forces consistency and analytical rigor into the segment labeling process.

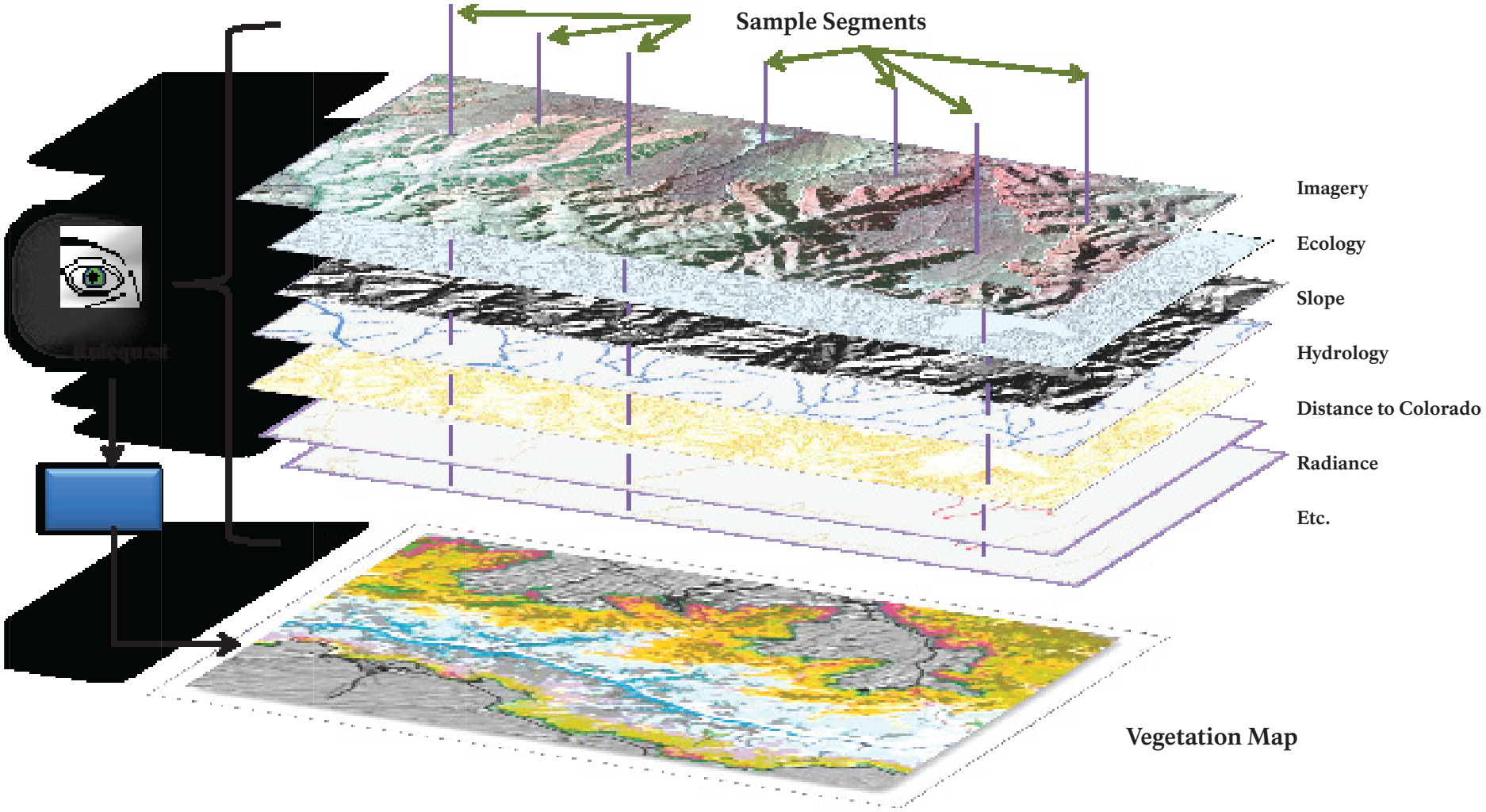
CART analysis was performed on the NPS Classification and Observation plots not reserved for accuracy assessment using See5 software (RuleQuest Research Pty, Ltd. 2008). Input variables to CART were the database of segment dependent variables (i.e. vegetation class as specified by the map classification system rules), and independent variables , such as the various measures from the ADS40 imagery (tone, color, segment shape, texture, etc) and ancillary data sets (e.g. Landsat imagery, landform, slope, aspect, elevation, closeness to meadows, closeness to the river, etc.). The segment labels were then imported into ArcGIS. Figure 25 is a conceptual illustration of how CART analysis combines independent variables to predict the vegetation of sampled segments.

For each Phase, CART was implemented hierarchically. First a map of life form (i.e. conifer forest, riparian forest, deciduous forest, evergreen shrub, deciduous shrub, pinyon juniper woodland, xeric shrub, and *Coleogyne*) was created and manually edited. Within each life form, CART was run again to build rules for determining segment draft map model classes which were a combination of Groups or Alliances.

Manual Editing to Produce the Draft and Final Maps

Manual edits were conducted to improve the accuracy of the map resulting from CART modeling. Manual editing was done in ArcMap. For quality control, pull down lists of allowable attribute domains were created both for lifeform and for map class editing. Typically, manual editing took place at scales between 1:5,000 and 1:10,000. At times, however, analysts would work at larger scales, especially in riparian areas.

Figure 25. Conceptual illustration of the CART data mining and rule creation process.



Two stages of editing occurred in each Phase:

- *Lifeform editing* resulted in changing a segment's CART lifeform label to a lifeform class believed by the image analyst to be more accurate. For example evergreen shrub could be confused with pinyon juniper woodland in a mixed pinyon juniper – evergreen shrub type such as *Pinus monophylla - Juniperus osteosperma* / *Quercus turbinella* Woodland, especially if the pinyon juniper vegetative cover is low (e.g. close to class boundary of 10% pinyon juniper) and the evergreen shrub cover is high. Image analysts carefully reviewed the lifeform map created by CART and edited lifeform class where they found errors.
- *Map class editin*g occurred within lifeforms and resulted in changing a segment's map label to what was believed to be a more accurate map class which was derived from manual interpretation added by field notes, ancillary data, and legacy vegetation maps and data. Since many of the map classes in the Grand Canyon are difficult to distinguish using manual interpretation, map label editing was often used as a way to expand field-labeled segment labels to surrounding segments with similar spectral signatures, slope, aspect, etc.

Following the competition of all three Phases, a final round of editing was performed on the entire project area to remove false seam lines and correct for any newly discovered errors.

Draft Map and *Report Review*

During each phase, a draft map and metadata were delivered to NPS and KGA botanists for review. NPS personnel performed an informal validation with 40 to 50 samples in each phase before approving the draft map for further work (Lea and Curtis 2010). Because the project and mapping contract with KGA were commenced before the revised requirements, no formal reporting resulted from for the validation step. A draft report was also submitted to NPS personnel for each phase as well. Comments on both draft deliverables were incorporated into the map and the report to produce each Phase's final map and report.

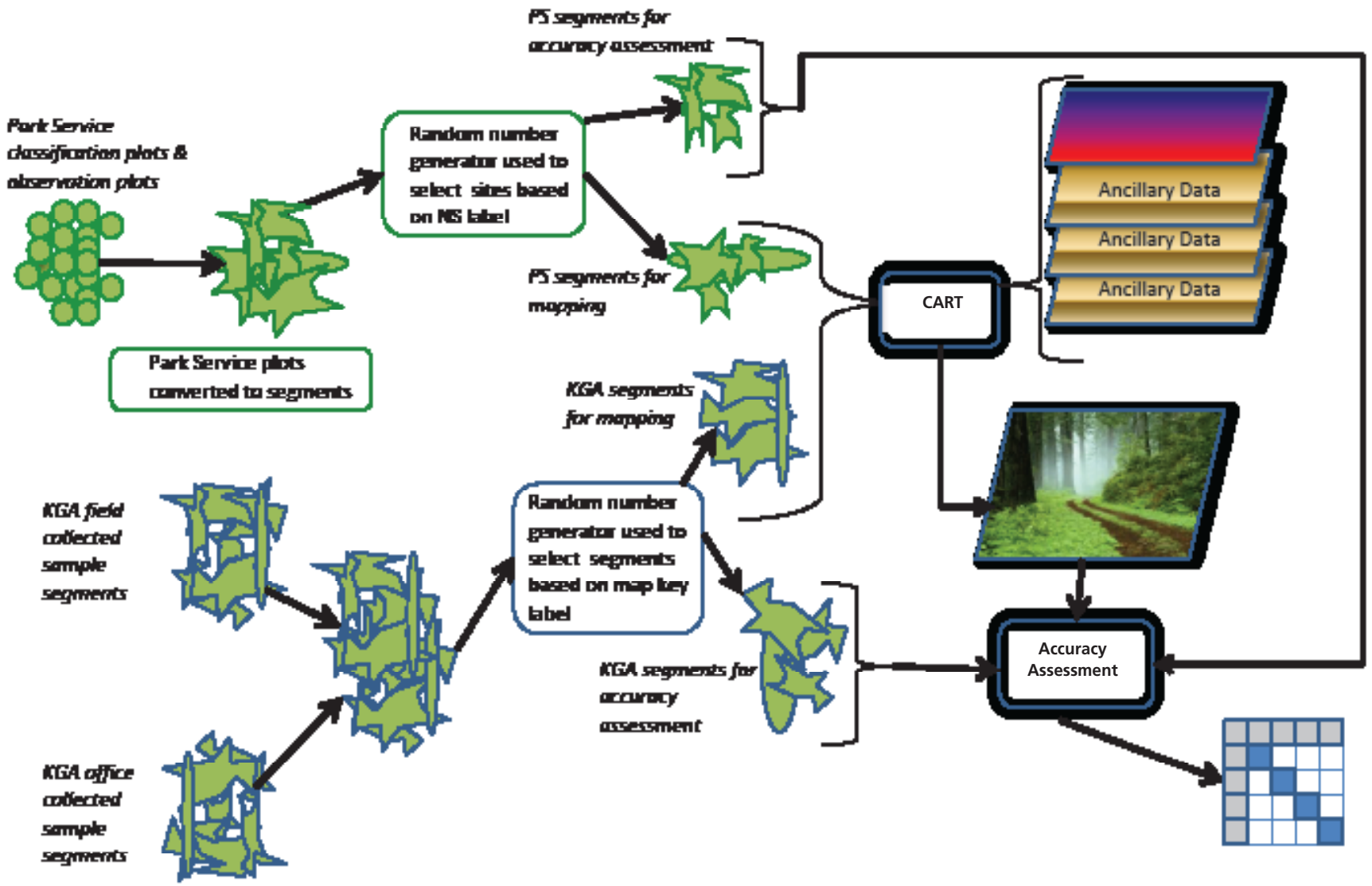
Accuracy Assessment

The accuracy assessment sample selection design for this project was developed during the proposal process in April of 2010 and before release of the NPS update of the agency's *Thematic Accuracy Assessment Procedures* (Lea and Curtis, 2010). Therefore, the procedures used in each Phase's accuracy assessment follow the earlier 1994 NPS guidance on thematic accuracy assessment (Environmental Systems Research Institute et al. 1994). However, new NPS standard contingency tables (Lea and Curtis, 2010) were also developed for the final project wide accuracy assessment presented in this report.

Figure 26 illustrates how accuracy assessment samples were selected from the KGA and NPS sample segments prior to CART analysis for each Phase. First, all the sample segments in each Phase (NPS classification and observation plots converted to segments and KGA sample segments) were labeled by the Autolabeler. Next, a random number generator was used to select a stratified subset of the sample segments for accuracy assessment. Accuracy assessment sample segments were held separate from the sample segments used to build the CART rules and were not available to map analysts or editors.

The number of accuracy assessment samples per class was determined by the abundance of NPS and KGA segment samples in each map model class. In general, classes with higher acreages in the project area received more total segment samples and, correspondingly, more accuracy assessment samples. The goal was to collect at least 30 accuracy assessment samples per map class per Phase. However, some classes (such as *Canotia holacantha* Shrubland) are too rare across the landscape to generate 30 samples segments, much less a subset of 30 accuracy assessment samples. The number of accuracy assessment sample segments collected per map model class per Phase can be found

Figure 26. Sample selection for CART and accuracy assessment.



in Appendix F.

Because numerous map model classes span more than one Phase area, final project accuracy assessment required choosing a subsample of the accuracy assessment Phase samples to ensure that abundant classes were not over sampled and, therefore, allowed to unduly weight the accuracy assessment to the more abundant classes. For example, the *Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance map model class exists in all three Phases and received 141, 15, and 2 accuracy assessment samples in Phases 1, 2, and 3, respectively. For the final project accuracy assessment, a random number generator was used to select no more than 50 of the total 158 accuracy assessment samples in the *Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance map model class.

Final Map, Report and *Database Delivery*

Prior to final delivery for each Phase, the known locations (from NPS or KGA field work) of vegetation associations which had been collapsed into map model classes were "burned" into the final map. Accuracy assessment reference labels were also "burned" into the map for all accuracy assessment sample segments. Therefore, the final map includes both plant association and map model class labels.

Final delivery included electronic and hard copy maps required at a 1:48,000 scale for the each project Phase. Additionally a geodatabase of the final maps was delivered in UTM NAD83 HARN datum. All electronic data, including GIS Data, includes metadata compliant with Federal Geographic Data Committee Metadata Standards. Each Phase also has a final report which details the vegetation mapping and accuracy assessment methods and results for each phase (Green and Tukman; 2010, 2011, & 2012).

Results

Final vegetation maps for each phase are displayed in Figures 27a-d. After combining results from all three phases, the final map for the project area was comprised of 86 modeled map classes. Of these, 82 were vegetation types and four were unvegetated surfaces.

Vegetation Classes to Map Classes

There were several conditions under which an Association level community could not be mapped at all. First, there were many cases of Associations for which CART did not have enough data to analyze. Most Park Specials had only one or a very few samples associated with them. As such, it was not possible to generate enough training samples for CART to predict their distribution reliably. Second the physical characteristics of some habitats did not lend themselves to reliable mapping. Hanging garden communities typically occur in alcoves and on vertical cliff faces where they could not be seen from above. *Peucephyllum schottii* Sparse Vegetation could not be mapped reliably either, even though it was seen extensively throughout the western end of the mapping area. It was seen almost exclusively on steep canyon walls along the Colorado River and its tributaries. When viewed in aerial imagery, these habitats were only a few pixels wide and were often shadowed. The segmentation did not consistently separate these cliff habitats from the surrounding matrix and this limited the quality and abundance of data that CART could work with, even when patches were distributed along hundreds of meters of cliff face.

Some communities, especially woody riparian types, were found in areas where the scales of variation were finer than the mapping project was designed to document. *Acer negundo* riparian forests with *Brickellia*, *Quercus gambelii*, or *Quercus turbinella* could only be mapped as *Acer negundo* Woodland Alliance. Similarly, riparian forests with Sonoran affinities supporting *Populus fremontii* in the overstory were mapped as *Populus fremontii - Salix gooddingii* Woodland Alliance, regardless of whether they contained *Fraxinus*, *Acer*, or *Baccharis* in the understory. Along the Colorado River, most vegetation occurs in vertically stratified strands which are rarely more than a few meters wide. The shrub-dominated vegetation there were mapped as either *Tamarix spp*. Tempo-

Figure 27a. Final vegetation map of the Phase 1 area

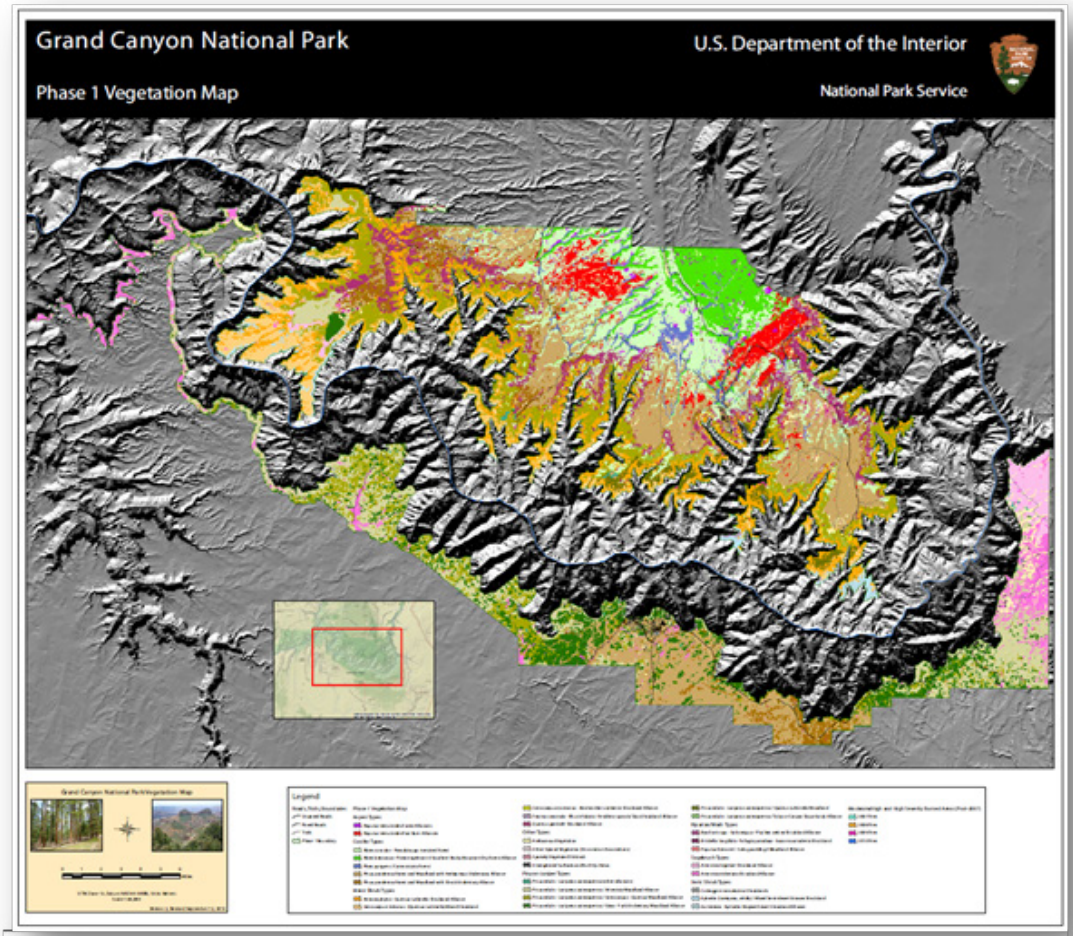
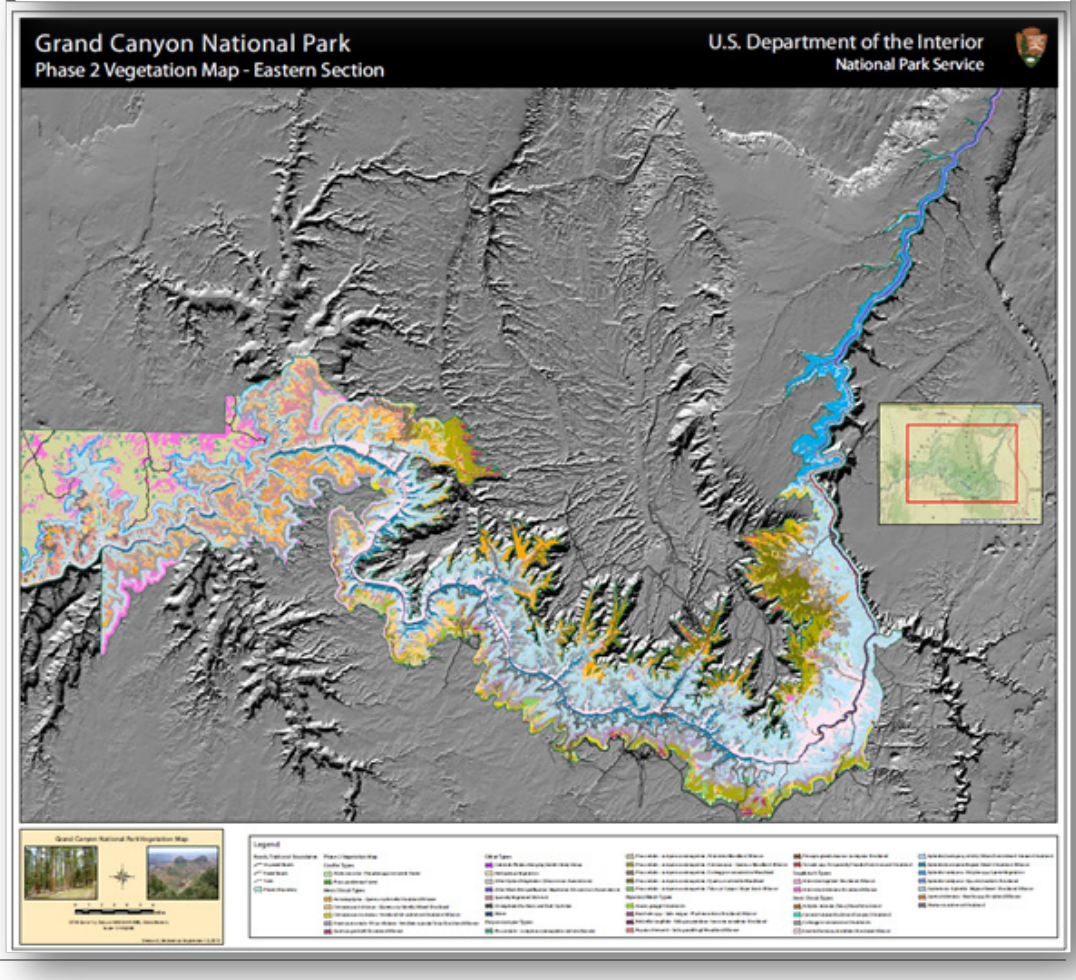


Figure 27b. Final vegetation map of the east portion of the Phase 2 area.



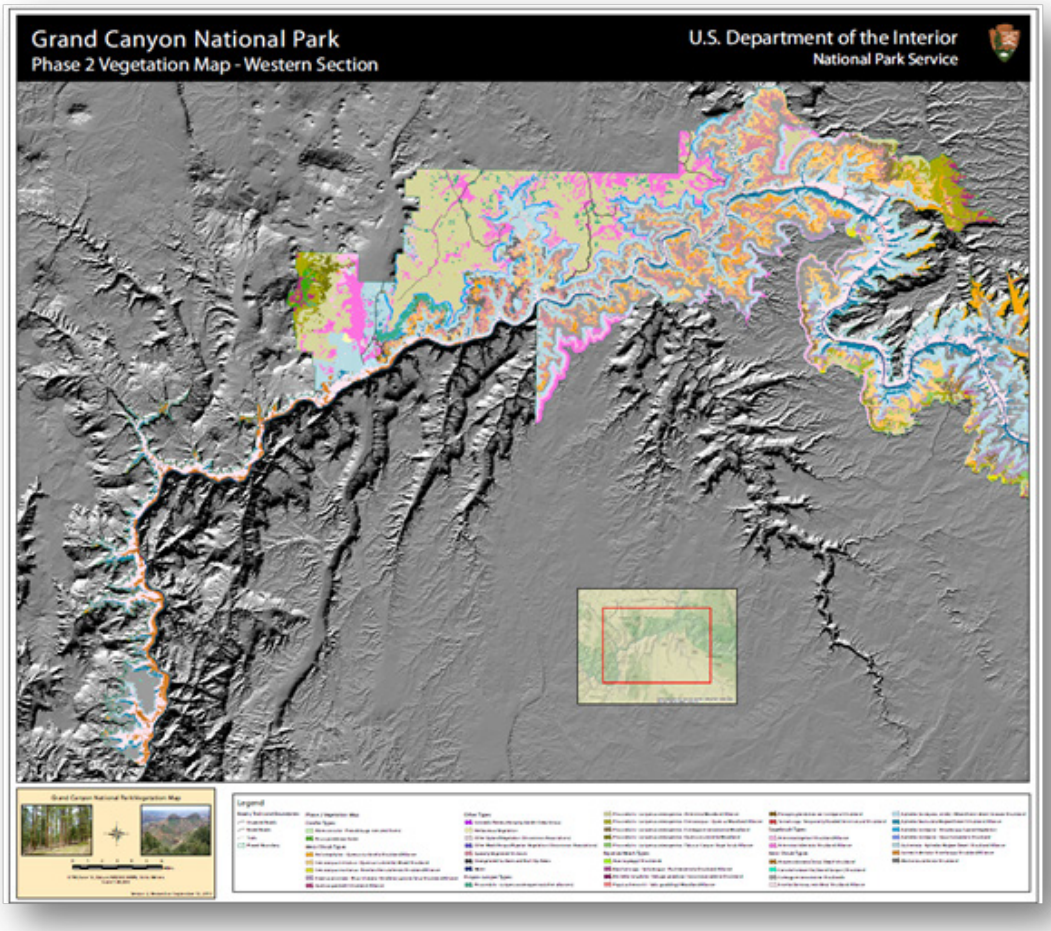


Figure 27C. Final vegetation map of the west portion of the Phase 2 area.

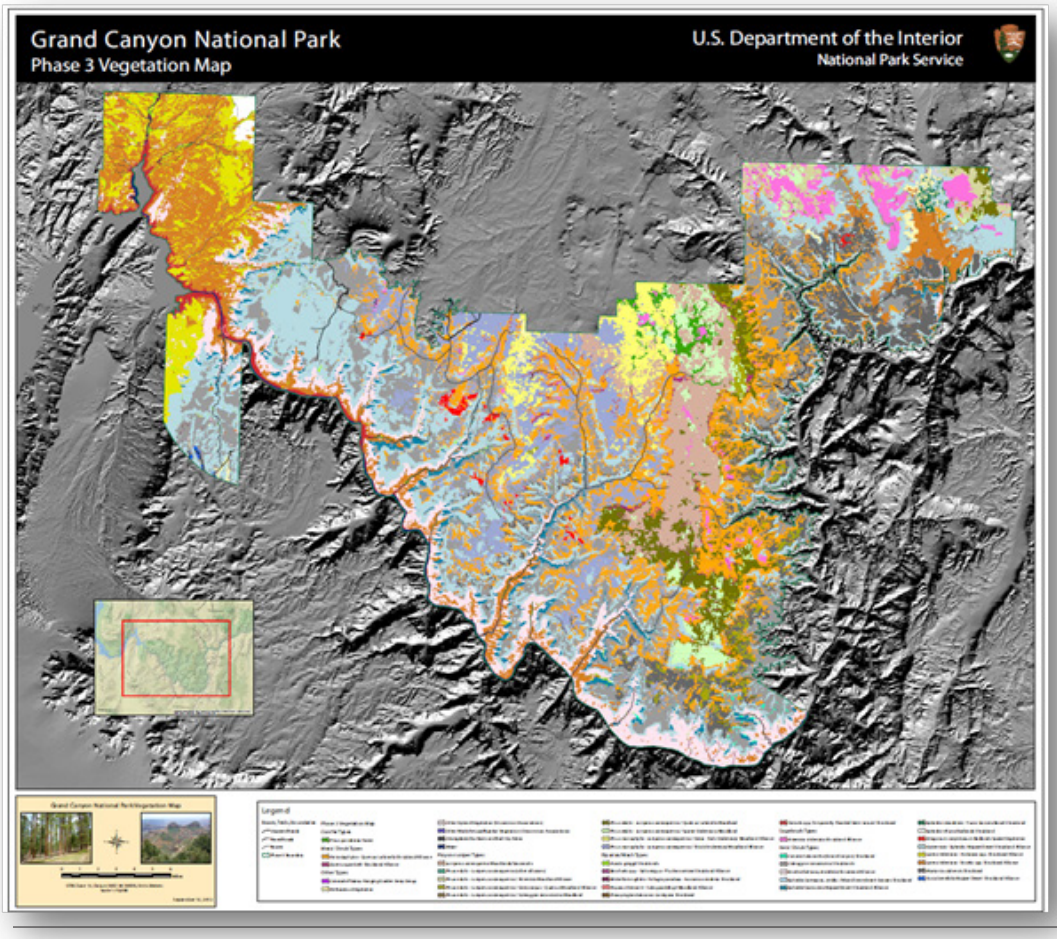


Figure 27d. Final vegetation map of the Phase 3 area.

rarily Flooded Semi-natural Shrublands or as the *Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance, which were comprised of 8 separate NVCS Association level communities.

In less constrained habitats, many Associations appeared extremely similar in the aerial imagery because they are structurally and floristically very similar. Spectral data, both simple reflectance and derived measures of roughness, could not distinguish between forests and woodlands that have similar canopies but differ in the herbaceous species in the understory. When values of the other environmental variables were too similar across the same communities for CART to distinguish them, they were placed in a single map class. For example, *ponderosa* pine woodlands with *Carex siccata*, *Carex rossii*, *Bouteloua gracilis*, and *Pteridium aquilinum* could not be reliably distinguished and were mapped as *Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance. Similarly the denser canopy of the spruce-fir forests in the northeast parts of the Phase 1 mapping area obscured the understories of both the *Abies lasiocarpa - Picea engelmannii / Carex siccata* Forest and the *Abies lasiocarpa - Picea engelmannii / Juniperus communis* Woodland, so both were mapped as *Abies lasiocarpa - Picea engelmannii* Southern Rocky Mountain Dry Forest Alliance. Similar difficulties resulted in the lumping of the Associations within the *Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance.

Some map classes could only be developed using geographic information not used in the mapping of other groups. Nine Association level communities in the Great Basin Pinyon - Juniper Woodland Group had nearly identical correlate Association level communities in the Colorado Plateau Pinyon - Juniper Group. The primary difference between them was that the former were dominated by *Pinus monophylla* and *Juniperus osteosperma*, and the latter by *Pinus edulis* and *Juniperus osteosperma*. After reviewing sample and field crew experiences, it was determined that, for mapping purposes, a dividing line between Great Basin and Colorado Plateau pinyon - juniper communities would be drawn at Kelley Point at the southern end of the Shivwits Plateau. East of that point would be modeled as Colorado Plateau communities and west would have the Great Basin types.

In the end, the 222 NVCS Association level community types classified during this project were reduced to only 195 map classes. Less than half of the map classes were modeled to predict their distribution; 113 were simply "burned" into the map in the segments where they had been sampled in a "map only where seen" approach. The remaining 82 vegetated map classes were a mix of communities representing varying levels in the NVCS hierarchy. There were 35 Association-level communities described by this project which were common and distinct enough to make predictions about their distribution. There were also 36 NVCS Alliance level map classes and 11 which represented NVCS Group levels or higher categories in the NVCS hierarchy. There were also four unvegetated map classes: Built-up, Sparsely Vegetated Slickrock, Unvegetated Surfaces, and Water. Appendix E contains a table showing the arrangement of NVCS Association into map classes.

Accuracy Assessment

Following completion of the Draft and Final Maps for each Phase, accuracy assessment matrices (Congalton and Green, 2009) were built that compare the Final Map Model Class label for each accuracy assessment sample to that sample's reference label. Overall accuracy assessment percentages for each Phase can be found in Table 14. Error matrices for each Phase can be found in each Phase's final report (Green and Tukman, 2010, 2011, 2012).

Accuracy was analyzed as follows:

- Cases of agreement were where the map class and the reference sample's label were the same.
- All other cases were "confused" samples (e.g. the map and the reference label do not match).
- Overall accuracy was determined by

dividing the number of samples in agreement by the total number of samples.

- Producer's accuracy was the number of samples in agreement for a class divided by the total number of reference samples in that class.
- User's accuracy was the number of samples in agreement for a class divided by the total number of map samples in that class.

Overall accuracy for the project wide accuracy assessment is 77% with 1415 of the total 1847 accuracy assessment samples in agreement and 432 confused. Of the 47 map model classes assessed, 28 have an average user's and producer's accuracy above 75%.

Table 14. Draft and final overall accuracies for Phases 1-3.

	Phase 1	Phase 2	Phase 3
Draft Overall Accuracy	81%	67%	79%
Final Overall Accuracy	85%	73%	82%

Approximately one third of the confusion (128 of the 432 confused samples) is along the margins of map classes where confusion is to be expected. For example, both the *Larrea tridentata - Encelia spp.* Shrubland Alliance and the *Encelia* (*farinosa, resinifera*) Shrubland Alliance are sparsely vegetated types with shrub cover between 10-20%. Both types include both species of *Encelia* and *Larrea tridentata*. *Fouquieria splendens* can also occur in both types. The two types are distinguished primarily by the amount of *Larrea tridentata* which occurs up to 1% for the *Encelia* (*farinosa, resinifera*) Shrubland Alliance, and averages 3-5% in the *Larrea tridentata - Encelia spp.* Shrubland Alliance. Given that both photo interpreters and vegetation surveyors often vary by more than 10% in their estimates of vegetation cover (Spurr, 1948, Helm and Mead 2004), it is not surprising that 9 of the accuracy assessment samples confuse the *Larrea tridentata - Encelia spp.* Shrubland Alliance with the *Encelia* (*farinosa, resinifera*) Shrubland Alliance.

Other similar class margin confusion occurs as follows:

- Twenty-five percent of the confused samples are within lifeform class with
  - 11% (48 samples) within the *Pinus edulis - Juniperus osteosperma* types,
  - 7% (31 samples) within the *Ephedra* classes,
  - 5% (20 samples) between the two *Pinus monophylla - Juniperus osteosperma* classes, and
  - 2% (8 samples) between the two *Larrea tridentata* classes.
- Three percent (13 samples) of the samples confuse *Pinus monophylla - Juniperus osteosperma* / Grass - Forb Understory Woodland Alliance with *Juniperus osteosperma* Woodlands/Savannahs.

Other sources of confusion are:

- Six *Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance and 7 *Prosopis glandulosa* var. *torreyana* Shrubland samples classified as *Tamarix spp.* Temporarily Flooded Semi-natural Shrubland. Twelve of these 13 samples are from the Phase 2 area.
- Eight *Ephedra torreyana* - (*Atriplex canescens*, *Atriplex confertifolia*) Sparse Vegetation committed to *Artemisia bigelovii* Shrubland Alliance.

The level of overall map accuracy, 77%, was acceptable to Grand Canyon N.P. and Grand Canyon - Parashant N.M. for several reasons. First, the overall accuracy for the project was higher than the 70% standard required when the project began (The Nature Conservancy and Environmental Systems Research Institute 1994), and written into the mapping contract. Second, the mapping was done at a fine enough scale, that the trade-off of accuracy for detail was considered beneficial overall. And third, the confusion at the margins of vegetation classes (e.g., between *Larrea tridentata* and *Encelia* alliances or among *Ephedra* alliances) was most often between classes with similar management criteria, so that management recommenda-

Table 15. Summary of producer's and user's accuracies for all three phases combined.

Map Model Class	Producer's Accuracy	User's Accuracy
Canotia holacantha [Grand Canyon] Shrubland	100%	100%
Eriogonum corymbosum Badlands Sparse Vegetation	96%	100%
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	86%	100%
Populus tremuloides - Ceanothus fendleri / Carex spp. Shrubland	97%	88%
Southern Rocky Mountain Montane-Subalpine Grassland Group	86%	98%
Larrea tridentata - Ambrosia spp. Shrubland Alliance	86%	96%
Quercus gambelii Shrubland Alliance	94%	85%
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	86%	93%
Mortonia utahensis Shrubland	88%	90%
Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance	90%	87%
Abies concolor - Pseudotsuga menziesii Dry Forest Alliance	92%	84%
Ceanothus fendleri / Poa fendleriana Shrub-Steppe Shrubland	75%	100%
Picea pungens / Carex siccata Forest	88%	86%
Ephedra torreyana - Opuntia basilaris Shrubland	74%	97%
Coleogyne ramosissima Shrublands	90%	80%
Pleuraphis rigida Herbaceous Vegetation	65%	100%
Artemisia tridentata Shrubland Alliance	76%	88%
Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	76%	88%
Populus tremuloides / Carex siccata Forest	86%	75%
Cercocarpus intricatus Shrubland Alliance	83%	77%
Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	92%	68%
Pinus ponderosa Forest and Woodland with Herbaceous Understory Alliance	82%	77%
Larrea tridentata - Encelia spp. Shrubland Alliance	92%	66%
Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	76%	81%
Populus fremontii - Salix gooddingii Woodland Alliance	63%	93%
Tamarix spp. Temporarily Flooded Semi-natural Shrubland	74%	80%
Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	71%	78%
Acacia greggii Shrublands	72%	77%
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	62%	85%
Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	80%	67%
Prosopis glandulosa var. torreyana Shrubland	78%	69%
Ephedra fasciculata Mojave Desert Shrubland Alliance	64%	82%
Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	52%	94%
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	76%	69%
Arctostaphylos - Quercus turbinella Shrubland Alliance	80%	63%
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	70%	70%
Populus tremuloides / Robinia neomexicana Shrubland	40%	100%
Ephedra (torreyana, viridis) / Mixed Semi-desert Grasses Shrubland	72%	62%
Juniperus osteosperma Woodlands/Savannahs	60%	73%
Encelia (farinosa, resinifera) Shrubland Alliance	76%	54%
Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	50%	80%
Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	62%	67%
Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	57%	66%
Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	70%	53%
Artemisia bigelovii Shrubland Alliance	62%	60%
Pinus monophylla - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	46%	52%
Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance	13%	50%

tions would not differ between the confused classes.

Appendix F contains a table of the accuracy assessment with the number of samples taken in each map class and the number of accurate and confused samples. Table 15 summarizes the project-wide producer's and user's accuracies.

Literature Cited

Ayers, T., K. Christie, R. Hiebert, and M. Kearsley. 2010. Grand Canyon National Park - National Vegetation Mapping Program - 2007 - 2008 Field Crew Support, Data Management, and Review Meetings for GRCA Vegetation Mapping - Final Report. Colorado Plateau Cooperative Ecosystems Studies Unit, Northern Arizona University, Flagstaff, Arizona.

Breiman, Leo, Jerome Friedman, Richard Oshen, and Charles Stone. 1984. *Classification and Regression Trees*. Chapman and Hall. New York, New York. 358pp.

Congalton, Russ and Kass Green. 2009. *Assessing the Accuracy of Remotely Sensed Data: Principles and Practices*. Taylor and Francis Publishers. 183 pg. Second Edition.

Environmental Systems Research Institute 2009. ArcGIS Desktop. Accessed at http://www.ESRI.com/ArcGIS-for-Desktop.html

Green, Kass and Mark Tukman. 2010. *Grand* canyon *Vegetation Mapping. Phase 1 Final Report*. National Park Service, Fort Collins, Colorado.

Green, Kass and Mark Tukman. 2011. *Grand* canyon *Vegetation Mapping. Phase 2 Final Report*. National Park Service, Fort Collins, Colorado.

Green, Kass and Mark Tukman. 2012. *Grand* canyon *Vegetation Mapping. Phase 3 Final Report*. National Park Service, Fort Collins, Colorado.

Helm, D.J. and B.R. Mead. 2004. Reproducibility of vegetation cover estimates in south-central Alaska Forests. Journal of Vegetation Science 15: 33-40.

Lea, Chris and Anthony Curtis. 2010. *Thematic Accuracy Assessment Procedures National Park Service Vegetation Inventory, Version 2.0*. Natural Resource Report NPS/NRPC/NRR—2010/204. National Park Service, Fort Collins, Colorado

NatureServe. 2010. DRAFT Vegetation Key to the Plant Associations of Grand Canyon National Park

NatureServe. Undated. Colorado Plateau Ecoregion: Development and Application of Ecological Land Units. Unpublished paper.

Ralston, Barbara E., Davis, Philip A., Weber, Robert M., and Rundall, Jill M., 2008, A vegetation database for the Colorado River ecosystem from Glen Canyon Dam to the western boundary of Grand Canyon National Park, Arizona: U.S. Geological Survey Open-File Report 2008–1216.

RuleQuest Research Pty, Ltd, 2008. RuleQuest See5. Accessed at https://www.rulequest.com/see5-info.html.

Spurr, Stephen, H. 1948. Photogrammetry and Photo-Interpretation. 2nd Edition. The Ronald Press Company, New York. 472pp

The Nature Conservancy and Environmental Systems Research Institute 1994. Field methods for vegetation mapping. U.S. Department of the Interior, National Biological Survey and National Park Service. Washington, D.C.

Trimble 2009. Trimble eCognition. Accessed at www.ecognition.com/

US Geological Survey, National Biological Information Infrastructure, Gap Analysis Program (GAP). February 2010. National Land Cover Version 1. http://www.nbii.gov/portal/server.pt/community/maps_and_data/1850 . Last visited Nov. 2010.

Warren, P.L., K.L. Reichardt, D.A. Mouat, B. T. Brown, and R.R. Johnson. 1982. Technical Report No. 9, Vegetation of Grand Canyon National Park. Cooperative National Park Resources Studies Unit, University of Arizona.

Woodcock, C.E. and Strahler, A.H. 1987. The Factor of Scale in Remote Sensing. *Remote Sensing of the Environment*. 21: 311-332.

VI. Discussion and Conclusions

Here we have presented the results of a 5-year effort that produced a standards-based vegetation map which uses an NVC vegetation classification and a minimum mapping unit of 0.5 hectares. The innovative methods employed during the mapping and accuracy assessment phases facilitated the rapid and accurate completion of the tasks. The constant communication among all participants greatly reduced the number of difficult problems and shortened the time to a solution.

The map is already being used for management purposes. A new map of Mexican spotted owl habitat is being created based on map class distributions and the tree diameter data collected during the vegetation classification sampling. Grand Canyon National Park fire managers have used the map and data for fire planning purposes, and in preliminary analyses of fire management practices over the past decade. Data on unique vegetation types and rare plants species are being used in the revisions to Grand Canyon's backcountry management practices. Voucher specimens collected during plot surveys are being incorporated into regional databases on plant distributions

In this section, some lessons learned during the different phases of the project will be discussed. Because this was one of the first large, western National Park units to be mapped, and because adjacent NPS units will be going through the same things, these may be important.

Vegetation Dynamics and Vegetation Mapping

Because the NPS Vegetation Inventory Program is based on classifying existing vegetation and mapping its distribution, it creates maps which represent necessarily a single moment in time. It creates a baseline condition from which future change can be measured, but the program is not aimed at monitoring vegetation over time. There are Several areas in which Grand Canyon National Park is planning on making alterations to the map in the future.

First is the mapping of the distributions of the high-level herbaceous Associations. The classification of meadow vegetation was not complete when the mappers were in the field, and there was nothing to base a key on. As a result, four grass-dominated Associations and one sedge-dominated Association are mapped together as "Southern Rocky Mountain Montane Herbaceous Vegetation." Meadows are easily identified from aerial imagery and can be placed into the appropriate Association using a small subset of the vegetation key.

Second is the mapping of vegetation types in well-defined habitats where remote sensing is difficult. Riparian habitats of tributaries of the Colorado River are often shadowed and present a physiognomically similar appearance even when there are strong differences in the make-up of the community. All eight tree-dominated riparian habitat Associations are mapped as Fremont cottonwood – Gooddings willow Woodland Alliance, including the Velvet Ash Riparian Woodland Alliance. As with the high elevation meadows, these habitats are predictable and constrained; this will allow their labeling to the Association level an easier task.

The third involves habitats where disturbance creates vegetation-altering changes, specifically the impacts of fire on forests and woodlands of the rim areas. Grand Canyon National Park has an active fire management program which has a goal of returning fire to its historic place as a community organizing force. In areas where fire burns at moderate-high or high intensities, a major change in vegetation results. During Phase 1, mapping commenced two years after the aerial imagery was taken and several burns with higher intensities had taken place on the North Rim. These areas had to be excluded from accuracy assessment because the vegetation on the ground during accuracy assessment was different from what had been captured in the aerial photographs.

While the details of how to update the map are not yet finalized, two elements of the

process are clear. First, re-mapping will probably only be done in areas where high- or moderate-high severity fire has occurred. By definition, low and moderate-low severity fires do not cause change in the emergent, canopy or sub-canopy strata. These are what define vegetation types in forest and woodland Associations. Second, a minimum area affected by high- and moderate-high fire will have to be specified. The minimum mapping unit for this vegetation map is 0.5 hectares, and fire severity maps are currently being produced with pixel sizes 0.09 hectares. Neither of these is of a size suitable for management activities for forest communities. Vegetation and fire managers are working on creating a set of rules regarding the minimum extent of contiguous high-severity fire or the local density of high-severity fire pixels which would trigger a re-mapping need. Finally, re-mapping will likely not take place until at least five years have passed since a fire. Data collected by the Grand Canyon Fire Effects Program and post-fire field visits by Grand Canyon National Park vegetation and fire personnel have shown that the pace of change in the first several years following fire is so rapid that visits within five years would not produce worthwhile results.

Lessons Learned

Classification versus mapping

Future classification and mapping projects should consider separating the two activities. They were combined into a single project here, even though they were performed through different acquisitions using different types of acquisition instruments: cooperative agreements for vegetation sampling and classification and contracting for vegetation mapping and accuracy assessment. When mapping began with the contract with KGA, the first phase (rims and above) of classification had not yet been completed. As a result, high-elevation communities were all lumped into a single map class, and completing mapping of pinyon-juniper communities in the Phase 1 mapping area was delayed to Phase 2.

Future projects like this one would do well to treat the two activities separately. Vegetation classification can proceed to completion in the absence of a vegetation map. At that point, a second acquisition can proceed which will map the distribution of the vegetation classes identified. Although new vegetation Associations may be identified as calibration samples are collected during the mapping phase, they will be a minor addition to the overall classification; only two were seen in this project. And while it may extend the length of the NPS-VIP's commitment to each Park's inventory process, the quality gains may be worth the investment.

Mapping Phases

Because of this project's large size and the uncertainty of year-to-year funding at the national level, the mapping activities of the project were separated into three phases, each with its own report, map, and accuracy assessment. The phases were delineated by factors relating to shared floristics and access methods, and ordered according to levels of management interest. Phase 1 included the North and South Rims, the most heavily visited and most intensively managed parts of the project area. Phase 2 included the most-often visited parts of the inner canyon where desert bighorn sheep, California condors, peregrine falcons and other wildlife of interest are concentrated. Phase 3 encompassed the little-visited western end where vegetation has greater affiliation with Mojavean elements.

There are both positive and negative results of this strategy. The positive side is that at the end of each year, complete map products with known accuracies were available for that phase. Interruptions and reductions in funding in out-years would not affect the usefulness of the mapping already performed, nor would it result in a partially finished map of the entire park languishing until more funds became available. Furthermore, when projects are put on hold, local staff may be lost if they are reassigned to other work or move on to other parks. The negative result was that when map classes bled across phase boundaries, more accuracy assessment work was done than would have been in a single-phase map project. For example, some *ponderosa* pine classes

were found in all three phases. For the final all-phase map, only 50 samples were needed, although more than 150 were collected during the three phases.

Overall, we would recommend this approach for large parks. Although funding for mapping in each year was available in this case, projects in other parks may not be so fortunate. Having a fully functional vegetation map, even if it is only for a quarter of the project area, is a preferable outcome, especially if it covers the area of greatest concern to management. The extra time and money spent collecting and analyzing accuracy assessment data is outweighed by the benefits that come from an immediately useful map.

Gradsect analysis

The official sampling protocols available at the start of this project called for the creation of one or more gradsects to allow efficient sampling of as broad a group of vegetation types as possible without blowing logistical costs up too much. For this project, a gradsect analysis of the mapping area was performed (von Loh 2006). Originally, field crews were intended to use it in real-time, with a GIS-capable handheld field unit. Although biophysical units have worked well in other settings, crews' experiences for this project were not so; very little differences were seen among the BPUs provided to them.

Several suggestions were made to increase the utility of gradsects in large western NPS units.

- Follow the recommended gradients suggested in the original USGS - NPS vegetation sampling handbook (The Nature Conservancy and Environmental Systems Research Institute 1994). Those instructions included using elevation, slope, aspect, soils and geology to construct the gradsects. The gradsect performed before fieldwork began on this project included solar input, distance to riparian habitats and the Formation level of the Brown-Lowe-Pase (1980) classification version used in the Warren et al. (1982) vegetation map.
- Break up the gradsect into multiple, smaller gradsects based on logistics, geography or elevation as recommended in the same handbook. The great breadth of this project's habitats may have overwhelmed the ability of a single gradsect to discern important, but finer-scale, variation. Separate gradsects could have been run for rim- and inner canyon habitats. Alternatively, the sampling area could have been divided into Mojavean, Colorado Plateau, and transition areas with separate gradsects for each.
- Attempt multiple different gradsect analyses and then test them as sampling proceeds to determine which has the best set of predictors for vegetation change. Every NPS unit will present a unique suite of ecological drivers with a concurrent biogeographic history. Such an approach would yield large benefits later in the project and would help NPS engage the scientific community at the same time.

Electronic data collection

Three lessons were learned about the use of electronic data collection solutions in the field during this project. By design they should make field work as quick and efficient as possible, and data entry and quality checks should be minimal.

- Classification data and mapping data have very different requirements of electronic data collection and a single application is not the best choice. In our experience, the extensive GPS and GIS capabilities of mobile mapping units were not needed during the vegetation classification data collection phase and their expense precluded more than one field crew member from collecting data at the same time. In addition, the slow boot-up process and complex nature of the application actually slowed the data collection process. During the mapping and accuracy assessment phases, only location information, and the abundance estimates for a few dozen species are needed. Mobile mappers are more suited to this task.
- In spite of the benefits of electronic data

collection, untested applications should not be sent out with field crews. The mobile mapping application released to this project in 2007 was completed and loaded onto field computers the night before field crews were to be trained. As a result, numerous programming bugs and hardware issues slowed down field data collection. The 2008 application had gone through six rounds of office- and field testing before it was issued to field crews. The benefits of these solutions only obtain if they are fully functional.

Field crews

Future mapping projects should use the best local botanical expertise available. Botanical expertise tends to be localized, and classification should be based on surveys with the best expertise available. First e2M, then NAU, hired from the pool of local experts on Southern Colorado Plateau flora. As a result, benefits accrued to the NPS-VIP, Grand Canyon and Grand Canyon – Parashant herbaria and resource managers, and the vegetation surveyors themselves. Not all NPS units will have a university at their borders, but we would recommend that projects such as this one seek out botanists working in their area and work to create arrangements which are mutually beneficial.

Mapping acquisition elements

Our experiences with this large mapping project taught us that elements of the acquisition process have strong effects on the outcomes. Vegetation classification worked well as a cooperative process, because of the shared expertise of many NPS employees and local botanists. Each group could contribute the place-based knowledge required to understand patterns in the distribuion of vegetation across a large and varied landscape.

However, mapping at the scale of over a million acres requires a set of skills that is not always available locally. By opening the acquisition to all qualified vendors, the full breadth of technologies and constantly evolving techniques will be available. This requires additional time for planning, writing requirements, publishing notices to inform potential vendors, and holding pre-solicitation meetings to craft a solid scope of work. This investiment will be repaid when quality vendors deliver their final products on time and at projected costs.

The Park as the Customer

Although the majority of funding for park vegetation maps is provided by NPS-VIP, the maps themselves provide benefits primarily to the individual parks and I&M networks. For this reason, parks and networks need to be actively engaged in all phases of these projects, even before workplans are generated. Grand Canyon personnel recognized the value of a complete vegetation inventory and a vegetation map to their management and planning functions when the program was first announced within the agency. They approached the NPS-VIP twice with plans for vegetation inventories before being approved. The project agreement between Grand Canyon and the NPS-VIP was the keystone to the ultimate success of the project. Grand Canyon's funding of a full-time, term position Mapping Coordinator to ensure the timely flow of information and to oversee project cooperative agreements and contracts helped to keep the park's interest at the center of the work. The park's active participation in the earliest phases of planning resulted in a process and a map that now satisfies the needs of the Fire and Aviation Division, the Wildlife and Vegetation programs within Science and Resource Management, the Facilities Division, and the Office of Planning and Compliance.

Literature Cited

Brown, D.E., C.H. Lowe, and C. P. Pase. 1979. A digitized classification system for the biotic communities of North America, with Community (Series) and Association examples for the Southwest. Journal of the Arizona - Nevada Academy of Science 14 (Suppl.): 1 - 16.

The Nature Conservancy and Environmental Systems Research Institute. 1994. Field methods for vegetation mapping USGS/ NPS Vegetation Mapping Program Pages vi, 106. U.S. Department of Interior, National Biological Survey and National Park Service, Washington, DC.

Warren, P.L., K.L. Reichert, D.A. Mouat., B.T. Brown, and R.R. Johnson. 1982. Vegetation of Grand Canyon National Park. Technical Report No. 9. Cooperative National Park Resources Studies Unit Contribution No. 017/16. Tucson, AZ.

Appendix A: Project Agreement between Grand Canyon National Park and NPS Vegetation Inventory Program

GRAND CANYONNATIONAL PARK
and
NPS NATIONAL VEGETATION MAPPING PROGRAM

Amendment to
Project Agreement for Vegetation Classification and Mapping Project (2009-2012)

Revised 20 July 2010

Introduction

Since the original Project Agreement between Grand Canyon National Park (GRCA) and the NPS Washington Office National Vegetation Mapping Program (WASO - NVMP) was signed in October 2006, changes have taken place in the management structure of Grand Canyon NP and in the organization of the project. This document is an amendment to the original 2006 agreement and reflects the changes in personnel, roles and responsibilities since that time.

Project Background

In order to understand, maintain, restore, and protect the integrity of Grand Canyon's natural resources, processes, systems, and values, park managers require current and comprehensive information about park resources. The project seeks to obtain consistent data on the composition and distribution of vegetation cover types, ensure the compatibility of these data with national standards, and allow for easy access to and use of the data in a geographic information system (GIS) database. A complete vegetation inventory and an accurate map of plant community distribution will facilitate the identification of resource needs during park planning and management activities and provide a framework for landscape-level ecosystem management.

This project is part of a long-term, cooperative national effort between the U.S. Geological Survey (USGS) and the National Park Service (NPS) to provide parks with up to date information about vegetation resources. The purpose of the overall National Vegetation Mapping Program (NVMP) is to sample, classify, describe, and map the vegetation within 280 park units. This project focuses on GRCA and an area around the park's perimeter, including a total area in excess of 1.6 million acres. The NPS Washington Office, Biological Resources Management Division (WASO-BRMD) will provide 85-90% of the project costs currently estimated at $4,510,029. GRCA will provide matching support estimated at $519,354 in the form of the project coordinator (GS-11 term position) required to initiate and facilitate a NVMP project within the park between fiscal years 2007 and 2012.

For additional details about this project, refer to the August 2006 "Work Plan, Volume I, Vegetation Classification and Mapping Project, Grand Canyon National Park" and the August 2008 "Grand Canyon National Park Vegetation Mapping Project FY 2009 Work Plan and Budget Request." These documents detail the proposed project tasks, objectives, and schedules and including changes to the original workplan.

Project Timeline

This project began with the approval of the original Project Agreement (PA) document by both signatories. These revisions will take effect with the approval of this document by all signatories. All project deliverables, including the final versions of the vegetation map, databases and reports will be completed or in a final review cycle by September 30, 2012.

Project Management and *Contracting*

Project management duties, formerly performed by e2M Consulting of Englewood, CO will be distributed among other parties, including the GRCA Vegetation Mapping Coordinator and the WASO-BRMD Vegetation Mapping Program Manager.

The contracting workload for this project will be taken on by GRCA and NPS Denver-based contracting officers. GRCA contracting actions will include Cooperative Ecosystems Studies Unit (CESU) agreements for seasonal hiring and logistical support for field crews, contracting for image segmentation and interpretation and geodatabase preparation and report writing. NPS Denver-based contracting actions will include acquisition of associated support staff (NatureServe, State Heritage ecologists, and others).

Roles and Responsibilities

Agency	Position	Responsibilities
National Park Service Washington Office Biological Resource Management Division	Vegetation Inventory Program Manager	• Arranges for WASO Vegetation Mapping funding for 85-90% of the cost of the project. • Signatory to Project Agreement • Reviews Annual Progress report from GRCA • Participates on a Remote Sensing team to review technologies and available imagery for the purpose of recommending mapping actions by GRCA. • Participates in the Request for Proposals (RFP) process by reviewing the scope of work, schedule of deliverables, technical requirements, compliance plan, performance plan etc. and as a technical expert in reviewing proposals themselves. • Serves as Agreement Technical Representative for Task Agreements with NatureServe related to Grand Canyon / Parashant Vegetation Mapping Project • Serves as liaison between NatureServe personnel and the rest of the Grand Canyon / Parashant Vegetation Mapping Project team.
	Vegetation Mapping Program Ecologist	• Works to ensure consistency among projects relative to Federal Geographic Data Committee (FGDC) and national program standards • Provides advice on the conduct of project tasks within the context of the NVMP • Provides guidance on incorporating new NVCS and NVMP directions into RFP documents • Attends planning and progress meetings
National Park Service Grand Canyon Superintendents Office	Superintendent	• Signatory to Project Agreement; • Supports roles and duties of the Project Agreement on behalf of Grand Canyon NP
	Assistant Superintendent for Business Activities	• Reviews the project agreement between GRCA and the WASO-NVMP to specify funding, and level of investment made by all entities to support the project
	Assistant Superintendent for Park Operations	• Reviews the project agreement and directs the programming of Park staff and resources to support the GRCA's commitment to project support and logistical contributions

Agency	Position	Responsibilities
NPS Grand Canyon Science and Resources Management Division	Division Chief	• Reviews project agreement • Supports staff involvement in this project and facilitates coordination with other Science and Resources Management Division staff
	Deputy Division Chief for Operations	• Reviews project agreement • Facilitates coordination with other Science and Resources Management Division staff
	Deputy Division Chief for Natural Resources	• Reviews project agreement • Supports staff involvement in this project and facilitates coordination with other Grand Canyon NP staff • Provides supervision, guidance and work plan development to GRCA Project Coordinator • Keeps Grand Canyon NP management briefed on project progress
	Deputy Division Chief for Socio-Cultural Resources	• Reviews project agreement • Supports Cultural Resources staff involvement in this project
	American Indian Prorgram Manager	• Serves as liaison between tribal cooperators and park staff and contractors • Ensures proper tribal consultation for project activities • Arranges joint data collection activities when possible

Agency	Position	Responsibilities
NPS Grand Canyon Science and Resources Management Division	Vegetation Mapping Coordinator	• Provides project management and administrative oversight within Grand Canyon NP • Serves as liaison between Grand Canyon NP and National Vegetation Mapping Program office, contractors and cooperators • Coordinates day-to-day project administrative needs including drafting Minimum Requirement Analysis documents for working in backcountry areas and acquiring necessary research and backcountry permits for field activities associated with the project • Organizes Grand Canyon NP staff input • Organizes and attends planning, scoping and progress reporting meetings • Participates in the Request for Proposal process by creating documents including scope of work, schedule of deliverables, technical requirements, performance plans, budget estimates etc. and providing all necessary documents to Grand Canyon NP procurement staff • Provides expert technical advice to project cooperators and in creation of vegetation classification • Prepares and administers the CESU agreements for seasonal hiring and logistical support functions of the data collection crews • Provides progress reports to supervisor for distribution to park management • Prepares documents for RFP process and CESU agreements and, pending appointment, serves as Contracting Officer's Technical Representative and Agreements Technical Representative on contracts and cooperative agreements for vegetation mapping activities.
	Vegetation Program Manger	• Provides expert technical advice by reviewing field keys, vegetation descriptions and lists of plant associations and alliances • Reviews progress reports • Attends planning progress meetings as needed
	GIS Coordinator	• Reviews work plans and draft reports • Provides expert technical advice in the writing of documents for the Request for Proposal process, in the reviews of proposals and for validation and accuracy assessment phases of mapping • Attends planning and progress meetings as needed

Agency	Position	Responsibilities
NPS Grand Canyon Visitor and Resource Protection Division	Visitor and Resource Protection Chief	• Reviews project agreement • Supports Fire and Aviation staff involvement in this project
	Fire GIS Specialist	• Reviews work plans and draft reports • Provides expert technical advice to vegetation mapping coordinator during writing of RFP documents and review of proposals, deliverables from vendors and geodatabase. • Attends planning and progress meetings as needed • Reviews new National Vegetation Classification Standard (NVCS) hierarchy with respect to suitability for fuels and fire concerns
	Fire Ecologist	• Provides expert technical advice in creation of documents for RFP and reviews of field forms for fuels data collection, plant association / alliance list, NVCS hierarchy and deliverables from vendors as needed. • Attends planning and progress meetings as needed

Decision-making

Day-to-day decision-making will be the responsibility of the GRCA Vegetation Mapping Project Coordinator. Substantive changes in work plan, timeline, roles, and deliverables will require notification of the WASO-BRMD Vegetation Mapping Program Manager and the appropriate GRCA management team member(s) as recommended by the Science and Resource Management Division Director and Visitor and Resource Protection Division Chief. Because the GRCA will be administering the vegetation mapping contract, the responsibility for technical direction and communication with that contractor will lie with the GRCA Vegetation Mapping Project Coordinator and the GRCA Contracting Officer. Conflicts over decisions that cannot be worked out on a consensus-basis between the GRCA Decision-Making Team and WASO-BRMD Vegetation Mapping Program Manager will be elevated to the GRCA Superintendents Office and the Chief of WASO - BRMD.

Review of Deliverables and *Adherence to Work Plan Timeline*

The GRCA Vegetation Mapping Coordinator is responsible for quality control and adherence to work plan timeline by GRCA contracted entities.

Authorizing Signatures

In witness hereof, the following authorized representatives of the parties have signed their names on the dates indicated, thereby executing this agreement.

_____ _____ _____

Steven P. Martin Date
Superintendent, Grand CanyonNational Park

_____ _____ _____

Karl E. Brown Date
WASO-BRMD Vegetation Mapping Program Manager

List of Personnel as of 20 July 2011

NPS Washington Office	
Biological Resource Management Division	
Chief	Jerry Mitchell
Vegetation Inventory Program	
Program Manager	Karl Brown
Ecologist	Chris Lea
NPS Grand Canyon National Park	
Superintendent's Office	
Superintendent	Dave Uberuaga
Assistant Superintendent for Business Activities	Barclay Trimble
Assistant Superintendent for Operations	Palma Wilson
Science and Resource Management Division	
Chief	Martha Hahn
Deputy Chief – Operations	Jan Balsom
Deputy Chief – Socio-Cultural Resources	Jane Rodgers
American Indian Program Manager	Janet Cohen
Deputy Chief – Natural Resources (Acting)	Jane Rodgers
Vegetation Program Manager	Lori Makarick
Vegetation Mapping Coordinator	Michael J.C. Kearsley
GIS Coordinator	Mark Nebel
Division of Visitor and Resource Protection	
Chief	Bill Wright
Fire GIS Specialist	Eric Gdula
Fire Ecologist	Windy Bunn

Appendix B: Dichotomous keys to vegetation surveyed in Grand Canyon National Park and Grand Canyon - Parashant National Monument

This appendix contains two keys used during the mapping and accuracy assessment phases of the Grand Canyon National Park / Grand Canyon - Parashant National Monument Vegetation Inventory and Classification Project. The first key contains the key to the vegetation Associations created by NatureServe for all Associations described during the vegetation classification. The second isthe key used by Kass Green and Associates (KGA) when the rim areas were mapped during Phase 1. Funding issues delayed writing of the descriptions for most Pinyon - Juniper Woodland Associations and all high-elevation herbaceous and meadow Associations at the time when mapping had to begin, so this ad-hoc version of the key was created.

Vegetation Key to the Plant Associations of Grand Canyon National Park

The vegetation of Grand Canyon National Park was sampled and classified under the US Geological Survey and National Park Service Vegetation Mapping Program during the 2007-2009 field seasons and has been prepared to assist in the accurate field identification of 217 plant associations.

This dichotomous key is designed to allow identification of plant associations with one or more dominant or indicator species combined with a description of the habitat. Because of natural variation within plant associations and observer bias, observers may key to vegetation associations using more than one of the physiognomic keys. For sites that occupy ecotones (areas where dominant species intermix between plant associations), it may be difficult to determine a definitive association name.

There are several conditions to consider when using this key. The cover breaks used to distinguish associations are strongly based on plot data collected as part of this project and may not fully represent variation between stands. Therefore the cover values presented in this key should be used as guidance, in particular when they are described as "*Pinus ponderosa* up to 20% cover" for example. Also, there are a number of associations with only one or 2 plots collected for them, hence the key will not necessarily account for the floristic variation of the association if it occurs more widely in the Park. Furthermore, precipitation during 2007 was particularly low. Therefore shrub and herb cover data recorded from plots collected that year may have been lower than other years. Finally, in comparing plot photos to cover values recorded in plots, it's believed that cover estimates for tree species were consistently lower for this particular field season.

HOW TO USE THE KEY:

The key approaches plant association identification at two levels. The first level is physiognomic, and allows the user to determine which major group is being evaluated, e.g., forest, woodland, shrubland, or graminoid. The second level allows identification to plant association based on dominant species canopy cover, in some cases assisted by a brief description of the typical habitat. In a few cases, plants name in the key are indicators of a particular association, and may not necessarily be dominant in all stands of that association.

It is possible that in using this key, you will have difficulty arriving at an association that desc*Ribes* your community. There are several potential reasons for this, and each has a solution:

1. You are observing vegetation that you think is an herbaceous or shrubland community, but it has some tree cover. In this case, try keying the vegetation through the woodland key as well as the herbaceous or shrubland key. In general with any layer, if it does not cover at least 15% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities (see #4 below).

2. If you have keyed to an association and there is low confidence in the overall fit, the user should read the local description to determine if they have arrived at this association in error or if the key requires further editing. In any case, the user should retry the key in a different group.

3. You can follow a key to a certain point, but you clearly have something not described in the key. This is to be expected – very likely you have an association that was not found during the sampling phase of the project. In this case, simply record "Unclassified association". Be sure to note the dominant or indicator species in each stratum as you fill out the Vegetation Description portion of the accuracy assessment form, and if a place is provided put in your own name for the stand.

4. Communities that are sparsely vegetated (e.g., < 15% total vascular plant cover) should be run through multiple keys. Even though they contain trees or shrubs, they may not fall cleanly into a "woodland "or "shrubland" category. "Sparse" vegetation is defined as having total vascular plant cover of < 10%.

5. When in doubt, record detailed field notes on your field forms, and these notes and the Vegetation Description information will be entered into a database to be evaluated in detail by NatureServe and GRCA ecologists.

Key to Physiognomic Classes

1) Canopy of plant species (including bryophytes, lichens) exceeds 1% 2
1) Cover of plant species less than 1% ..... **Unvegetated surfaces/areas**

2) Vegetation occupying wet meadows, arroyos, canyon bottoms, washes, alluvial terraces/benches, stream banks, drainages, seeps, or other places that receive runoff and/or retain moisture, but may dry out later in the year ..... **Go to Palustrine, Drainage, Wash, and Seep VegetationKey**
2) Vegetation occupying upland habitats 3

3) Canopy cover of tree species (see list provided of species by scientific name and lifeform) regardless of their size class (i. e. T1, T2, T3, S1, S2, H) is at least 5%. Note that early successional forests and woodlands with short trees key here and not in the shrubland key, ... **Go to Forest and Woodland Key**
3) Tree species, regardless of their size class, constitute less than 5% canopy cover (unless special cases as denoted in b in the above lead) 4

4) Shrub species, regardless of size class, comprise at least 10% cover, individually or in the aggregate; if the stand has reduced total cover (< 25%) then the shrub component comprises at least 25% of the total vegetative cover . ..... **Go to Shrubland Key**
4) Shrub species comprise less than 10% canopy cover, and herbaceous species typically constitute more than 10% cover; if total vegetation cover is < 25%, the shrub component constitutes less than 25% of the total. If shrub cover exceeds 10%, than grass cover exceeds 25% ..... **Go to Herbaceous Key**

Key to Forests and Woodlands

1. Evergreen forests and woodlands of higher elevations, cool slopes, or sheltered canyons. Typically *Ponderosa* Pine lifezones and above dominated by pure stands (e.g. *Pinus ponderosa*) or mixed stands of many tree species, such as *Abies concolor*, *Picea pungens*, *Pinus ponderosa*, *Populus tremuloides*, and/or *Pseudotsuga menziesii*. If *Abies concolor* is present with *Pseudotsuga menziesii*, then *Abies concolor* is the indicator species. If *Abies concolor* is present where *Picea pungens* is the most abundant conifer, then *Picea pungens* is the indicator species. If *Abies concolor* or *Pinus ponderosa* are present with low cover in Pinyon-Juniper woodlands, then these communities should be keyed as PJ types. 2

1. Evergreen forests and woodlands of lower elevations; Pinyon-juniper woodlands occupying a variety of habitats, including barrens, and other steep, exposed slopes. Total tree canopy cover on barrens or other sparse habitats can be low (<10%) but is still considered a tree layer. Woodlands are dominated by a single (rare) or mix (more typical) of *Pinus edulis*, *Pinus monophylla*, and/or *Juniperus osteosperma*. When *Pinus edulis - Juniperus spp.* are the dominants, other conifers (such as *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Abies concolor*) may rarely be present with less than half the total cover of Pinyon and/or Juniper. The understory can be quite barren, or contain abundant shrub and herb layers..... **Go to Pinyon – Juniper Woodland Key**

2. Montane forests and woodlands dominated by *Abies concolor*, *Picea pungens*, *Pseudotsuga menziesii*, *Populus tremuloides*, and *Pinus ponderosa*. 3

2. Subalpine forests and woodlands dominated or co-dominated by *Abies lasiocarpa* and/or *Picea engelmannii*..... 5

3. Forests and woodlands dominated or codominated by *Abies concolor*, *Picea pungens* and *Pseudotsuga menziesii*. When *Pinus ponderosa* is present it typically occupies less than 50% of the relative tree cover. Seedling regeneration, when present, is by mixed conifer tree species, predominantly *Abies concolor*. If *Pinus ponderosa* is the dominate canopy tree, then *Abies concolor* and/or other mixed conifer tree species cover exceeds 10%…….....……...4

3. Forests and woodlands dominated by *Pinus ponderosa*; if mixed conifer tree species such as *Abies concolor*, *Pseudotsuga menziesii*, and (*Populus tremuloides*) are present, they typically constitute less than 50% of the relative tree cover ..... **Go to Southern Rocky Mountain Ponderosa Pine Forest & Woodland Group Key**

4. Forests and woodlands dominated by *Abies concolor* and/or *Pseudotsuga menziesii* .....**Go to White Fir – Douglas-Fir Forests and Woodlands Key**

4. Forests and woodlands where *Picea pungens* or *Populus tremuloides* are dominant. If *Populus tremuloides* is dominant, then *Picea pungens* is regenerative in the understory and/or dominant in the subcanopy and considered indicative. *Pinus ponderosa* may also be a canopy codominant, but *Picea pungens* is the indicator species. .....**Go to Blue Spruce Forests and Woodlands Key**

5. *Abies lasiocarpa – Picea engelmannii* (Subalpine fir – Engelmann Spruce) forests. *Populus tremuloides* may be present up to 10% cover in the subcanopy or understory, but *Abies lasiocarpa* and *Picea engelmannii* are the indicator species. ..... **Go to Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest & Woodland Group Key**

5. *Populus tremuloides* forests, and re-generational Aspen stands; (note that these Aspen forest types lack a significant component of other mixed-conifer tree species including *Abies concolor* and *Pseudotsuga menziesii*; if these associates constitute a notable portion of the canopy, use the White Fir - Douglas Fir Forests and Woodlands Key/couplet 4.) ..... **Go to Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group Key**

Southern Rocky Mountain Ponderosa Pine Forest & Woodland Group

1. Open canopy of *Pinus ponderosa* (8-12%) with a stark lack of shrub, graminoid, and forb components in the understory. Typically no herbaceous species exceed 1% cover. Often, scattered *Juniperus osteosperma* (2%) and *Pinus ponderosa* (2%) form a sparse subcanopy. Sporadic *Quercus gambelii* and *Artemisia tridentata* may occur in some stands at trace covers ..... *Pinus ponderosa* / Sparse Understory Woodland [Provisional]
1. Woodlands or forests of *Pinus ponderosa* with prominent herbaceous or shrub component..... 2

2. Understory dominated by herbaceous species; sometimes with very low cover, shrub cover typically less than 5% 3
2. Understory dominated by shrubs, shrub cover typically exceeding 5%..... 6

3. Woodlands with herbaceous layers dominated by grass species such as *Bouteloua gracilis* and *Poa fendleriana*, typically more xeric sites, *Carex rossii* and *C. siccata* cover is very sparse..... 4
3. Woodlands with herbaceous layers dominated *Carex spp.* or *Pteridium aquilinum*, typically more mesic sites..... 5

4. Woodlands with open canopies of *Pinus ponderosa* where *Bouteloua gracilis* is the most constant dominant in the herbaceous layer. *Poa fendleriana* is often present, but with sparse cover ..... *Pinus ponderosa* / *Bouteloua gracilis* Woodland
4. Woodlands with canopies of *Pinus ponderosa* varying from open to somewhat closed (10-40% cover) where *Poa fendleriana* is the most constant dominant in the herbaceous layer. *Carex geophila* and/or *Muhlenbergia montana* are often present; *Bouteloua gracilis* may also be present, but is never dominant. Total cover of the herbaceous layer may be <5%..... ..... *Pinus ponderosa* / *Poa fendleriana* Woodland

5. Rare woodlands with an understory dominated by *Pteridium aquilinum*. Graminoids such as *Carex siccata* and *Poa fendleriana* are prevalent, but their cover never exceed that of *Pteridium* which can be as high as 30% ..... *Pinus ponderosa* / *Pteridium aquilinum* Woodland [Provisional]
5. Woodlands where the herbaceous layer is dominated by abundant *Carex siccata* which can reach up to 30% cover. Other deer sedges can be abundant, such as *Carex rossii*, C. *geophila*, or *C. occidentalis*. *Pteridiumaquilinum* is occasionally present, but never dominant..... *Pinus ponderosa* / *Carex siccata* Woodland

6. Woodlands, often with very open but mature *Pinus ponderosa*, with understories dominated by *Arctostaphylos patula* ..... *Pinus ponderosa* / *Arctostaphylos patula* Woodland
6. Woodlands with understories not as above..... 7

7. Woodlands with well-developed understories dominated by *Purshia stansburiana*. Other shrub associates include *Cercocarpus ledifolius*, *Quercus turbinella*, *Quercus gambelii*, and *Cercocarpus montanus* ..... *Pinus ponderosa* / *Purshia stansburiana* Woodland
7. Woodlands with understories not as above..... 8

8. Woodlands with understories dominated by *Quercus gambelii* ..... *Pinus ponderosa* / *Quercus gambelii* Woodland
8. Woodlands with understories dominated by *Robinia neomexicana* ..... *Pinus ponderosa* / *Robinia neomexicana* Woodland

White Fir – Douglas-Fir Forests and Woodlands

1. Forests and woodlands where *Pseudotsuga menziesii* is the clear canopy dominant or is codominant with *Abies concolor*, but can be mixed with lesser amounts of *Pinus ponderosa*, and/or *Populus tremuloides* 2
1. Forests and woodlands where *Abies concolor* is the most consistent canopy dominant but can be mixed with lesser amounts of *Pinus ponderosa*, and/or *Populus tremuloides*..... 6

2. Dominant understory vegetation woody, shrub cover typically exceeds 5% 3
2. Dominant understory herbaceous, shrub cover less than 5% except in stands where *Juniperus communis* may exceed 5%, but does not exceed herbaceous cover 5

3. *Robinia neomexicana* is the characteristic shrub in the understory
.....*Abies concolor - Pseudotsuga menziesii* / *Robinia neomexicana* Woodland
3. *Robinia neomexicana* is absent, or low in cover 4

4. *Symphoricarpos oreophilus* is the dominant shrub. Associated shrubs may include *Ribes*, *Rhus*, or *Amelanchier*
.....*Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest
4. *Quercus gambelii* is the dominant shrub.....*Pseudotsuga menziesii* / *Quercusgambelii* Forest

5. Forest characterized by open, sparse canopies of *Abies concolor* (up to 13%) and *Pinus ponderosa* (up to 8%) with a distinct sub-canopy of *Abies concolor* (up to 8%); sometimes with a small component of *Pinus ponderosa*, as well as scattered *Populus tremuloides*. Shrub cover is generally very low (<1 or 2%) to non-existent. *Carex rossii* characteristically dominates the understory at low covers (up to 5%), while *Poa fendleriana* (up to 5%) and *Elymus elymoides* (up to 1%) are also frequent .....*Abies concolor - Pseudotsuga menziesii* / *Carex rossii* Forest
5. Forest characterized by open canopies of *Pinus ponderosa* (up to 10%), *Populus tremuloides* (up to 10%), with scattered *Abies concolor* (2%-15%) and *Pseudotsuga menziesii* (2%-7%). Shrub cover is generally very low (<1 or 2%) to non-existent. *Carex siccata* dominates the understory at an average of 4% cover, but it can occur at up 12% cover in some areas. *Poa fendleriana* (to 4%) and *Bromus ciliatus* (to 3%) are also common components.
.....*Abies concolor - Pseudotsuga menziesii* / *Carex siccata* Forest

6. Canopy clearly dominated by *Abies concolor*. *Cercocarpus ledifolius* is the major component of the tall shrub stratum (3% cover in the one sampled stand), while *Amelanchier utahensis* and *Holodiscus dumosus* are also present at 1% cover. Common short shrubs include *Chamaebatiaria millefolium*, *Fendlerella utahensis*, and *Shepherdia rotundifolia* (all at roughly 1% cover).....*Abies concolor* / *Cercocarpus ledifolius* Woodland
6. *Juniperuscommunis*, *Mahoniarepens* or *Symphoricarpos oreophilus* is dominant in the understory..... 7

7.*Juniperus communis* (3-4%) is the dominant component of the sparse shrub strata. *Carex siccata*, *Bromus ciliatus*, and *Carex rossii* are frequent members of a sparse graminoid layer .....*Abies concolor* / *Juniperus communis* Forest
7. *Mahoniarepens* or *Symphoricarpos oreophilus* are the dominant species in the shrub layer..... 8

8. Very sparse covers of *Abies concolor* (2% to 3%) and *Pinus ponderosa* (3% to 4%), as well as *Populus tremuloides* (2% to 3%) dominate the canopy. *Abies concolor* (3% to 5%) is also the predominant component of the sub-canopy, but various other mixed-conifer tree species also occasionally occur. *Symphoricarpos oreophilus* is the dominant and characteristic component of the short shrub and dwarf-shrub strata, at up to 5% cover.
.....*Abies concolor* / *Symphoricarpos oreophilus* Forest
8. *Abies concolor* (up to 20% cover) and *Pinus ponderosa* (up to 12% cover) dominate the canopy while *Populus tremuloides* and *Pseudotsuga menziesii* can occur occasionally in the canopy as well. The understory is characterized by the sparse to occasionally moderately dense, low-diversity understory with 1-10% cover of the diagnostic dwarf-shrub *Mahonia repens*. *Poa fendleriana* and *Carex rossii* are the most frequent graminoid components of the sparse herbaceous layer, and usually occur at about 1% cover.....*Abies concolor* / *Mahonia repens* Forest

Blue Spruce Forests and Woodlands

1. Canopy characterized by *Picea pungens* (up to 25% cover), *Pinus ponderosa* (up to 10% cover), and occasionally low covers of *Populus tremuloides*. *Juniperus communis* (3% cover) is the most frequent and abundant short shrub, while Rosa woodsii occurs occasionally as a dwarf-shrub with extremely low covers. *Carex siccata* clearly dominates the herbaceous layer at 5% cover, but in some stands it occurs at up to 20% cover
.....*Picea pungens* / *Carex siccata* Forest
1. Woodlands where *Populus tremuloides* (13%) dominates the canopy and *Picea pungens* is present as an emergent and in the sub-canopy. *Picea pungens* is treated as indicative of this association. Shrubs are essentially absent. *Festuca arizonica* dominates the understory, while *Carex spp.* can also be present
.....*Picea pungens* / *Festuca arizonica* Woodland

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest & Woodland Group

1. Canopy dominated by mixture of *Picea engelmannii* (up to 15% cover) and *Abies lasiocarpa* (up to 10% cover), with scattered *Populus tremuloides*. Shrub layer is absent or sparse with *Juniperus communis* common at less than 2% cover. The herbaceous layer is dominated by swaths of *Carex rossii* and *Carex siccata*.
.....*Abies lasiocarpa - Picea engelmannii* / *Carex siccata* Forest
1. Canopy dominated by mixtures of *Picea engelmannii* and *Populus tremuloides*, the former being more prevalent. *Abies lasiocarpa* codominates in some stands. The shrub layer is never dense, but *Juniperus communis* is present in all stands 5% cover, and is typically as abundant or more abundant than *Carex siccata* in the understory
..... *Abies lasiocarpa - Picea engelmannii* / *Juniperus communis* Woodland

Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group

1. Successional woodland or shrubland communities that have either experienced recent high intensity fires or mortality. Canopies consist of short statured regenerating young trees. Understories are characterized by *Ceanothus fendleri* and *Carex spp.*, or *Robinia neomexicana*. 2
1. Mature woodlands or forests with understories dominated by *Juniperus communis* or *Muhlenbergia montana*. 3

2. Shrublands found on the North Rim that have recently experienced high intensity fires and are characterized by prominent regeneration of *Populus tremuloides* at up to 60% cover. This layer can be taller, and more reminiscent of a sub-canopy, or it can be a shorter layer of re-generational *Populus tremuloides* seedlings. *Ceanothus fendleri* is a dominant and consistent component of the dwarf-shrub stratum, and *Mahonia repens* also occurs frequently. Dry-land "deer" sedges (*Carex siccata*, C. *rossii*, *C. geophila*, and *C. occidentalis*) are very frequent in the herb layer, along with occasional patches of other post-disturbance, early seral forbs such as *Pteridum aquilinum*,*Erigeron divergens*, *Gayophytum diffusum*, *Chenopodium sp.*, *Conyza canadensis*, and *Epilobium brachycarpum*.
.....*Populus tremuloides - Ceanothus fendleri* / *Carex spp.* Shrubland
2. Canopy with ubiquitous dominance of *Populus tremuloides* (up to 50% cover) where individuals are commonly less than 5 meters in height due to near 100% mortality of previously extant individuals. The shrub layer is characterized by vigorous regeneration of *Robinia neomexicana* and it is usually present at 20-30% cover, appearing either as a tall shrub or as a short shrub. .....*Populus tremuloides* / *Robinia neomexicana* Woodland

3. Forest or woodlands with open canopies of *Populus tremuloides* (17%) with scattered *Pinus ponderosa* (2%). The subcanopy may have low cover of *Abies concolor* (3%), as well as sporadic *Picea engelmannii*, *Abies lasiocarpa*, and *Pinus ponderosa* individuals. *Juniperus communis* (3%) is a common and characteristic short shrub, while *Mahonia repens* (1%) is frequent.
.....*Populus tremuloides* / *Juniperus communis* Forest
3. Forest or woodland with canopy dominated by *Populus tremuloides* with graminoid dominated understories.....4

4. *Populus tremuloides* (up to 50% cover) is the dominant canopy tree, although conifers may be present in the under-growth as seedlings or small saplings, *Picea engelmannii* was present in the single stand sampled. There is no shrub layer, although *Juniperus communis* is present at very low cover. A well-developed herbaceous layer is dominated by *Muhlenbergia montana* .....*Populus tremuloides* / *Muhlenbergia montana* Woodland [Park Special]
4. Canopies of *Populus tremuloides* (40%) and sparse sub-canopies of *Abies concolor* (4%) and other mixed-conifer tree species and herbaceous layer dominated by *Carex siccata* .....*Populus tremuloides* / *Carex siccata* Forest

Pinyon-Juniper Woodland Group

1. *Pinus edulis* or *Pinus monophylla* dominant or occurring with *Juniperus osteosperma*. 2
1. *Juniperus* clearly dominant. Individual *Pinus spp.* may be present, but are accidental and not occurring throughout the stand 26

2. *Pinus edulis* dominant or codominant 3
2. *Pinus monophylla* dominant or codominant.....19

3. Shrub characterize the understory, generally with shrub cover >5%, but may be less. Herbaceous cover in some stands exceeds that of shrub cover, but woody vegetation is to be considered indicative 4

3. Grass and/or forb dominated, or where understories are sparse (<10% cover for all lifeforms). Understories lack a distinct shrub layer 16

4. Stands characterized by *Pinus edulis* and *Juniperus osteosperma* which are often dwarfed. Dominant shrubs include *Cercocarpus intricatus*, *Quercus turbinella*, and *Coleogyne ramosissima* 5
4. Stands not as above 7

5. *Coleogyne ramosissima* is dominant in the shrub layer. Other shrubs can include *Ceanothus greggii*, *Ephedra fasciculata*, *Mahonia fremontii*, and *Glossopetalon spinescens*, *Mortonia utahensis*
..... *Pinus edulis - Juniperus osteosperma* / *Coleogyne ramosissima* Woodland
5. *Quercus turbinella* and/or *Cercocarpus intricatus* dominant in the shrub layer 6

6. *Cercocarpus intricatus* characterizes the shrub strata, although it is not always the most dominant shrub species on each site, but is considered diagnostic. *Quercus turbinella* commonly co-dominates the shrub layers, and can occur as either a tall shrub or a short shrub .....*Pinus edulis - Juniperus osteosperma* / *Cercocarpus intricatus* Woodland
6. Open to dense (5-35% cover) shrub layer of *Quercus turbinella*. Other common short shrub species include *Ceanothus greggii*, *Ephedra viridis*, and *Glossopetalon spinescens*. Common dwarf-shrubs include *Agave utahensis*, *Yucca baccata*, *Gutierrezia sarothrae*, *Thamnosma montana*, and *Opuntia spp.*; *Cercocarpus intricatus* may be present, but not dominant.....*Pinus edulis - Juniperus osteosperma* / *Quercus turbinella* Woodland

7. Understory dominated by *Artemisia spp*; or if dominated by *Artemisia bigelovii*, then there tends to be low cover of all shrub taxa, but *A. bigelovii* is present throughout the stand 8
7. Understory dominated by shrubs other than *Artemisia spp.* 9

8. Dominant shrub understory of *Artemisia tridentata*. Some stands within this community support a very sparse tree layer (6-8% cover), and occasionally trees are stunted and assume shrub-like forms.
..... *Pinus edulis - Juniperus spp.* / *Artemisia tridentata* (*ssp. wyomingensis*, *ssp. vaseyana*) Woodland
8. Tall shrubs essentially absent. The dwarf-shrub stratum is particularly well-represented by the dominant *Artemisia bigelovii* while *Gutierrezia sarothrae* and *Opuntia polyacantha* occur frequently
. . ..*Pinus edulis - Juniperus osteosperma* / *Artemisia bigelovii* Woodland

9. Woodland occurring in the Inner Canyon on unstable and dynamic talus slopes. The shrub layer consists of a varied assemblage of shrub species (a characteristic of this association) including *Amelanchier utahensis*, *Cercocarpus ledifolius*, *Purshia stansburiana*, *Cercocarpus montanus*, *Fendlera rupicola*, *Rhus trilobata*, *Artemisia bigelovii*, *Ericameria nauseosa*, *Quercus gambelii*, *Ephedra viridis*, and *Ribes leptanthum*
.....*Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland
9. Woodlands occurring on substrates other than talus, or not as above 10

10. Shrub layer dominated by *Cercocarpus spp.* 11
10. Shrub layer dominated by genera other than *Cercocarpus* 12

11. Shrub layer dominated by *Cercocarpus montanus* is the dominant shrub. Other associated shrubs may include *Glossopetalon spinescens*, *Ceanothus greggii*, *Ephedra viridis*, and *Yucca baccata*
..... *Pinus edulis - Juniperus spp.* / *Cercocarpus montanus* - Mixed Shrubs Woodland
11. Shrub layer dominated by *Cercocarpus ledifolius*
.....*Pinus edulis - Juniperus osteosperma* / *Cercocarpus ledifolius* Woodland

12. *Quercus gambelii* has the highest cover in the shrub layer. *Amelanchier utahensis*, *Arctostaphylos pungens*, *Purshia stansburiana* or *Mortonia utahensis* may be codominant in some stands
..... *Pinus edulis - Juniperus spp.* / *Quercus gambelii* Woodland
12. *Amelanchier utahensis*, *Arctostaphylos pungens*, *Purshia stansburiana* or *Mortonia utahensis* has the highest cover in the shrub layer 13

13. Shrub layer most consistently dominated by *Mortonia utahensis*

.....*Pinus edulis - Juniperus osteosperma* / *Mortonia utahensis* [Park Special] Woodland

13. Shrub layer most consistently dominated by *Arctostaphylos pungens*, *Purshia stansburiana* and / or *Amelanchier utahensis*.....14

14. Tall shrub layer lacking with a short shrub layer dominated by *Arctostaphylos pungens* lacking a tall shrub layer
.....*Pinus edulis - Juniperus osteosperma* / *Arctostaphylos pungens* Woodland

14. Shrub layer dominated by *Amelanchier utahensis* or *Purshia stansburiana* 15

15. *Amelanchier utahensis* dominates the tall shrub stratum, which typically supports 5% total cover. *Arctostaphylos pungens* characteristically dominates the short shrub stratum at 5% cover, yet may exist at up to 25% on some sites.
.....*Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis* Woodland

15. *Purshia stansburiana* is typically the dominant tall shrub. Also includes stands where *Purshia stansburiana* is codominant with other shrub species, but does not occur on steep talus slopes.
.....*Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland

16. Woodland codominated by *Juniperus osteosperma* and *Pinus edulis* at about 20% total cover with an extremely sparse understory. Shrub strata typically supports less than 2% cover, but species such as *Gutierrezia sarothrae*, *Ephedra viridis*, *Opuntia spp.*, or *Yucca baccata* may be present at extremely low covers. *Poa fendleriana* is the only consistently present graminoid at 1-2% cover
.....*Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland

16. Woodlands with more developed understories 17

17. Shrubs almost non-existent although *Artemisia bigelovii*, *Opuntia whipplei*, *Yucca baccata*, Echinocereus *fendleri*, and *Opuntia polyacantha* infrequently occur. *Bouteloua gracilis* (7%) clearly dominates the understory, but *Poa fendleriana* (1-3%) is also commonly present
.....*Pinus edulis* - (*Juniperus osteosperma*) / *Bouteloua gracilis* Woodland

17.Woodland dominated by *Poa fendleriana* (up to 10%). Total shrub cover is typically 3% or less
.....*Pinus edulis - Juniperus spp.* / *Poa fendleriana* Woodland

18. Shrub dominated understories, generally with shrub cover >5% 19

18. Grass and/or forb dominated understories, or where understories are sparse (<10% cover for all understory species). In grass and forb dominated communities, shrub cover may attain 5% or greater, but does not exceed that of the herbaceous layer 25

19. Shrub layer dominated or codominated by *Quercus spp.* 20

19. Shrub layer dominated or codominated by *Artemisia tridentata*,*Coleogyne ramosissima*,*Arctostaphylos pungens* or *Purshia stansburiana*.....21

20. Shrub layer dominated by *Quercus turbinella*
.....*Pinus monophylla - Juniperus osteosperma* / *Quercus turbinella* Woodland

20. Shrub layer dominated by a combination of *Quercus gambelii* and *Cercocarpus montanus*
..... *Pinus monophylla - Juniperus osteosperma* / *Cercocarpus montanus - Quercus gambelii* Woodland [Provisional]

21. Shrub layer dominated by *Artemisia tridentata*.....
.....*Pinus monophylla - Juniperus osteosperma* / *Artemisia tridentata* Woodland

21. Shrub layer dominated by shrubs other than *Artemisia tridentata* 22

22. Shrub layer dominated by *Coleogyne ramosissima*
..... *Pinus monophylla - Juniperus osteosperma* / *Coleogyne ramosissima* Woodland [Provisional]

22. Shrub layer dominated by *Purshia stansburiana* or *Arctostaphylos pungens* 23

23. Shrub layer dominated by *Purshia stansburiana*
.....*Pinus monophylla - Juniperus osteosperma* / *Purshia stansburiana* Woodland

23. Shrub layer dominated by *Arctostaphylos pungens* or *Ceanothus greggii*.....24

24. Shrub layer dominated by *Ceanothus greggii*. *Artemisia tridentata* is common, but not abundant
.....*Juniperus osteosperma* - (*Pinus monophylla*) / *Ceanothus greggii* Woodland
24. Shrub layer dominated by *Arctostaphylos pungens*. *Ceanothus greggii* and *Artemisia tridentata* are common, but not abundant.....*Juniperus osteosperma* - (*Pinus monophylla*) / *Arctostaphylos pungens* Woodland

25. Woodland with a graminoid understory characterized by *Bouteloua gracilis* and *Poa fendleriana*. Shrubs absent or scattered..... *Pinus monophylla - Juniperus osteosperma* / *Bouteloua gracilis* Woodland
25. Woodland sparse understory occurring on bedrock and gravelly substrates. No species in particular dominates the shrub or herbaceous layers..... *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland

26. Juniper woodlands occupying gravelly, rocky substrates without a well-developed shrub or herb layer. Total understory cover does not exceed 5%..... *Juniperus osteosperma* / Sparse Understory Woodland
26. Juniper woodlands with well-developed shrub and/or herbaceous layers exceeding 5% cover 27

27. Shrub dominated understories, generally with shrub cover >5% 28
27. Grass and/or forb dominated understories, or where understories are sparse (<10% cover for all lifeforms). In grass and forb dominated communities, shrub cover may attain 5% or greater, but does not exceed that of the herbaceous layer.....30

28. Shrub layer dominated by *Arctostaphylos pungens*. *Ceanothus greggii* and *Artemisia tridentata* are common, but not abundant.....*Juniperus osteosperma* - (*Pinus monophylla*) / *Arctostaphylos pungens* Woodland
28. Shrub layer dominated by *Ceanothus greggii* and *Artemisia tridentata*.....29

29. Shrub layer dominated by *Ceanothus greggii*. *Artemisiatridentata* is common, but not abundant
.....*Juniperus osteosperma* - (*Pinus monophylla*) / *Ceanothus greggii* Woodland
29. Shrub layer dominated by *Artemisia tridentata* .....*Juniperus osteosperma* / *Artemisia tridentata* Woodland

30. Sparse shrub layer. Understory characterized by *Elymus elymoides*
.....*Juniperus osteosperma* / *Elymus elymoides* [Park Special] Woodland
30. Herbaceous layer dominated by other bunch grass species.....31

31. Herbaceous layer dominated by a *Pleuraphis jamesii*. Other bunch grasses may be present or codominant, but *Pleuraphis* is considered indicative .....*Juniperus osteosperma* / *Pleuraphis jamesii* Woodland
31. Herbaceous layer dominated by *Poa fendleriana* or *Pseudoroegneria spicata* 32

32. Herbaceous layer dominated by *Poa fendleriana* .....*Juniperus osteosperma* / *Poa fendleriana* Woodland
32. Herbaceous layer dominated by *Pseudoroegneria spicata*
.....*Juniperus osteosperma* / *Pseudoroegneria*spicata Woodland

Key to Shrublands

1. Sparsely vegetated shrublands of cliffs, talus, scree, dunes, or other lithomorphic settings. Characteristic species include *Peucephyllum schottii*, *Abronia elliptica*, *Prosopis glandulosa var. torreyana*, *Eriogonum corymbosum*, and *Psorothamnus fremontii* which may be codominant with *Acacia greggii*
.....**Go to Semi-Desert Cliff, Scree & Rock Vegetation Key**
1. Shrublands dominated by *Purshia stansburiana* (usually 10-15% cover) typically found openings in *Pinus ponderosa* or *Pinus edulis - Juniperus spp*. woodlands. .....*Purshia stansburiana* Shrubland
1. Shrublands dominated by species other than *Purshia stansburiana*.....2

2. Shrublands dominated by *Cercocarpus intricatus*, usually with less than 10% cover, growing in bedrock cracks. *Quercus turbinella* is often present as a codominant. Other shrubs with less cover commonly associated include *Ceanothus greggii*, *Glossopetalon spinescens*, *Nolina microcarpa*, and *Rhus trilobata*

..... *Cercocarpus intricatus* - (*Quercus turbinella*) Mixed Shrubland
2. Shrublands not dominated by *Cercocarpus intricatus*.....3

3. Shrubland characterized by a sparse to moderately dense (10-60% cover) tall-shrub layer dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer. *Quercus gambelii* does not codominate (<5% cover).....*Amelanchier utahensis* Shrubland
3. Shrublands not as above.....4

4. Shrublands where *Arctostaphylos patula* (averaging 12% cover) dominates. *Ceanothus fendleri* (8%) is also a notable component of the dwarf-shrub stratum. *Carex rossii* (6%) and *Poa secunda* (3%) are the dominant graminoids, while both *Carex occidentalis* and *Carex siccata* can occur at low covers (1%). *Achillea millefolium*, *Chamerion angustifolium*, and *Solidago velutina* are the dominant forbs, but don't attain high cover. This association typically occurs in openings in Ponderosa Pine forests, often caused by past fires. .....*Arctostaphylos patula* Shrubland
4. Shrublands dominated by species other than *Arctostaphylos patula*.....5

5. Generally tall shrublands dominated by one or more of the following species: *Quercus gambelii*, *Quercus turbinella*, *Quercus X pauciloba*, *Cercocarpus ledifolius*, *Cercocarpus intricatus*, *Robinia neomexicana*,, sapling *Populus tremuloides*, *Ceanothus fendleri*., *Garrya flavescens*, *Amelanchier utahensis*, *Arctostaphylos spp*., *Fendlera rupicola*, *Fraxinus anomala*, *Rhus trilobata*, *Ostrya knowltonii*, *Symphoricarpos oreophilus*, *Mortonia utahensis*,and *Garrya flavescens*
...**Go to Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland and Arizonan Chaparral Key**
5. Shrublands not as above:.....6

6. Shrublands or shrub herbaceous vegetation characterized by species such as *Artemisia spp.*, *Ericameria nauseosa*, *Krascheninnikovia lanata*, *Acacia greggii*, *Canotia holacantha*, *Coleogyne ramosissima*, *Ephedra spp.*, *Gutierrezia spp.*, *Lycium andersonii*, *Nolina microcarpa*, *Opuntia spp.*, *Parthenium incanum*, *Psorothamnus fremontii*, *Salazaria mexicana*, *Ambrosia spp.*, *Encelia spp.*, *Fouquieria splendens*, *Krameri*a *spp.*, *Larrea tridentata* and *Yucca spp.*.....7
6. Shrubland dominated by *Atriplex spp.* .....**Go to Shadscale-Saltbush Cool Semi-Desert Scrub Key**

7. Shrublands dominated or codominated by *Artemisia tridentata* or *Artemisia bigelovii*. *Artemisia spp.* are considered indicative and contribute >40 total shrub cover. Other shrubs may include *Ephedra spp. Ericameria nauseosa*, or *Purshia stansburiana* .....**Go to Intermountain West Sagebrush Groups Key**
7. Shrublands not dominated or codominated by *Artemisia spp.* 8

8. Shrublands dominated exclusively by *Encelia spp.*, *Larrea tridentata*, *Fouquieria splendens*, *Ambrosia spp.*, or *Krameri*a *erecta* or codominant with *Ephedra spp.*, or *Coleogyne ramosissima*. If *Coleogyne ramosissima* is dominant or codominant, it is so with *Larrea tridentata* or *Ambrosia spp.* If *Ephedra spp.* are dominant or codominant, they are so with *Ambrosia dumosa*..... **Go to Sonoran-Mojave Creosotebush-White Bursage Desert Scrub Groups Key**
8. Shrublands or shrub herbaceous vegetation characterized by *Ericameria nauseosa*, *Krascheninnikovia lanata*, *Acacia greggii*, *Canotia holacantha*, *Coleogyne ramosissima*, *Ephedra spp.*, *Gutierrezia spp.*, *Lycium andersonii*, *Lycium pallidum*, *Nolina microcarpa*, *Opuntia spp.*, *Parthenium incanum*, *Psorothamnus fremontii*, *Salazaria mexicana* and *Yucca spp.* If *Ambrosia spp.* or *Larrea tridentata* are present they are never dominant or codominant
.....**Go to Intermountain and Mojave Mid-Elevation Mixed Desert Scrub Groups Key**

Semi-Desert Cliff, Scree & Rock Vegetation

1. Sparsely vegetated cliffs dominated by *Peucephyllum schottii*..... *Peucephyllum schottii* Sparse Vegetation
1. Communities not as above.....2

2. Vegetation of sand dunes and beaches. Characteristic species include *Abronia elliptica* and *Prosopis glandulosa var. torreyana* 3
2. Vegetation of badlands and shale substrates. Characteristic species include *Eriogonum corymbosum*, *Psorothamnus fremontii* and *Acacia greggii*.....4

3. Dominated by *Abronia elliptica* .....*Abronia elliptica* Herbaceous Dune Vegetation [Park Special]
3. Dominated by *Prosopis glandulosa var. torreyana*
.....*Prosopis glandulosa var. torreyana* Sand Dune Shrubland [Park Special]

4. Dominated by *Eriogonum corymbosum* .....*Eriogonum*corymbosum Badlands Sparse Vegetation
4. Dominated by *Psorothamnus fremontii* and/or *Acacia greggii*
..... *Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation [Park Special]

Sonoran-Mojave Creosotebush-White Bursage Desert Scrub Group

1. Dominated by *Ambrosia spp.* or codominated by *Ambrosia spp.* with *Encelia farinosa*, *Ephedra spp.*, or *Coleogyne ramosissima* 2
1. *Ambrosia spp.* absent or present, but never dominant or codominant.....8

2. *Ambrosia eriocentra* dominant with *Coleogyne ramosissima* or *Purshia stansburiana* often codominant
.....*Ambrosia eriocentra* - (*Coleogyne ramosissima*) Dwarf-Shrubland
2. *Ambrosia dumosa* dominant or codominant with *Encelia farinosa*, *Ephedra spp.* 3

3. *Ambrosia dumosa* clearly dominant. If *Encelia farinosa* or *Ephedra spp.* are present each species contributes less than 1% cover .....*Ambrosia dumosa* Dwarf-Shrubland
3. *Ambrosia dumosa* codominant with *Encelia farinosa*, *Larrea tridentata*, *Fouquieria splendens* or *Ephedra spp.* 4

4. *Ambrosia dumosa* codominant with *Encelia farinosa*. *Larrea tridentata*, *Fouquieria splendens*, *Ephedra spp.* may be present, but cover does not exceed that of *Encelia farinosa*
.....*Ambrosia dumosa - Encelia farinosa* Dwarf-Shrubland
4. *Ambrosia dumosa* codominant with *Larrea tridentata*, *Fouquieria splendens*, *Ephedra spp.* 5

5. *Ambrosia dumosa* codominant with *Ephedra fasciculata* and/or *Ephedra nevadensis*
.....*Ambrosia dumosa - Ephedra* (*fasciculata*, *nevadensis*) Dwarf-Shrubland
5. *Ambrosia dumosa* codominant with *Larrea tridentata*, *Fouquieria splendens* or *Krameria spp.*.....6

6. Both *Larrea tridentata* and *Ambrosia dumosa* have >1% absolute cover in the shrub canopy. Both species exceed twice the cover of other shrub species .....*Larrea tridentata - Ambrosia dumosa* Shrubland
6. *Larrea tridentata*, *Ambrosia dumosa*, *Fouquieria splendens*, or *Krameria spp.* have >1% absolute cover in the shrub canopy. These four species exceed twice the cover of all other shrub species present.....7

7. *Larrea tridentata*, *Ambrosia dumosa*, and *Fouquieria splendens* have >1% absolute cover in the shrub canopy. These three species exceed twice the cover of all other shrub species present
.....*Larrea tridentata - Ambrosia dumosa - Fouquieria splendens* Shrubland
7. *Larrea tridentata*, *Ambrosia dumosa*, and *Krameria spp.* have >1% absolute cover in the shrub canopy. These four species exceed twice the cover of all other shrub species present
.....*Larrea tridentata - Ambrosia dumosa - Krameri*a (*erecta*, grayi) Shrubland

8. Dominated exclusively by *Krameria erecta* or *Fouquieria splendens* or codominated by *Fouquieria splendens* and *Encelia spp.* 9
8. Dominated or codominated by *Encelia spp.*, *Coleogyne ramosissima*, or *Larrea tridentata* 11

9. Dominated by *Fouquieria splendens*. Some stands may be codominated by *Encelia spp.* 10
9. Dominated exclusively dominated by *Krameria erecta* .....*Krameria erecta* Shrubland

10. Dominated exclusively by a sparse layer of *Fouquieria splendens*. *Encelia spp.* may be present, but contributes less than 1% total cover .....*Fouquieria splendens* Shrubland
10. Tall shrub layer dominated by *Fouquieria splendens* with a short shrub layer of *Encelia spp.*
.....*Fouquieria splendens* / *Encelia* (*farinosa*, *resinifera*) Shrubland

11. Dominated exclusively by *Encelia spp. Larrea tridentata* may be present, but contributes <1% cover 12
11. *Larrea tridentata* contributes >1% cover and is dominant or codominant with other shrubs 13

12. Dominated exclusively by a sparse to moderately dense shrub layer of *Encelia farinosa* with a highly variable mixture of other shrubs including *Ephedra spp.*, *Acacia greggii*, cacti *spp.* at lower covers
..... *Encelia farinosa - Ephedra* (*fasciculata*, *nevadensis*) Shrubland
12. Dominated exclusively by relatively sparse layer of *Encelia resinifera* and a highly variable mixture of other shrubs including, but not limited to *Ephedra spp.*, *Lycium andersonii*, and *Encelia farinosa* .....*Encelia resinifera* shrubland

13. Dominated exclusively by a sparse to open (2-25% cover) shrub layer of *Larrea tridentata*. Many other shrubs may be present at much lower cover including cacti *spp.*, *Krameria spp.*, and *Encelia farinosa*
.....*Larrea tridentata* shrubland
13. Codominated by *Larrea tridentata* and other shrub species 14

14. *Larrea tridentata* codominant with *Ambrosia dumosa* and sometimes *Fouquieria splendens* or *Krameria spp. Encelia farinosa* may be present, but never codominant 15
14. *Larrea tridentata* codominant with *Encelia farinosa* or *Coleogyne ramosissima*.....15

15. *Larrea tridentata* and *Coleogyne ramosissima* have >1% absolute cover in the shrub canopy. These two species combined exceed twice the cover of other shrub species .....*Larrea tridentata - Coleogyne ramosissima* Shrubland
15. *Larrea* codominant with *Encelia farinosa* and sometimes *Fouquieria splendens* 16

16. Both *Larrea tridentata* and *Encelia farinosa* have >1% absolute cover in the shrub canopy. Cover of both species exceed twice the cover of other shrub species ..... *Larrea tridentata - Encelia farinosa* Shrubland
16. *Larrea tridentata*, *Encelia farinosa* and *Fouquieria splendens* have >1% absolute cover in the shrub canopy. These three species exceed twice the cover of all other shrub species present
.....*Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland

Intermountain and Mojave Mid-Elevation Mixed Desert Scrub Groups

1. Shrub dominated vegetation where native graminoids are absent or have less than 5% cover. 2
1. Shrub dominated vegetation where there is a distinct graminoid layer with 5-25% cover 28

2. Dominated by *Ephedra spp. Coleogyne ramosissima* not present or codominant 3
2. *Ephedra spp.* absent or if present not dominant.....8

3. Dominated by *Ephedra fasciculata* sometimes occurring with mixed graminoid understory.....4
3. Dominated by *Ephedra torreyana*, *Ephedra viridis*, *Ephedra nevadensis* or *Ephedra trifurca*. Stands can be sparse and occurring with *Atriplex spp.*, *Opuntia basilaris*, or with a mixed graminoid understory.....5

4. Shrubland dominated by *Ephedra* fasciculata. Bernardia myricifolia codominate in some stands
.....*Ephedra fasciculata* Shrubland
4. Shrubland dominated by *Ephedra fasciculata* with a mixed grass understory. The most common species are *Muhlenbergia porteri*, *Pleuraphis jamesii*, and *Bromus rubens*. *Gutierrezia sarothrae* dominate in the dwarf shrub layer in some stands..... *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland

5. Shrub dominated vegetation although *Bromus rubens* may be invading and have substantial cover, but should be disregarded.....6
5. Dominated by *Ephedra torreyana* and/or *Ephedra viridis* with a mixed grass understory. Common grass species may include *Muhlenbergia porteri*, *Bouteloua eriopoda*, *Tridens muticus*, *Pleuraphis jamesii*, and *Achnatherum speciosum*. ..... *Ephedra* (*torreyana*, *viridis*) / Mixed Semi-desert Grasses shrubland

6. *Ephedra torreyana* or *Ephedra nevadensis* is the dominant species 7
6. Sparse shrubland dominated by *Ephedra trifurca*.....*Ephedra trifurca* Badlands Shrubland

7. *Ephedra torreyana* is the dominant shrub.....8
7. *Ephedra nevadensis* is dominant or codominant with *Yucca baccata*. Community associated with basaltic substrates
.....*Ephedra nevadensis – Yucca baccata* Basalt Shrubland

8. *Ephedra torreyana* forms a sparse shrub layer (<10% cover) often in association with *Atriplex canescens* and *Atriplex confertifolia*. *Bromus rubens* may be present up to 15% cover in some stands
.....*Ephedra torreyana* - (*Atriplex canescens*, *Atriplex confertifolia*) Sparse Vegetation
8. *Ephedra torreyana* forms a sparse shrub layer (<10% cover) in association with a sparse (<10% cover) dwarf shrub layer of *Opuntia basilaris*. *Bromus rubens* may be present up to 15% cover in some stands
.....*Ephedra torreyana - Opuntia basilaris* shrubland

9. Shrublands dominated by *Coleogyne ramosissima*. *Ephedra spp.* and *Purshia stansburiana* may be codominant.....
.....10
9. *Coleogyne ramosissima* absent or if present, not dominant or in stands with a tall shrub layer of *Yucca brevifolia* ...
.....12

10. Open to moderately dense short-shrub layer that is clearly dominated by *Coleogyne ramosissima*
.....*Coleogyne ramosissima* Shrubland
10. Shrub layer codominated by *Coleogyne ramosissima* and *Ephedra spp.* or occurring with a sparse tall shrub layer of *Purshia stansburiana*.....11

11. Shrub layer codominated by *Coleogyne ramosissima* and *Ephedra spp.* which may exceed or double the cover of *Coleogyne ramosissima* .....*Coleogyne ramosissima - Ephedra spp.* Warm Desert Shrubland
11. *Coleogyne ramosissima* dominates the short shrub layer with a sparse tall shrub layer of *Purshia stansburiana*
.....*Coleogyne ramosissima - Purshia stansburiana* Shrubland

12. *Gutierrezia spp.* are dominant and form a sparse to open (2-20%) dwarf shrub layer. There is often a short shrub layer dominated by *Ephedra spp.* and/or *Agaveutahensis*.....12
12. Shrublands not dominated by *Gutierrezia spp.* 14

13. *Gutierrezia spp.* dominant in the dwarf shrub layer with no other dominant species in other shrub layers
..... *Gutierrezia* (*microcephala*, *sarothrae*) Dwarf-Shrubland
13. *Gutierrezia spp.* dominant in the dwarf shrub layer with a short shrub layer dominated by *Ephedra spp.* and/or *Agave utahensis* ..... *Gutierrezia* (*sarothrae*, *microcephala*) – *Ephedra spp. - Agave utahensis* Dwarf-Shrubland

14. Shrublands dominated by species of *Yucca*. 15
14. Shrublands dominated by genera other than *Yucca*. 17

15. Relatively characterized by a relatively sparse shrub layer of *Yucca baccata*, *Ephedra* and *Encelia spp.* are common at lower covers, but not dominant ..... *Yucca baccata* shrubland
15. *Coleogyne ramosissima* and *Yucca brevifolia* codominant or *Yucca schidigera* is dominant as a small tree.....16

16. *Coleogyne ramosissima* and *Yucca brevifolia* are dominant
..... *Yucca brevifolia* / *Coleogyne ramosissima* Wooded Shrubland
16. *Yucca schidigera* is dominant as a small tree with a short shrub layer of *Larrea tridentata* and *Ambrosia dumosa*.
.....*Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland

17. Dwarf-Shrublands dominated by *Krascheninnikovia lanata* 18
17. *Krascheninnikovia lanata* absent or if present not dominant 19

18. Vegetation characterized by an open to moderately dense (10-60% cover) dwarf-shrub layer dominated by *Krascheninnikovia lanata* with an open to moderate herbaceous layer dominated by *Hesperostipa comata*
..... *Krascheninnikovia lanata* / *Hesperostipa comata* Dwarf-shrubland
18. Dwarf-Shrubland clearly dominated by *Krascheninnikovia lanata* with no other dominant species in other strata

..... *Kraschenninnikovia lanata* Dwarf-shrubland

19. Shrub layer dominated by species of *Opuntia*. 20
19. Shrub layer dominated by genera other than *Opuntia*. 21

20. Shrubland clearly dominated by *Opuntia bigelovii* ..... *Opuntia bigelovii* Shrubland
20. Vegetation characterized by an open, patchy canopy of *Opuntia polyacantha*, with between 2 and 25% cover, and low to moderate cover of *Pleuraphis jamesii*, usually with between 2 and 10% cover
..... *Opuntia polyacantha* / *Pleuraphis jamesii* Shrubland

21. Shrublands characterized by a sparse shrub layer of *Acacia greggi*i usually not exceeding 10% cover. *Ephedra fasciculata* may be codominant in some stands. *Canotia holacantha* is absent or has low cover
..... *Acacia greggii* Shrubland
21. Shrublands dominated by shrubs other than *Acacia greggii* 22

22. Shrubland dominated by *Canotia holacantha* up to 20% cover. *Gutierrezia spp.*, *Acacia greggii*, and *Ephedra spp.* are common to codominant in some stands ..... *Canotia holacantha* Grand Canyon Shrubland
22. Shrublands not as above 23

23. Sparsely vegetated shrubland dominated by *Lycium andersonii* and *Ephedra torreyana* and/or *Ephedra viridis*
..... *Lycium andersonii* - *Ephedra* (*torreyana*, *viridis*) Shrubland
23. Shrublands not as above 24

24. Shrublands dominated by *Nolina microcarpa* ..... *Nolina microcarpa* Shrubland
24. Shrublands not as above 25

25. Shrublands dominated by *Parthenium incanum* or codominated by *Ephedra fasciculata*
..... *Parthenium incanum* - (*Ephedra fasciculata*) Shrubland[Park Special]
25. Shrublands dominated by species other than *Parthenium incanum* or *Ephedra fasciculata* 26

26. Shrublands dominated by *Salazaria mexicana*. *Ephedra fasciculata* and *Hymenoclea salsola* are common, but not codominant ..... *Salazaria mexicana* Shrubland
26. Shrublands dominated by *Lycium pallidum* or *Psorothamnus fremontii* 27

27. Shrublands dominated by *Lycium pallidum* ..... *Lycium pallidum* Shrubland
27. Shrublands dominated by *Psorothamnus fremontii* ..... *Psorothamnus fremontii* Shrubland

28. Herbaceous layer dominated by *Bouteloua gracilis* 29
28. Herbaceous layer dominated by graminoid species other than *Bouteloua gracilis* 30

29. Dwarf-shrub steppe dominated by a moderately dense graminoid layer of *Bouteloua gracilis* with an open (10-25% cover) dwarf-shrub layer characterized by *Artemisia bigelovii*
..... *Artemisia bigelovii* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
29. Shrub-herbaceous community characterized by a short-shrub canopy of *Ericameria nauseosa* that ranges in cover from 5 to 25% cover, and an understory dominated by *Bouteloua gracilis* that ranges in cover from 5 to 35%.
..... *Ericameria nauseosa* / *Bouteloua gracilis* Shrub Herbaceous Vegetation

30. Dominant shrubs include *Ephedra spp.*, or *Gutierrezia spp.*, and/or *Agave utahensis* or with an herbaceous layer clearly dominated by *Bouteloua eriopoda* 31
30. Shrub layer dominated by *Acacia greggii*, *Yucca baccata*, or *Ceanothus fendleri* 34

31. Shrub layer dominated by *Ephedra spp. Gutierrezia spp.* may be present, but never exceeds cover of *Ephedra spp.* 32
31. Dominant vegetation characterized by a dwarf shrub layer of *Gutierrezia spp.* or with a sparse shrub layer and

herbaceous layer clearly dominated by *Bouteloua eriopoda*. Cover by *Ephedra spp.* may reach that of *Gutierrezia spp.* 33

33. Shrub layer dominated by *Ephedra viridis* or *Ephedra torreyana*
..... *Ephedra* (*torreyana*, *viridis*) / Mixed Semi-desert Grasses Shrubland
33. Shrub layer dominated by *Ephedra fasciculata*..... *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland

34. Vegetation characterized by a dwarf shrub layer dominated by *Gutierrezia spp.* If *Bouteloua eriopoda* is present cover does not exceed 5%..... *Gutierrezia* (*sarothrae*, *microcephala*) - *Ephedra spp.* - *Agave utahensis* Shrubland
34. Herbaceous layer dominated by *Bouteloua riopoda* (5-35% cover)
..... *Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation

35. Shrub layer dominated by *Ceanothus fendleri* with an herbaceous layer dominated by *Poa fendleriana*
..... *Ceanothus fendleri* / *Poa fendleriana* Shrub Steppe
35. Shrub layer dominated by *Yucca baccata* or *Acacia greggii* 35

36. Shrub layer dominated by *Acacia greggii* ..... *Acacia greggii* Shrubland
36. Shrub layer dominated by *Yucca baccata* ..... *Yucca baccata* Shrubland

Shadscale-Saltbush Cool Semi-Desert Scrub

1. Sparse shrublands of talus slopes dominated by *Atriplex obovata* ..... *Atriplex obovata* Talus Dwarf-shrubland
1. Shrublands dominated by other species of *Atriplex* 2

2. Shrublands clearly dominated by *Atriplex confertifolia* rarely exceeding 20% cover. Other species of shrubs may also be present, although they contribute little to the total canopy..... *Atriplex confertifolia* Great Basin Shrubland
2. Shrublands dominated by *Atriplex canescens* 3

3. Vegetation characterized by a sparse to moderately dense shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer..... *Atriplex canescens* Shrubland
3. Shrublands having a graminoid layer dominated by *Pleuraphis jamesii* or *Muhlenbergia porteri* 4

4. Vegetation characterized by *Atriplex canescens* with a grass understory dominated by *Muhlenbergia porteri*, which can reach 40% total cover ..... *Atriplex canescens* / *Muhlenbergia porteri* Shrubland
4. Vegetation characterized by *Atriplex canescens* with a grass understory dominated by patches *Pleuraphis jamesii* ...
..... *Atriplex canescens* / *Pleuraphis jamesii* Shrubland

Intermountain West Sagebrush Groups

1. Shrublands dominated by *Artemisia bigelovii* 2
1. Shrublands dominated by *Artemisia tridentata* 4

2. Shrublands found on colluvial deposits that form the lower slopes of canyons and valleys and on mesa tops, steep canyon sides, benches, hills and escarpments. Vegetation cover ranges from 2-25% and is composed of *Artemisia bigelovii* and *Ephedra torreyana* or *Ephedra viridis* which are conspicuous although not always dominant
..... *Artemisia bigelovii* - *Ephedra* (viridis, *torreyana*) Talus Shrubland
2. Shrublands found on ledgy slopes, canyon rims and ridges and less often on valley floors and high-level plateaus, dominated by *Artemisia bigelovii* 3

3. Shrublands found on ledges, canyon rims and ridges, dominated by *Artemisia bigelovii*. Other shrub species are always present, including *Atriplex confertifolia*, *Ephedra torreyana*, *Gutierrezia sarothrae*, and *Purshia stansburiana*. The herbaceous layer is typically sparse due to the rocky nature of the sites ..... *Artemisia bigelovii* Shrubland
3. Dwarf-shrub steppe found near canyon rims and mesa tops dominated by a moderately dense graminoid layer of *Bouteloua gracilis* with an open (10-25% cover) dwarf-shrub layer characterized by *Artemisia bigelovii*

.....*Artemisia bigelovii* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation

4. Moderately dense short-shrub layer (25-70%) dominated by *Artemisia tridentata*. Herbaceous layer is variable and is typically sparse and contributes <10% cover.....*Artemisia tridentata* Shrubland
4. Less dense short shrub layer (generally <20%) dominated by *Artemisia tridentata* codominant with *Ephedra spp.* (at least 1% cover), *Purshia stansburiana* (~5-15 % cover) or with an herbaceous layer dominated by *Bouteloua gracilis* or *Bromus tectorum*.....5

5. Shrublands codominated by *Artemisia tridentata* and *Ephedra spp.* or *Purshia tridentata*.....6
5. Shrublands with an herbaceous layer dominated by *Bouteloua gracilis*, *Bromus tectorum* or *Elymus elymoides*.....7

6. Vegetation characterized by a short shrub layer dominated by *Artemisia tridentata* (15-20%) and *Ephedra spp.* (may be as low as 1% cover). *Purshia stansburiana* is absent .....*Artemisia tridentata - Ephedra spp.*Shrubland
6. Vegetation characterized by a short shrub layer of *Artemisia tridentata* (10-20%) and the tall shrub *Purshia stansburiana* (5-10%). stands often contain a sparse tree layer made up of *Pinus monophylla*, *Pinus edulis*, and *Juniperus osteosperma* .....*Artemisia tridentata - Purshia stansburiana* Shrubland [Park Special]

7. Shrublands dominated by *Artemisia tridentata* or and lesser amounts of *Ericameria nauseosa* with an herbaceous layer sparse *Elymus elymoides*, *Bromus tectorum*, and *Bouteloua gracilis*
.....*Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland
7. Vegetation characterized by a near monoculture of *Artemisia tridentata* with a well-developed herbaceous layer of *Bouteloua gracilis* (usually ~10% cover, but as high as 40%) .....*Artemisia tridentata* / *Bouteloua gracilis* Shrubland

Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland and Arizonan Chaparral

1. Shrublands where *Quercus gambelii* is dominant or codominant with other shrub species.....2
1. Shrublands dominated by species other than *Quercus gambelii* 9

2. Scattered *Quercus gambelii* (5-7%) dominates the sparse shrub layers, while *Gutierrezia sarothrae* (average cover = 4%) is a common dwarf-shrub ground cover. This association usually supports a well-developed graminoid layer dominated by *Bouteloua gracilis* (10-15%). *Elymus elymoides* (1%) and the exotic *Bromus tectorum* (3%) are also common..... *Quercus gambelii* Shrubland
2. Mixed shrublands dominated or co-dominated by *Quercus gambelii* in association with other shrub species.....3

3. *Robinia neomexicana* codominant or well-represented in the tall shrub layer, with *Quercus gambelii*. If *Quercus turbinella* is present, then it is at very low cover.....4
3. *Robinia neomexicana* not dominant or codominant 5

4. *Quercus gambelii – Robinia neomexicana* mixed shrublands where *Symphoricarpos spp.*are present in the short shrub layer..... *Quercus gambelii* / *Robinia neomexicana* / *Symphoricarpos* rotundifolius Shrubland
4. *Quercus gambelii – Robinia neomexicana* mixed shrublands where *Symphoricarpos* species are not present
.....*Quercus gambelii* / *Robinia neomexicana* Shrubland

5. Typically dense shrublands occurring below the rim on gentle to moderately steep slopes, *Quercus gambelii* and *Amelanchier utahensis* are the dominant shrubs; *Quercus turbinella* and *Arctostaphylos* are absent or have very low cover ..... *Quercus gambelii* / *Amelanchier utahensis* Shrubland
5. Not as above.....6

6. Vegetation dominated by a tall shrub layer of *Quercus gambelii* and an open to dense herbaceous layer dominated by *Poa fendleriana*. Other shrubs may be present, but do not exceed >10% cover
.....*Quercus gambelii* / *Poa fendleriana* Shrubland
6. Shrublands dominated or codominated by *Quercus gambelii*, *Arctostaphylos pungens* or *Cercocarpus ledifolius*
.....7

7. Shrublands codominated by *Cercocarpus ledifolius* and *Quercus gambelii* ..... *Cercocarpus ledifolius* / *Quercus gambelii* Woodland

7. Shrublands characterized by a tall shrub layer of *Quercusgambelii* and a short shrub layer of *Arctostaphylos pungens* and/or *Garrya spp* ..... *Quercus gambelii* / *Arctostaphylos pungens* Shrubland

8. Shrublands where *Quercus turbinella* is dominant or codominant with other shrub species.....9

8. Shrublands dominated by species other than *Quercus turbinella* 13

9. Diverse and variable mixed shrublands, where Querucs *turbinella*, *Arctostaphylos pungens*, and *Garrya spp.* are dominants Other shrubs commonly include *Ostrya knowltonii*, *Rhus trilobata*, *Amelanchier utahensis*, *Yucca baccata*, *Cercocarpus montanus*, or *Purshia stansburiana*, but rarely do these have cover over 15% ..... *Quercus turbinella - Garrya flavescens - Arctostaphylos pungens* Shrubland

9. Shrub layer dominated by *Coleogyne ramosissima*, *Rhus trilobata*, *Artemisia tridentata*, *Juniperus osteosperma*, *Ptelea spp.*, or *Fraxinus spp.* 10

10. Tall shrub layer characterized by and open canopy of *Quercus turbinella* and short shrub layer of *Coleogyne ramosissima*. *Pinus edulis* and *Juniperus osteosperma* are common, but cover is low and never exceeds that of *Quercus turbinella* ..... *Quercusturbinella - Coleogyne ramosissima* Shrubland

10. Shrub layer dominated by *Rhus trilobata*, *Artemisia tridentata*, *Juniperus osteosperma*, *Gutierrezia sarothrae*, *Ptelea trifoliata*, or *Fraxinus anomala* 11

11. Shrub layer dominated by *Rhus trilobata*, *Artemisia tridentata*, or *Gutierrezia sarothrae* or in various combinations of two or all of these..... *Quercus turbinella* - (*Rhus trilobata*, *Artemisia tridentata*) Shrubland

11. Short canopy dominated by *Juniperus osteosperma* with a shrub layer of *Ptelea trifoliata*, or *Fraxinus anomala* 12

12. Shrub layer sparse to open shrub layer (1-30% cover) dominated by *Quercus turbinella* and a sparse to open canopy (1-20% cover) of *Juniperus osteosperma*..... *Quercus turbinella - Juniperus osteosperma* Shrubland

12. Shrub layer open (5-30%) and dominated by *Quercus turbinella* with a tall shrub layer characterized by *Ptelea trifoliata* and/or *Fraxinus anomala* .....*Quercus turbinella - Ptelea trifoliata - Fraxinus anomala* Mesic Shrubland

13. Shrublands dominated by post-fire regeneration of *Populus tremuloides* and/or *Ceanothus fendleri* 14

13. Shrublands not as above. *Ceanothus fendleri* is common and may attain up 15% cover, but is never dominant 15

14. Shrubland found on the North Rim that has recently experienced high intensity fires and is characterized by prominent regeneration of *Populus tremuloides* at up to 60% cover. This layer can be taller, and more reminiscent of a sub-canopy, or it can be a shorter layer of re-generational *Populus tremuloides* seedlings. *Ceanothus fendleri* is a dominant and consistent component of the dwarf-shrub stratum, and *Mahonia repens* also occurs frequently. Dry site "deer" sedges (*Carex siccata, C. rossii, C. geophila, C. occidentalis*) are very frequent in the herb layer. .....*Populus tremuloides - Ceanothus fendleri* / *Carex spp.* Shrubland

14. Low shrubland dominated by *Ceanothus fendleri* averaging 10-15% cover (with Aspen generally sparse or absent). No other shrub species is consistently present, or comprises significant cover. Graminoid cover averages 10-12%, but can sometimes be as high as 25%. *Poa fendleriana* (6-12%) dominates the herbaceous layer, while *Bromus tectorum* (up to 3%) and *Elymus elymoides* (up to 3%) also occur frequently. Fire adapted forbs such as *Erigeron* divergens, *Gayophytum diffusum*, *Chenopodium sp.*, *Conyza canadensis*, and *Epilobium brachycarpum* are frequent .....*Ceanothus fendleri* / *Poa fendleriana* Shrub Steppe

15. Shrublands dominated by *Robinia neomexicana*. *Ceanothus fendleri* is common and may attain up 15% cover, but is never dominant. Graminoid composition varies significantly between stands with mesic sites hosting dense covers of *Poa pratensis* and *Poa fendleriana*, and drier sites hosting moderate amounts of *Bromus tectorum* (4%). Forb cover is variable, but sometimes can total up to about 15%. The fire-adapted *Gayophytum diffusum*, *Erigeron divergens*, *Solidago velutina*, and *Chenopodium sp.* are common.....*Robinia neomexicana* Shrubland

15. Shrublands dominated by species other than *Robinia neomexicana*.....16

16. Vegetation occupying colluvial canyon slopes or extremely thin soils dominated by *Fendlera rupicola*, *Rhus trilobata*, and/or *Fraxinus anamola*.....17
16. Vegetation not as above.....18

17. Small patch vegetation occurring on colluvial canyon slopes dominated by *Fendlera rupicola*. *Juniperus osteosperma* may be present as saplings/seedlings.....*Fendlera rupicola* Talus Shrubland
17. Vegetation occurring on colluvial canyon slopes or extremely thin soils near the edges of canyon and mesa rims dominated by a sparse to low cover of *Fraxinus anomala* and *Rhus trilobata*
.....*Fraxinus anomala - Rhus trilobata* Talus Shrubland

18. Sparse to open (5-35% cover) shrublands dominated by *Ostrya knowltonii* often occurring with a sparse canopy of *Pinus ponderosa*, *Pseudotsuga menziesii*, *Pinus edulis*, and *Abies concolor*..... *Ostrya knowltonii* Woodland
18. Shrublands not as above.....19

19. Small patch shrubland often occurring in transition zones between forests and grasslands dominated by *Symphoricarpos oreophilus*.....*Symphoricarpos oreophilus* Shrubland
19. Shrublands not as above.....21

20. Shrubland dominated by moderately dense to dense tall-shrub layer dominated by *Quercus X pauciloba*. *Cercocarpus montanus* may be common in the short-shrub layer.....*Quercus X pauciloba* Shrubland
20. Shrublands dominated by *Arctostaphylos pungens* or *Mortonia utahensis*.....21

21. Shrublands characterized by a sparse to open shrub layer of *Mortonia utahensis*. *Pinus edulis* and *Juniperus osteosperma* are often present, but not dominant.....*Mortonia utahensis* shrubland
21. Dense shrublands where *Arctostaphylos pungens* strongly dominates typically at 40-50% cover either as a tall or short shrub. Scattered *Amelanchier utahensis*, *Cercocarpus montanus*, *Quercus gambelii*, and *Garrya flavescens* are common as associates. The herbaceous layer is sparse, and graminoids and forbs account for only 1-2% cover. *Poa fendleriana* is a dominant graminoid, but only at trace cover.....*Arctostaphylos pungens* Shrubland

Key to Herbaceous Communities

1. Semi-natural herbaceous vegetation dominated by *Bromus tectorum*,*Schismus spp.*, or *Erodium cicutarium* (non-native species cover >50%). Other invasive exotic species are also often abundant.....2
1. Herbaceous vegetation dominated by native species (native species cover >50%). Exotic species may be present, but are not dominant.....4

2. *Schismus spp.* dominant..... *Schismus* (*arabicus*, *barbatus*) Semi-natural Herbaceous Vegetation
2. *Bromus tectorum* or *Erodium cicutarium* dominant.....3

3. *Bromus tectorum* dominant.....*Bromus tectorum* Semi-natural Herbaceous Vegetation
3. *Erodium cicutarium* dominant.....*Erodium cicutarium* Semi-natural Annual Herbaceous Vegetation

4. Vegetation characterized by a well-developed herbaceous layer that is dominated by *Sphaeralcea ambigua*
..... *Sphaeralcea ambigua* HerbaceousVegetation
4. Vegetation dominated by graminoid species.....5

5. Graminoid dominated vegetation where shrubs are absent or have less than 5% cover.....6
5. Graminoid dominated vegetation where there is a distinct short or dwarf shrub layer with 5-25% cover.....20

6. Montane and subalpine graminoid vegetation dominated by *Carex spp.*, *Festuca spp.*, *Muhlenbergia montana*, or *Poafendleriana*. 7
6. Intermountain semi-desert graminoid vegetation dominated by *Bouteloua spp.*, *Aristida purpurea*, *Sporobolus*

cryptandrus, *Pleuraphis spp.*, *Tridens muticus* and/or *Hesperostipa comata* 12

7. *Carex siccata* and or *Carex rossii* dominated vegetation, typically occurring in post-burn, early-successional areas. *Bromus tectorum* and *Elymus elymoides* are also common at very low cover. The disturbance-adapted *Erigeron divergens*, *Chenopodium spp.*, *Gayophytum diffusum*, *Pseudognaphalium macounii*, and *Conyza canadensis*, as well as *Pseudostellaria jamesiana* are common forbs. The shrub *Ceanothus fendleri* is common at low cover
..... *Carex siccata - Carex rossii* HerbaceousVegetation
7. Vegetation dominated by grass species.....8

8. *Muhlenbergia montana* dominated herbaceous vegetation, generally at montane elevations, or if mixed *Muhlenbergia* has >5% cover.....9
8. Grasslands in which *Festuca spp.*, *Hesperotstipa comata*, *Bouteloua gracilis*, *Pleuraphis jamesii*, or *Poa fendleriana* are the dominant species; *Muhlenbergia montana* absent or if present is not dominant.....10

9. Herbaceous vegetation where *Muhlenbergia montana* overwhelmingly dominates the graminoid stratum, sometimes at up to 50% cover. *Blepharoneuron tricholepis* (8%) is characteristic of this association but does not occur on every site. *Elymus elymoides* is also a characteristic component of the graminoid layer, but at low cover. *Poa fendleriana* and *Bouteloua gracilis* are frequent as well, sometimes comprising up to 30% cover each, but in these cases *Muhlenbergia montana* is the indicator .....*Muhlenbergia montana* Herbaceous Vegetation
9. Herbaceous vegetation where *Muhlenbergia montana* and *Hesperostipa comata* overwhelmingly co-dominate the graminoid component, and other grass species only occur at trace covers.
.....*Muhlenbergia montana - Hesperostipa comata* herbaceous Vegetation

10. North Rim grasslands where *Festuca spp.* or a mix of herbaceous forbs and *Festuca spp.* dominate
..... *Festuca* (*calligera*, *arizonica*, brachyphylla) Herbaceous Vegetation
[*Note: the correct taxonomy for fescues at Grand* canyon *appears unclear. All plots classified to this association had Festuca ovina recorded in them, but that species is not recorded to be present in GRCA, and instead it is considered to be F. brachyphylla. F. arizonica is the fescue expected to be in the Park, but apparently the field crews did not think these plots were Arizona fescue. Therefore all the fescue dominated communities have been lumped into the above type.*]
10. Not as above.....11

11. Herbaceous vegetation where *Poa fendleriana* is dominant. Other graminoids include *Elymus elymoides* (5%) cover can range up to 15% cover. Other graminoid species including *Carex rossii*, *Bromus tectorum*, and *Carex occidentalis* are frequent. Semi-desert grasses such as *Hesperotstipa comata*, *Bouteloua gracilis*, *Pleuraphis jamesii* may occur but typically at cover <5% .....*Poa fendleriana* Herbaceous Vegetation
11. Grasslands where *Poa fendleriana* is not present or has cover <5% 12

12. Vegetation dominated by *Aristida purpurea* or *Tridens muticus* 13
12. Vegetation dominated by *Bouteloua spp.*, *Sporobolus cryptandrus*, *Pleuraphis spp.*, or *Hesperostipa comata*. *Aristida purpurea* may present, but not dominant.....14

13. *Aristida purpurea* dominant..... *Aristida purpurea* Herbaceous Vegetation
13. *Tridens muticus* dominant ..... *Tridens muticus* Herbaceous Vegetation

14. Vegetation dominated by *Bouteloua gracilis*,*Pleuraphis spp.*, or *Sporobolus cryptandrus*. If *Hesperostipa comata* is present, it is not a dominant or codominant 15
14. Vegetation dominated by *Hesperostipa comata* and/or *Bouteloua eriopoda*
.....*Hesperostipa comata* Great Basin Herbaceous Vegetation

15. Herbaceous vegetation dominated only by *Bouteloua gracilis* and lacking a significant *Pleuraphis jamesii* component *Bouteloua gracilis* Herbaceous Vegetation
15. Herbaceous vegetation dominated by *Bouteloua gracilis*, *Pleuraphis spp.*, and/or *Sporobolus cryptandrus* 16

16. Dominated only by *Sporobolus cryptandrus*.....*Sporobolus cryptandrus* Great Basin Herbaceous Vegetation

16. Codominated exclusively by *Pleuraphis spp.* or by *Bouteloua gracilis* with either *Pleuraphis spp.*or *Sporobolus cryptandrus* 17

17. Herbaceous layer dominated exclusively by *Pleuraphis spp. Bouteloua eriopoda* may contribute as much as 5% cover, but is never codominant.....18
17. Dominated by *Bouteloua gracilis* and either *Pleuraphis spp.*or *Sporobolus cryptandrus*.....19

18. Dominated by *Pleuraphis jamesii* ..... *Pleuraphis jamesii* Herbaceous Vegetation
18. Dominated by *Pleuraphis rigida* .....*Pleuraphis rigida* Herbaceous Vegetation

19. Codominated by *Bouteloua gracilis* and *Pleuraphis jamesii*
..... *Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation
19. Codominated by *Bouteloua gracilis* and *Sporobolus cryptandrus*
..... *Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation

20. *Bouteloua eriopoda* the only dominant grass.....
..... *Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation
20. *Hesperostipa comata* dominant or codominant with *Bouteloua eriopoda* and/or *Pleuraphis jamesii*.....21

21. *Hesperostipa comata* the only dominant grass.....*Hesperostipa comata* Great Basin Herbaceous Vegetation
21. *Hesperostipa comata* codominant with *Bouteloua eriopoda* and/or *Pleuraphis jamesii*
.....*Hesperostipa comata* - (*Bouteloua eriopoda*, *Pleuraphis jamesii*) Herbaceous Vegetation

22. Herbaceous layer dominated by *Bouteloua gracilis* 23
22. Herbaceous layer dominated by graminoid species other than *Bouteloua gracilis* 24

23. Dwarf-shrub steppe dominated by a moderately dense graminoid layer of *Bouteloua gracilis* with an open (10-25% cover) dwarf-shrub layer characterized by *Artemisia bigelovii*.
.....*Artemisia bigelovii* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
23. Shrub-herbaceous community characterized by a short-shrub canopy of *Ericameria nauseosa* that ranges in cover from 5 to 25% cover, and an understory dominated by *Bouteloua gracilis* that ranges in cover from 5 to 35%.
.....*Ericameria nauseosa* / *Bouteloua gracilis* Shrub Herbaceous Vegetation

24. Understory dominated by *Bouteloua eriopoda*. Dominant shrubs may include *Ephedra fasciculata* and *Gutierrezia sarothrae* ..... *Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation
24. Shrub layer dominated by *Ceanothus fendleri* with an herbaceous layer dominated by *Poa fendleriana*
.....*Ceanothus fendleri* / *Poa fendleriana* Shrub Steppe

Palustrine, Drainage, Wash, and Seep Vegetation

1. Forest and woodland vegetation. Tree species contribute >5% total cover
.....**Go to Western North American Cool Temperate Flooded Forest Group Key**
1. Shrub and herbaceous vegetation. Trees, if present contribute <5% cover 2

2. Shrub dominated vegetation of washes, arroyos, riparian zones and seeps/hanging gardens.....3
2. Herbaceous vegetation of wet meadows and marshes
..... **Go to Arid West Emergent Marsh Group and Vancouverian & Rocky Mountain Montane Wet Meadow Groups Key**

3. Shrub vegetation of riparian zones, washes, and arroyos. Characteristic species include *Acacia greggii*, *Bebbia juncea*, *Brickellia longifolia*, *Chilopsis linearis*, *Ericameria nauseosa*, *Ericameria paniculata*, *Fallugia paradoxa*, *Hymenoclea*, *Isocoma acradenia*, *Baccharis spp.*, *Ericameria nauseosa*, *Pluchea sericea*, *Prosopis glandulosa*, *Salix exigua*, *Tamarix spp.*, and *Vitis arizonica*.....4
3. Shrub vegetation of saline marshes, seeps and hanging gardens. Characteristic species include *Suaeda moquinii*,

Atriplex hymenelytra, *Betula occidentalis*, *Tamarix ramosissima*, *Celtis laevigata*, *Cladium spp.*, or *Cercis orbiculata* .....**Go to Colorado Plateau Hanging Garden Seep and Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland Groups Key**

4. Shrub vegetation of washes and arroyos. Characteristic species include *Acacia greggii*, *Bebbia juncea*, *Brickellia longifolia*, *Chilopsis linearis*, *Ericameria nauseosa*, *Ericameria paniculata*, *Fallugia paradoxa*, *Hymenoclea*, *Isocoma acradenia* ..... **Go to North American Semi-Desert Shrub Wash-Arroyo Group Key**
4. Shrub vegetation of riparian zones. Characteristic species include *Baccharis spp.*, *Ericameria nauseosa*, *Pluchea sericea*, *Prosopis glandulosa*, *Salix exigua*, *Tamarix spp.*, and *Vitis arizonica* .....**Go to North American Warm Desert Riparian Low Bosque and Shrubland and Cool Semi-Desert Xero-Riparian Groups Key**

Western North American Cool Temperate Flooded Forest Group

1. Woodlands occupying riparian zones dominated by *Acer negundo*, *Brickellia spp.*, *Quercus spp.*, and *Celtis laevigata* 2
1. Woodlands occupying riparian zones, marshes and other areas subject to flooding dominated by *Populus fremontii*, *Fraxinus velutina*, and *Salix gooddingii*. *Acer negundo* may occur, but in conjunction with *Populus fremontii* 6

2. Woodlands dominated by *Acer negundo* 3
2. Woodlands dominated by *Celtis laevigata* 5

3. Understory dominated by *Brickellia grandiflora* and/or *Brickellia* longiflora .....*Acer negundo* / *Brickellia* (*grandiflora*, *longifolia*) Woodland [Provisional]
3. Understory dominated by *Quercus spp* 4

4. Understory dominated by *Quercus gambelii*.....*Acer negundo* / *Quercus gambelii* Woodland
4. Understory dominated by *Quercus turbinella* .....*Acer negundo* / *Quercus turbinella* Woodland

5. Woodlands occurring in drainage bottoms and washes dominated by *Celtis laevigata var. reticulata* .....*Celtis laevigata var. reticulata* Slickrock Canyon Woodland [Provisional]
5. Woodlands occurring in seepage areas with understories characterized by *Cladium spp* .....*Celtis laevigata* / *Cladium spp.* Saturated Seep Shrubland

6. Forests and woodlands dominated by *Populus fremontii* 7
6. Woodlands lacking *Populus fremontii* and dominated by *Salix gooddingii* or *Fraxinus velutina* 10

7. Forests characterized by a subcanopy or co-dominance of *Acer negundo* ..... *Populus fremontii* / *Acer negundo* Forest
7. Woodlands characterized by a shrub layer of *Fraxinus velutina*, *Salix gooddingii*, or *Baccharis emoryi*.....8

8. Shrub layer dominated by *Fraxinus velutina* .....*Populus fremontii - Fraxinus velutina* Woodland
8. Shrub layer dominated by species other than *Fraxinus velutina*.....9

9. Shrub layer dominated by *Salix gooddingii* .....*Populus fremontii - Salix gooddingii* Woodland
9. Shrub layer dominated by *Baccharis emoryi* .....*Populus fremontii* / *Baccharis emoryi* Woodland

10. Woodlands dominated by *Salix spp.* 11
10. Woodlands dominated by *Fraxinus velutina* .....*Fraxinus velutina* Riparian Woodland [Park Special]

11. Woodlands clearly dominated by *Salix gooddingii* ..... *Salix gooddingii* Woodland
11. Woodlands dominated by and open canopy of *Salix gooddingii* with an understory of *Baccharis emoryi* .....*Salix gooddingii* / *Baccharis emoryi* Woodland

North American Semi-Desert Shrub Wash-Arroyo Group

1. *Acacia greggii* dominant or codominant with *Larrea tridentata* 2
1. Neither *Acacia greggii* nor *Larrea tridentata* dominant 3

2. *Acacia greggii* is clearly the dominant species. In some stands *Chilopsis linearis* may have substantial cover. *Hymenoclea salsola* may be present, but with low cover..... *Acacia greggii* Wash Shrubland
2. *Acacia greggii* dominant with *Larrea tridentata* present to codominant and is regarded as an indicator species. *Hymenoclea salsola* may be codominant in some stands
..... *Acacia greggii - Larrea tridentata* - (*Hymenoclea salsola*) Wash Shrubland [Park Special]

3. *Bebbia juncea* is dominant in the short shrub layer. *Acacia greggii* is often present, but not dominant
..... *Bebbia juncea* Shrubland
3. *Brickellia longifolia*, *Chilopsis linearis*, *Ericameria nauseosa*, *Ericameria paniculata*, *Fallugia paradoxa*, *Hymenoclea salsola*, or *Isocoma acradenia* are dominant 4

4. *Brickellia longifolia* is the dominant shrub. *Bromus rubens* may have high cover in some stands .....
..... *Brickellia longifolia* Shrubland
4. *Brickellia spp.* may be present, but not dominant..... 5

5. *Chilopsis linearis* is the dominant shrub. Occasionally *Fallugia paradoxa*, *Isocoma acradenia*, or *Bebbia juncea* can be codominant, but *Chilopsis linearis* is consider indicative of the community..... *Chilopsis linearis* Shrubland
5. *Chilopsis linearis* may be present, but not dominant 6

6. *Ericameria paniculata* or *Ericameria nauseosa* are dominant. Other common associates are *Hymenoclea salsola*, *Larrea tridentata*, and *Chilopsis linearis* 7
6. *Ericameria spp.* may be present, but not dominant 8

7. *Ericameria nauseosa* is the dominant shrub ..... *Ericameria nauseosa* Desert Wash Shrubland
7. *Ericameria paniculata* is the dominant shrub ..... *Ericameria paniculata* Wash Shrubland

8. *Fallugia paradoxa* the dominant shrub. Occasionally grass cover may exceed that of the shrub layer, but *Fallugia paradoxa* is considered indicative..... *Fallugia paradoxa* Grand Canyon Desert Wash Shrubland
8. *Fallugia paradoxa* may be present, but not dominant 9

9. *Hymenoclea salsola* is the dominant shrub. Occasionally other shrub species are codominant, but *Hymenoclea* is considered indicative ..... *Hymenoclea salsola* Wash Shrubland
9. *Isocoma acradenia* is the dominant shrub. Occasionally *Tamarix spp.* are codominant, but *Isocoma* is considered indicative ..... *Isocoma acradenia* Shrubland

North American Warm Desert Riparian Low Bosque and Shrubland Group

1. *Baccharis spp.* and/or *Salix exigua* are dominant in the shrub layer 2
1. *Prosopis glandulosa*, *Tamarix ramosissima*, or *Vitis arizonica* dominant and indicative, but *Baccharis spp.* and *Salix exigua* may occasionally be codominant 8

2. *Salix exigua* codominant with *Baccharis emoryi*. In some stands, either species may be subordinate to one another, but are both considered indicative ..... *Baccharis emoryi - Salix exigua* Shrubland
2. *Baccharis spp.* or *Salix exigua* dominant or codominant with other species (but not with each other) 3

3. *Baccharis spp.* dominant..... 4
3. *Salix exigua* dominant..... 6

4. *Baccharis emoryi* dominant in the shrub layer with a dense understory of *Imperata brevifolia*

.....*Baccharis emoryi* / *Imperata brevifolia* Shrubland
4. *Baccharis salicifolia* or *Baccharis sarothroides* dominant.....5

5. *Baccharis salicifolia* dominant ..... *Baccharis salicifolia* Riparian Shrubland
5. *Baccharis sarothroides* dominant (if herb layer dominated by *Cynodon dactylon* and *Baccharis* 15% or less, key also as an herbaceous type [*couplet 11 in the Arid West Emergent* Marsh Group *and Vancouverian* & *Rocky Mountain* Montane *Wet Meadow* Groups] .....*Baccharis sarothroides* Shrubland

6. Nearly pure stands of *Salix exigua* .....*Salix exigua* / Barren Shrubland
6. *Salix exigua* dominant in the shrub layer with an herbaceous layer of *Equisetum x ferrissii* and *Carex aquatilis* .....*Salix exigua* / *Equisetum* X *ferrissii* Shrubland [Park Special]

7. *Tamarix ramosissima*, *Pluchea sericea* or *Prosopis glandulosa* dominant.....8
7. *Vitis arizonica* the dominant vine. *Phragmites australis* may be present at high cover..... *Vitis arizonica* Shrubland

8. *Tamarix ramosissima* or *Pluchea sericea* dominant. *Baccharis spp.* and *Prosopis glandulosa* may be present, but are not subordinate or co-dominant.....9
8. *Prosopis glandulosa* dominant. *Baccharis spp.* and *Pluchea sericea* may be present with substantial cover, but are subordinate ..... *Prosopis glandulosa var. torreyana* Shrubland

9. *Tamarix ramosissima* forms open to very dense canopy (up to 95% cover). *Pluchea sericea* often present, but with <15% cover .....*Tamarix spp.* Temporarily Flooded Semi-natural Shrubland
9. *Pluchea sericea* dominant forming open to very dense canopies (up to 95% cover). *Tamarix ramosissima* may occasionally codominate (up to 40% cover).....*Pluchea sericea* Seasonally Flooded Shrubland

Colorado Plateau Hanging Garden Seep and Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland Groups

1. Shrubland occupying alkaline-saline zones dominated by *Suaeda moquinii* and *Atriplex hymenelytra* 2
1. Shrub or shrub herbaceous vegetation occupying seepage areas (hanging gardens) dominated by *Betula occidentalis*, *Tamarix ramosissima*, *Celtis laevigata*, *Cladium spp.*, or *Cercis orbiculata*.....3

2. Shrubland characterized by sparse cover of *Atriplex hymenelytra* .....*Atriplex hymenelytra* Shrubland
2. Shrubland dominated by *Suaeda moquinii* .....*Suaeda moquinii* Shrubland

3. Shrubland dominated by *Betula occidentalis* or *Cercis orbiculata*.....4
3. Herbaceous, shrub, or shrub-herbaceous vegetation characterized by a graminoid layer of *Cladium californicum* with or without a shrub layer of *Tamarix ramosissima* and/or *Celtis laevigata*.....5

4. Shrub layer dominated by *Betula occidentalis*.....*Betula occidentalis* Desert Spring Shrubland
4. Shrub layer dominated by *Cercis orbiculata* ..... *Cercis orbiculata* Seep Shrubland

5. Herbaceous or shrub-herbaceous vegetation characterized by a graminoid layer of *Cladium californicum* with or without a shrub layer of *Tamarix ramosissima*.....*Cladium californicum* Seep
5. Shrubland dominated by *Celtis laevigata* with an understory of *Cladium californicum* .....*Celtis laevigata* / *Cladium californicum* Saturated Seep Shrubland

Arid West Emergent Marsh Group and Vancouverian & Rocky Mountain Montane Wet Meadow Groups

1. Emergent herbaceous vegetation dominated by *Aletes macdougalii*. *Baccharis spp.* may be present in the shrub layer, but are typically less than 5% cover.....*Aletes macdougalii* Herbaceous Vegetation [Park special]
1. Herbaceous vegetation dominated by *Equisetum*, *salsola*, *Geraea canescens* orgraminoids. *Phragmites australis* may be codominant, but is not considered diagnostic if codominant with native species.....2

2. Ruderal vegetation dominated by *Poa pratensis*
.....*Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation
2. Not as above.....3

3. Vegetation dominated by *Equisetum x ferrissii*. Other important species include *Cynodon dactylon* and *Andropogon gerardii* which can range up to 15% cover .....*Equisetum x ferrissii* Herbaceous Vegetation
3. Not as above.....4

4. Ruderal or ephemeral vegetation dominated by *Geraea canescens* or *salsola tragus*.....5
4. Vegetation characterized by graminoid vegetation.....6

5. Ruderal vegetation characterized *salsola tragus*..... *Salsola spp.* Herbaceous Vegetation [Provisional]
5. Ephemeral vegetation dominated by *Geraea canescens* ..... *Geraea canescens* Ephemeral Herbaceous Vegetation

6. Vegetation characterized by sedge or bulrush species of *Carex* and *Schoenoplectus*. *Tamarix spp.* may be present at <5% cover.....7
6. Vegetation characterized by grass and rush species. *Tamarix spp.* may be present at <5% cover.....11

7. *Carex* dominated vegetation.....8
7. Emergent herbaceous *Schoenoplectus* dominated vegetation 10

8. *Carex athrostachya* dominant..... *Carex athrostachya* Herbaceous Vegetation [Park Special]
8. *Carex vesicaria* or *Carex aquatilis* dominant.....9

9. *Carex vesicaria* dominant..... *Carex vesicaria* Herbaceous Vegetation
9. *Carex aquatilis* dominant ..... *Carex aquatilis* Herbaceous Vegetation

10. *Schoenoplectus americanus* dominant. .....*Schoenoplectus americanus* Western Herbaceous Vegetation
10. *Schoenoplectus pungens* dominant..... *Schoenoplectus pungens* Herbaceous Vegetation

11. *Juncus balticus* dominant. *Salix exigua* likely to be present at <3% cover
.....*Juncus balticus* Herbaceous Vegetation
11. Vegetation dominated by *Typha domingensis*, *Muhlenbergia asperifolia*, *Cynodon dactylon*, or *Phragmites australis*
.....12

12. Herbaceous layer dominated by *Cynodon dactylon*. *Tamarix ramosissima* and/or *Baccharis sarothroides* may range up to 15% cover.....*Cynodon dactylon* Herbaceous Vegetation
12. Vegetation dominated by *Muhlenbergia asperifolia*, *Typha domingensis* or *Phragmites australis*.....13

13. *Muhlenbergia asperifolia* is dominant..... *Muhlenbergia asperifolia* Herbaceous Vegetation
13. Vegetation dominated by *Typha domingensis* or *Phragmites australis*.....14

14. *Typha domingensis* dominant..... *Typha domingensis* Western Herbaceous Vegetation
14. *Phragmites* dominant
.....*Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation

Final Vegetation Mapping Classification Key

Phase 1: Grand Canyon National Park

Version 25

May 27, 2010

This map classification key was developed from analysis of Park Service vegetation plot and observation data, NVCS descriptions, and KGA field sample segments. It is compliant with the NVCS Version 2 (2008). To effectively use this key, the reader should first review and understand the basic concepts of NVCS. The key is for Phase 1 mapping areas. Vegetation class labels determined by this key are a function of percent cover of the components of a sample (be it a KGA segments or a Park Service vegetation plot or observation point) - its trees, shrubs, grass/herbs, bare land and human made features as specified in NVCS:

- Trees: Trees are woody plants that generally have a single main stem and have more or less definite crowns. In instances where growth form cannot be determined, woody plants equal to or greater than 5 meters in height at maturity shall be considered trees.
- Dwarf Trees: Dwarf trees are woody plants, typically less than 12 meters tall at maturity due to genetic and/or environmental constraints (e.g., pinyon pines, junipers, and mountain mahogany).
- Shrubs: Shrubs are woody plants … that generally exhibit several erect,spreading, or prostrate stems which give it a bushy appearance. In instances where growth form cannot be determined, woody plant less than 5 meters in height at maturity shall be considered shrubs. In this project, *Robinia neomexicana* and *Quercus gambelii* will be considered shrubs even if their height exceeds 5 meters.
- Grasses/Herbs: Grasses/herbs are vascular plants without significant woody tissue above the ground, with perennating buds borne at or below the ground surface." This feature type includes graminoids, forbs, ferns, club mosses,horsetails, and quillworts.
- Human Made Features: Human made features are features on the landscape which have been created by humans and include buildings, sidewalks, parking lots, roads, etc.
- Bare Land: Bare land is land with less than 3% vegetative cover.

Sample cover is determined by estimating the cover of the elements of a sample as seen from above. The cover of a sample is the total vertical projection on the ground of the cover for all elements collectively. Therefore, total sample cover must add up to 100%.

This mapping key is based on its companion documents "Vegetation Associations of Grand Canyon National Park: Local Descriptions for Plan Associations in the Phase 1 Mapping Area (NautreServe, current as of the time this key was finalized: November 9, 2009) and the appended general class descriptions provided by the Park Service and NatureServe . Users of this mapping key should also refer to these descriptions for a full understanding of the dynamic vegetation in the Grand Canyon National Park Phase 1 mapping area.

1. Is more than 80% of the segment covered in water?
If yes, ... Water

2. Is the segment labeled in the Park Service planametric GIS data as a building, sidewalk, parking lot, or some other human made feature?
If yes, ... Built up

3. Is the segment a paved road?
If yes, ...Road

4. Does vegetation cover less than 3% of the segment?
If yes, ...Bare Land

5. Is vegetation cover more than 3% of the segment AND is more than 60% of the segment adapted to intensive human manipulations AND the vegetation has distinctive structure, composition and development?
If yes, ...Cultural Vegetation

6. Is vegetation cover more than 3% of the segment, AND has the segment experienced a stand replacing fire during the last 30 years, AND is the remaining live conifer cover less than 10% of the segment cover?
If no, ... go to 7.
If yes, ...Post Burn Vegetation Type (6.1)

6.1 Does *Populus tremuloides* occupy more than 10% of the segment AND is *Populus tremuloides* cover more than *Robinia neomexicana* cover? .....*Populus tremuloides* Post Burn Vegetation(6.1.1)
If no, ... go to 6.2

6.1.1 Does *Robinia neomexicana* occupy more than 5% of the segment cover?
If yes,.....*Populus tremuloides* / *Robinia neomexicana* Woodland

6.1.2 Do *Populus tremuloides* shrubs occupy more area than *Populus tremuloides* trees?
If yes,..... *Populus tremuloides – Ceanothus fendleri* / *Carex spp.* Shrubland
Else .....*Populus tremuloides* / *Carex siccata* Forest

6.2 Do shrubs occupy more than 10% of the segment?.....Post Burn Shrub Type (6.2.1)
If no, ... go to 6.3.

6.2.1 Does *Robinia neomexicana* occupy more than 15% of the segment cover AND is *Arctostaphylospatula*, *Arctostaphylos pungens*, *Quercus gambelii*, or *Ceanothus fendleri* cover at least 5% lessthan*Robinia neomexicana* cover? .....*Robinia neomexicana* Shrubland

6.2.2 Does *Arctostaphylos patula* occupy more than 10% of the segment cover AND is *Arctostaphylos pungens*, *Quercus gambelii*, and*Ceanothus fendleri* cover at least 5% less than*Arctostaphylos patula* cover?
.....*Arctostaphylos patula* Shrubland

6.2.3. Does *Arctostaphylos pungens* occupy more than 10% of the segment AND is *Quercus gambelii*plus*Ceanothus fendleri* cover at least 5% less than *Arctostaphylos pungens* cover?
.....*Arctostaphylos pungens* Shrubland

6.2.4 Does *Ceanothus fendleri* occupy more than 10% of the segment AND is *Quercus gambelii* cover 5%less than*Ceanothus fendleri* cover? .....*Ceanothus fendleri* / *Poa fendleriana* Shrub Steppe

6.2.5 Does *Quercus gambelii* occupy more than 10 % of the segment?..... *Quercus gambelii* Shrubland

6.2.6 Else .....Mixed Post-Burn Shrub Type

6.3 Do grasses and herbs occupy more than 10% of the segment?..... Post-Burn Grass/Herb Type (6.3.1)

6.3.1 Is the segment adjacent to the rim AND does *Hesperostipa comata* occupy more than 20% of the segment cover? .....*Hesperostipa comata* Great Basin Herbaceous Vegetation

6.3.2.... Do *Carex spp.* make up more than 10% of the segment cover AND is *Poa fendleriana* cover 5% less than *Carex* cover?..... *Carex siccata – Carex rossii* Herbaceous Vegetation

6.3.3 Does *Poa fendleriana* make up more than 10% of the segment cover?
.....*Poa fendleriana* Herbaceous Vegetation

6.3.4 Else .....Post Burn Grass/Herb Type

6.4 Else..... .....Post Burn Vegetation Type

7. Is more than 10% of the segment cover comprised of trees (i.e. woody plants more than 5m tall)?

If yes, ... WESTERN NORTH AMERICAN COOL TEMPERATE FOREST (7.1)

If no, ... go to 8.

7.1 Does *Populus fremontii* comprise more than 15% of the segment?

.....*Populus fremontii* Temporarily Flooded Forest Alliance

(*This type was added to capture the 2* or *3 riparian segments that were found on the edge of the Phase 1 boundary. Refinement of this type to the Association level will occur during Phase 2.*)

If no, ... go to 7.2.

7.2 Does *Pinus ponderosa* comprise more than 50% (relative cover) of the tree and dwarf tree cover, AND do *Abies spp.* plus *Pseudotsuga menziesii* comprise less than 15% of the total segment cover?

.....Southern Rocky Mountain *Ponderosa* Pine Forest and Woodland Group (7.2.1)

7.2.1 .....Do shrubs occupy more than 3% of the segment AND is shrub cover is greater than grass/herb cover?

.....*Pinus Ponderosa* Forest and Woodland with Shrub Understory Alliance (7.2.1.1)

If no .....go to 7.2.2.

7.2.1.1 Does *Quercus gambelii* occupy more than 2% of the total segment AND is *Robinia neomexicana*, *Arctostaphylos patula*, *Populus tremuloides*, or *Purshia stansburiana* cover at least 2% less than *Quercus gambelii* cover?..... *Pinus ponderosa* / *Quercus gambelii* Woodland

7.2.1.2 Does *Robinia neomexicana* occupy more than 2% of the segment AND is the cover of *Arctostaphylos patula*, *Populus tremuloides*, or *Purshia stansburiana* less than *Robinia neomexicana* cover?

.....*Pinus ponderosa* / *Robinia neomexicana* Woodland

7.2.1.3 Does *Arctostaphylos patula* occupy more than 2% of the total segment cover AND is *Purshia stansburiana*, and *Populus tremuloides* cover at least 2% less than *Arctostaphylos patula* cover?

.....*Pinus ponderosa* / *Arctostaphylos patula* Woodland

7.2.1.4 Is *Purshia stansburiana* present in the shrub strata?

..... *Pinus ponderosa* / *Purshia stansburiana* Woodland

Else..... *Pinus ponderosa* Forest and Woodland with Mixed Shrub Understory Alliance

7.2.2 Do herbs, grasses or ferns occupy more than 1% of the total segment cover?

..... *Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance (7.2.2.1)

7.2.2.1 Does *Pteridium aquilinum* occupy more than 3% of the segment cover, AND is *Pteridium aquilinum* cover greater than *Carex siccata* cover? ..... *Pinus ponderosa* / *Pteridium aquilinum* Woodland

7.2.2.2 Does *Carex siccata* occupy at least 2% of the total segment? .....

.....*Pinus ponderosa* / *Carex siccata* Forest

7.2.2.3 Is *Bouteloua gracilis* the dominant grass?.....*Pinus ponderosa* / *Bouteloua gracilis* Woodland

7.2.2.4 Are *Poa fendleriana*, *Carex rossii*, or C. *geophila* the most dominant graminoids?

.....*Pinus ponderosa* / *Poa fendleriana* Woodland

Else..... *Pinus ponderosa* Forest Woodland with Mixed Herbaceous and Grass Understory

7.2.3 Does a mix of shrubs, herbs, grasses, and ferns occupy less than 10% of the total segment cover?

.....*Pinus ponderosa* with sparse understory

7.2.4 Else .....Southern Rocky Mountain *Ponderosa* Pine Forest and Woodland Group

7.4 Does *Pseudotsuga menziesii* occupy more than 15% of the segment cover AND is the cover of *Abies concolor* at least 5% less than the *Pseudotsuga menziesii* cover, AND is the segment is below the rim in a steep rim rock environment?.....*Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest

7.5 Do *Abies spp.* occupy more than 5% of the segment cover, OR does *Abies spp.* plus *Pseudotsuga menziesii* occupy more than 10 % of the segment cover AND does *Populus tremuloides* (tree plus shrub) occupy less than 40% of the segment?. . .. .*Abies concolor – Pseudotsuga menziesii* Forest (7.5.1)

7.5.1 Is the segment on a steep rim-rock environment? .....*Abies concolor* / *Cercocarpus ledifolius* Woodland

7.5.2Does *Robinia neomexicana* occupy more than 5% of the cover AND are *Juniperus spp.*, *Mahonia repens*, or *Carex ssp.* cover less than *Robinia neomexicana* cover?

.....*Abies concolor – Pseudotsuga menziesii* / *Robinia neomexicana* Woodland

7.5.3 Is *Mahonia repens* present in the segment?

.....*Abies concolor – Pseudotsuga menziesii* / *Mahonia repens* Forest

7.5.4 Is *Juniperus spp.* present with greater cover than *Carex spp.*?

.....*Abies concolor* /*Juniperus communis* Forest

7.5.5 Is *Carex spp.* and/or *Poa fendleriana* more than 1% of the segment cover?
.....*Abies concolor – Pseudotsuga menziesii* / *Carex spp.* Forest
7.5.6 Does *Symphoricarpos oreophilus* occupy more than 2% of the segment cover?
.....*Abies concolor* / *Symphoricarpos oreophilus* Forest
7.5.7 Else .....*Abies concolor – Pseudotsuga menziesii* Mixed Understory Forest

7.6 Does *Populus tremuloides* occupy more than 10% of the segment AND is *Populus tremuloides* cover more than 5% greater than *Robinia neomexicana* cover?
..... Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group (7.6.1)
7.6.1 Does *Populus tremuloides* occupy more than 50% of the tree cover (relative cover) AND is the shrub layer less than 10% of the segment cover? .....go to 7.6.1.1
7.6.1.1 Does *Juniperus communis* occupy more than 1 % of the segment cover?
.....*Populus tremuloides* / *Juniperus communis* Forest
Else .....*Populus tremuloides* / *Carex siccata* Forest
7.6.2 Are shrubs (including *Populus tremuloides* shrubs) more than 10% of the segment cover?
.....*Populus tremuloides* Woodland with Shrub Understory (7.6.2.1)
7.6.2.1 Is more than 5% of the segment cover in *Robinia neomexicana*?
.....*Populus tremuloides* / *Robinia neomexicana* Woodland
Else ..... *Populus tremuloides* Woodland with Mixed Shrub Understory
7.6.3 Are herbs, grasses, and ferns more than 5 % of the segment cover?
.....*Populus tremuloides* Woodland with Herb, Grass, and Fern Understory (7.6.3.1)
7.6.3.1 Does *Muhlenbergia montana* occupy more than 5% of the segment?
.....*Populus tremuloides* / *Muhlenbergia montana* Woodland
7.6.3.2 Does *Pteridium aquilinum* occupy at least 3% of the segment?
..... *Populus tremuloides* / *Pteridum aquilinum* Woodland
Else ..... *Populus tremuloides* Forest with Mixed Herb/Grass/Fern Understory
7.6.4 Else…… Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group

7.7 Do two or more tree species contribute to the segment tree cover AND no one species is clearly dominant (i.e. no tree species has 5% more segment cover than another species)?
..... Undefined Sparse Mixed North American Temperate Forest

7.8 Else…… .....UNDEFINED WESTERN NORTH AMERICAN COOL TEMPERATE FOREST

8. Is *Pinus edulis* at least 5% of the segment cover AND is *Pinus edulis* plus *Juniperus spp.* cover at least 10%?
..... Colorado Plateau Pinyon-Juniper Woodland Group (8.1)
If no ..... go to 9.

8.1 Do shrubs occupy at least 5% of the cover AND is shrub cover greater than grass/herb cover?
.....Pinyon-Juniper w/ Shrub Understory (8.1.1)
8.1.1 Do *Artemisia spp.* occupy at least 4% of the segment cover?
..... *Pinus edulis - Juniperus osteosperma* / *Artemisia* Woodland Alliance (8.1.1.1)
8.1.1.1 Does *Artemisia tridentata* occupy at least 4% of the segment cover AND is *Artemisia bigelovii* cover less than *Artemisia tridentata* cover?
..... *Pinus edulis-Juniperus spp.*/ *Artemisia tridentata* (*ssp. wyomingensis-ssp. vaseyana*) Woodland
8.1.1.2 Does *Artemisia bigelovii* occupy ≥ 2% of the segment cover?
..... *Pinus edulis – Juniperus osteosperma* / *Artemisia bigelovii* Woodland
Else…. ..... *Pinus edulis – Juniperus osteosperma* / *Artemisia* Woodland Alliance
8.1.2 Does *Quercus gambelii* occupy at least 5% of the segment cover AND is *Arctostaphylos pungens* or *Purshia stansburiana* cover at least 5% less than *Quercus gambelii* cover?
.....*Pinus edulis – Juniperus spp.* / *Quercus gambelii* Woodland
8.1.3 Is more than 5% of the segment covered with *Arctostaphylos pungens* AND is *Purshia stansburiana* cover at least 5% less than *Arctostaphylos pungens* cover?
.....*Pinus edulis- Juniperus spp.* / *Arctostaphylos pungens* Woodland
8.1.4 Is at least 5% of the segment cover *Purshia stansburiana*?
.....*Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland
8.1.5 Is the segment on talus slope?… .....*Pinus edulis - Juniperus spp.* / Mixed Shrub Talus Woodland
Else ..... *Pinus edulis – Juniperus osteosperma* / *Cercocarpus – Quercus* Woodland Alliance

8.2 Is the cover of grasses and forbs at least 2% of the segment area?
.....*Pinus edulis – Juniperus osteosperma* / Grass-Forb Understory Woodland Alliance (8.2.1)
8.2.1 Is *Bouteloua gracilis* cover equal to or greater than 2%?
.....*Pinus edulis - Juniperus spp. Bouteloua gracilis* Woodland
8.2.2 Is *Poa fendleriana* cover at least 2% of the segment area?
.....*Pinus edulis - Juniperus spp.* / *Poa fendleriana* Woodland
8.2.3 Else ..... *Pinus edulis – Juniperus spp.* / Grass-Forb Understory Woodland Alliance
8.3 Else .....*Pinus edulis – Juniperus spp* / Sparse Understory Woodland

9 Is at least 10% of the segment cover woody plants that are shorter than 5m in height AND is less than 40% of the segment cover is in grass and forbs? ……. .....Southern Rocky Mountain Montane Shrublandand (9.1)
If no ..... go to 10.
9.1 Does *Populus tremuloides* occupy more than 20% of the segment
.....*Populus tremuloides* Shrub Vegetation (9.1.1)
9.1.1Does *Robinia neomexicana* occupy 20% or more of the segment?
.....*Populus tremuloides* / *Robinia neomexicana* Woodland
9.1.2 Do *Populus tremuloides* shrubs occupy more area than P. *tremuloides* trees?
..... *Populus tremuloides – Ceanothus fendleri* / *Carex spp.* Shrubland
Else .....*Populus tremuloides* / *Carex siccata* Forest
9.2 Does *Robinia neomexicana* occupy 15% or more of the segment AND is *Arctostaphylos patula*, *Arctostaphylos pungens*, *Quercus gambelii*, or *Ceanothus fendleri* cover at least 2% less than *Robinia neomexicana* cover?
.....*Robinia neomexicana* Shrubland
9.3 Does *Arctostaphylos patula* occupy 10% or more of the segment AND is *Arctostaphylos pungens*, *Quercus gambelii*, *Quercus turbinella*, or *Ceanothus fendleri* cover at least 2% less than *Arctostaphylos patula* cover?
.....*Arctostaphylos patula* Shrubland
9.4 Does *Arctostaphylos pungens* occupy at least 30% of the segment AND do *Quercus spp.* or *Ceanothus fendleri* cover less than 10% of the segment? .....*Arctostaphylos pungens* Shrubland
9.5 Does *Ceanothus fendleri* occupy 10% or more of the segment AND is *Quercus gambelii* cover at least 2% less than *Ceanothus fendleri* cover? .....*Ceanothus fendleri* / *Poa fendleriana* Shrub Steppe
9.6 Is 10% or more of the segment cover *Amelanchier utahensis*, AND do *Quercus gambelii*, *Quercus turbinella*, or *Garrya flavescens* cover less than 5% of the segment?.....*Amelanchier utahensis* Shrubland
9.7 Is more than10% of the segment cover a mix of shrubs that include more than 3% cover of at least three of the following species *Quercus turbinella*, *Quercus gambelii*, *Arctostaphylos pungens*, *Amelanchier utahensis*, or *Garrya flavescens* AND does no one of these species have greater than 30% segment cover singly?
.....*Quercus* (*turbinella*, *gambelii*) *spp. – Garrya flavescens – Arctostaphylos pungens* Shrubland
9.8 Is at least 20% of the segment cover a mix of *Quercus gambelii*, *Robinia neomexicana* and/or *Amelanchier utahensis*. AND is *Quercus gambelii* cover at least 8% AND is *Garrya flavescens* or *Arctostaphylos pungens* cover less than 5%?..... *Quercus gambelii*/*Robinia neomexicana*/*Amelanchier utahensis* Shrubland Type
9.8.1 Is *Quercus gambelii* cover 10% or more, AND is either *Symphoricarpos spp.* or *Robinia neomexicana* more than 10% of the cover? .....*Quercus gambelii* / *Robinia neomexicana* / *Symphoricarpos spp.* Shrubland
9.8.2 Is 50% or more of the segment in *Quercus gambelii* OR is at least 10% of the segment cover *Quercus gambelii*, AND is less than 5% of the segment cover composed of *Amelanchier utahensis*, *Garrya flavescens* or *Arctostaphylos pungens*? ..... *Quercus gambelii* Shrubland
9.8.3 Are *Quercus gambelii* and *Amelanchier utahensis* both at least 5% of the segment cover?
..... *Quercus gambelii* / *Amelanchier utahensis* Shrubland
Else ..... *Quercus gambelii* Shrubland Alliance
9.9 Is 5% or more of the segment cover in *Artemisia tridentata* AND is *Artemisia tridentata* cover at least 2% greater than *Atriplex canescens* cover??
If yes, ...*Artemisia tridentata* / *Bouteloua gracilis* Shrubland
9.10 Is 5% or more of the segment cover in *Atriplex canescens*, OR is *Atriplex canescens* plus *Artemisia tridentata* cover at least 10%? .....*Atriplex canescens* / *Artemisia tridentata* Shrubland Type (9.10.1)
9.10.1 Is more than 5% of the segment cover in *Atriplex canescens* AND is *Artemisia tridentata* at least 2% of the cover? .....*Atriplex canescens* /*Artemisia tridentata* Shrubland
9.10.2 Is 5% or more of the segment cover *Atriplex canescens*? . . ..*Atriplex canescens* Shrubland

Else. . . .. *Atriplex canescens* / *Artemisia tridentata* Mixed Shrubland

9.11 Is at least 5% of the segment cover in *Artemisia bigelovii*? ..... *Artemisia bigelovii* Shrubland Alliance (9.11.1)

9.11.1 Does *Bouteloua gracilis* occupy at least 15% cover?
..... *Artemisia bigelovii* / *Bouteloua gracilis* Shrub Herbaceous

Else ..... *Artemisia bigelovii* Shrubland

9.12 Is 20% or more of the segment cover in *Ericameria nauseosa*?
..... *Ericameria nauseosa* / *Bouteloua gracilis* Shrubland

9.13 Is more than 15% of the cover *Cercocarpus intricatus* AND does *Robinia neomexicana* occupy less than 20% of the segment 20%?
..... *Cercocarpus intricatus* Montane Shrubland

9.14 Does *Purshia stansburiana* occupy at least 10% of the segment cover?
..... *Purshia stansburiana* Shrubland

Else ..... Southern Rocky Mountain Montane Shrubland Alliance

10 Is at least 10% of the segment in grasses and/or forbs?
. . . . Southern Rocky Mountain Montane-Subalpine Grassland Group (10.1)

If no ..... go to 11

10.1 Does a Park Service or KGA sample fall within the segment or within an adjacent montane-subalpine grassland segment? ..... Grassland label equals sample label

10.2 Do *Carex spp.* occur in the segment AND is the segment in or near a wetland?
. . . . *Carex athrostachya - Carex vesicaria* Herbaceous Vegetation

Else Southern Rocky Mountain Montane-Subalpine Grassland Group

11 Is vegetation cover greater than 3% and less than 10%? . . . . Sparsely Vegetated Group

If no ..... go to 12.

12 Else ..... Unclassified GRCA Vegetation type

Appendix C: National Vegetation Classification Standard hierarchy with vegetation Associations and Alliances surveyed in Grand Canyon National Park and Grand Canyon - Parashant National Monument

This appendix contains a list of the Association and Alliance level vegetative communities classified and described during the Grand Canyon National Park / Grand Canyon - Parashant National Monument Vegetation Classification and Mapping project in the National Vegetation Classification System (NVCS) hierarchy (Federal Geographic Data Committee 2008). The hierarchy complied with the most recent revision of the NVCS as of the end of the project in 2012. As such, much of the Alliance and some parts of higher levels were still under construction and could not be included here. Undefined Groups are indicated by "G-NEW" and incomplete Alliance assignments are noted by no Alliance assignment, "Possible Alliance" or "Alliance Uncertain" in the hierarchy.

The first two pages contain tables describing the criteria used for creating hierarchy levels and providing an example of how one vegetation Association fits into the NVC hierarchy. The rest of the appendix shows the complete hierarchical structure of vegetation described for the project.

Criteria for constructing the NVCS revised Hierarchy

Hierarchy Level	Criteria
Upper	**Physiognomy plays a predominant role.**
L1 - Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.
L2 = Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate/aquatic conditions.
L3 - Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
Middle	**Floristics and physiognomy play predominant roles**
L4 - Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L5 - Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms, that reflect bio-geographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
L6 - Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes.
Lower:	**Floristics plays a predominant role**
L7 - Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8 - Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

Examples of levels used in the NVCS revised Hierarchy

Revised Hierarchy for Ponderosa Pine - Gambel Oak Woodland	
Upper Levels.	
L1 - Class	Scientific Name: Mesomorphic Tree Vegetation Colloquial Name: Forest and Woodland
L2 = Subclass	Scientific Name: Temperate Forest Vegetation Colloquial Name: Temperate Forest
L3 - Formation	Scientific Name: Cool Temperate Tree Vegetation Colloquial Name: Cool Temperate Forest
Middle Levels	
L4 - Division	Colloquial Name: Western North America Cool Temperate Forest
L5 - Macrogroup	Colloquial Name: Northern Vancouverian Montane and Foothill Forest
L6 - Group	Colloquial Name: East Cascades Oak-Ponderosa Pine Forest and Woodland
Lower Levels	
L7 - Alliance	Scientific Name: *Pinus ponderosa - Amelanchier - Quercus* Woodland Alliance Colloquial Name: Ponderosa Pine - Serviceberry - Oak Woodland Alliance
L8 - Association	Scientific Name: *Pinus ponderosa - Quercus gambelii* Woodland Colloquial Name: Ponderosa Pine - Gambel Oak Woodland

Class
Subclass
Formation
Division
Macrogroup
Group
Alliance
Association

1 Mesomorphic Tree Vegetation (Forest & Woodland)
1.C Temperate Forest
1.C.2 Cool Temperate Forest
D009- 1.C.2.b Western North American Cool Temperate Forest
MG020 Rocky Mountain Subalpine & High Montane Conifer Forest
G222 Rocky Mountain Subalpine & Montane Aspen Forest & Woodland Group
Populus tremuloides / *Amelanchier - Symphoricarpos* Mesic Forest Alliance
Populus tremuloides / *Juniperus communis* Forest
Populus tremuloides Dry Forest Alliance
Populus tremuloides / *Carex siccata* Forest
Populus tremuloides - Ceanothus fendleriana / *Carex spp*. Shrubland
Populus tremuloides / *Muhlenbergia montana* Woodland (Park Special)
Populus tremuloides / *Robinia neomexicana* Woodland
G219 Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest & Woodland Group
Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance
Abies lasiocarpa - Picea engelmannii / *Carex siccata* Forest
Abies lasiocarpa - Picea engelmannii / *Juniperus communis* Woodland
MG022 Southern Rocky Mountain Lower Montane Forest
G225 Southern Rocky Mountain Douglas-fir-White Fir-Blue Spruce Mesic Forest Group
Abies concolor - Pseudotsuga menziesii Moist Forest Alliance
Abies concolor / *Symphoricarpos oreophilus* Forest
Pseudotsuga menziesii / *Symphoricarpos oreophilus* Forest
Picea pungens Moist Forest Alliance
Picea pungens / *Carex siccata* Forest
G226 Southern Rocky Mountain White Fir-Douglas-fir Dry Forest Group
Abies concolor - Pseudotsuga menziesii Dry Forest Alliance
Abies concolor - Pseudotsuga menziesii / *Carex siccata* Forest
Abies concolor - Pseudotsuga menziesii / *Carex rossii* Forest
Abies concolor - Pseudotsuga menziesii / *Robinia neomexicana* Woodland
Abies concolor / *Cercocarpus ledifolius* Woodland
Abies concolor / *Juniperus communis* Forest
Abies concolor / *Mahonia repens* Forest
Pseudotsuga menziesii / *Quercus gambelii* Forest
Picea pungens Dry Forest Alliance
Picea pungens / *Festuca arizonica* Woodland
G228 Southern Rocky Mountain *Ponderosa* Pine Forest & Woodland Group
Pinus ponderosa / *Carex* Woodland Alliance
Pinus ponderosa / *Carex siccata* Woodland
Pinus ponderosa / *Poa fendleriana* Woodland
Pinus ponderosa / *Pteridium aquilinum* Woodland [Provisional]
Pinus ponderosa / *Interior Chaparral* Woodland Alliance
Pinus ponderosa / *Arctostaphylos patula* Woodland
Pinus ponderosa / *Artemisia tridentata ssp. vaseyana* Woodland
Pinus ponderosa / *Amelanchier - Quercus* Woodland Alliance
Pinus ponderosa / *Purshia stansburiana* Woodland
Pinus ponderosa / *Quercus gambelii* Woodland

Pinus ponderosa / *Robinia neomexicana* Woodland
Pinus ponderosa / Sparse Understory Woodland [Provisional]
G229 Southern Rocky Mountain *Ponderosa* Pine Savanna Group
Pinus ponderosa Savanna Alliance
Pinus ponderosa / *Bouteloua gracilis* Woodland
D010- 1.C.2.c Western North American Scrub Woodland & Shrubland
MG026 Intermountain Singleleaf Pinyon-Western Juniper Woodland
G246 Intermountain Juniper Savanna Group
Juniperus osteosperma Savanna Alliance
Juniperus osteosperma / *Elymus elymoides* Woodland [Park Special]
Juniperus osteosperma / *Pleuraphis jamesii* Woodland
G247 Great Basin Pinyon-Juniper Woodland Group
Pinus monophylla - Juniperus osteosperma / *Bouteloua gracilis* Woodland
Pinus monophylla - Juniperus osteosperma / Sparse Understory Woodland
Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance
Juniperus osteosperma - (Pinus monophylla) / *Arctostaphylos pungens* Woodland
Juniperus osteosperma - (Pinus monophylla) / *Ceanothus greggii* Woodland
Pinus monophylla - Juniperus osteosperma / *Artemisia tridentata* Woodland
Pinus monophylla - Juniperus osteosperma / *Cercocarpus montanus - Quercus gambelii* Woodland [Provisional]
Pinus monophylla - Juniperus osteosperma / *Coleogyne ramosissima* Woodland [Provisional]
Pinus monophylla - Juniperus osteosperma / *Purshia stansburiana* Woodland
Pinus monophylla - Juniperus osteosperma / *Quercus turbinella* Woodland
Cercocarpus ledifolius Montane Woodland Alliance
Cercocarpus ledifolius / *Quercus gambelii* Woodland
MG027 Rocky Mountain Two-needle Pinyon-Juniper Woodland
G251 Colorado Plateau Pinyon-Juniper Wooded Scrub Group
Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance
Pinus edulis - Juniperus osteosperma / *Cercocarpus intricatus* Woodland
Pinus edulis - Juniperus osteosperma / *Coleogyne ramosissima* Woodland
Pinus edulis - Juniperus osteosperma / *Quercus turbinella* Woodland
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland
G250 Colorado Plateau Pinyon-Juniper Woodland Group
Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance
Pinus edulis - (Juniperus osteosperma) / *Bouteloua gracilis* Woodland
Pinus edulis - Juniperus spp. / *Poa fendleri* Woodland
Pinus edulis - Juniperus osteosperma / *Artemisia* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Artemisia bigelovii* Woodland
Pinus edulis - Juniperus osteosperma / *Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Arctostaphylos pungens* Woodland
Pinus edulis - Juniperus spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland
Pinus edulis - Juniperus osteosperma / *Purshia stansburiana* Woodland
Pinus edulis - Juniperus osteosperma / *Cercocarpus ledifolius* Woodland
Pinus edulis - Juniperus spp. / *Quercus gambelii* Woodland
Pinus edulis - Juniperus osteosperma / *Amelanchier utahensis* Woodland
Pinus edulis - Juniperus osteosperma / *Mortonia utahensis* Woodland [Park Special]
Juniperus osteosperma Woodland Alliance
Juniperus osteosperma / *Artemisia tridentata* Woodland
Juniperus osteosperma / *Poa fendleriana* Woodland
Juniperus osteosperma / *Pseudoroegneria spicata* Woodland
Juniperus osteosperma / Sparse Understory Woodland
1.C.3 Temperate Flooded & Swamp Forest

D012- 1.C.3.b Western North American Cool Temperate Flooded & Swamp Forest
MG034 Rocky Mountain and Great Basin Flooded & Swamp Forest
G503 Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest Group
Acer negundo Woodland Alliance
Acer negundo / Brickellia (grandiflora, longifolia) Woodland [Provisional]
Acer negundo / Quercus gambelii Woodland
Acer negundo / Quercus turbinella Woodland
Alliance Undetermined
Celtis laevigata var. reticulata Slickrock canyon Woodland [Provisional]
D013- 1.C.3.c Western North American Warm Temperate Flooded & Swamp Forest
MG036 Warm Mediterranean & Desert Riparian, Flooded & Swamp Forest
G508 Sonoran-Chihuahuan Warm Desert Riparian Scrub Group
Populus fremontii - Salix gooddingii Woodland Alliance
Fraxinus velutina Riparian Woodland [Park Special]
Populus fremontii - Fraxinus velutina Woodland
Populus fremontii - Salix gooddingii Woodland
Populus fremontii / Acer negundo Forest
Populus fremontii / Baccharis emoryi Woodland
Salix gooddingii Woodland
Salix gooddingii / Baccharis emoryi Woodland
MG298 Western North American Warm Temperate Ruderal Flooded and Swamp Forest
G510 Southwest North American Ruderal Riparian Scrub Group
Tamarix spp. Ruderal Scrub Alliance
Tamarix spp. Temporarily Flooded Semi-natural Shrubland
2 Mesomorphic Shrub & Herb Vegetation (Shrubland & Grassland)
2.C Temperate & Boreal Shrubland & Grassland
2.C.1 Temperate Grassland, Meadow & Shrubland
D022- 2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland
MG167 Rocky Mountain-Vancouverian Montane Dry Grassland
G268 Southern Rocky Mountain Montane-Subalpine Grassland Group
Carex spp. (Deer Sedge) Alliance
Carex siccata - Carex rossii Herbaceous Vegetation
Fescue - Muhly Alliance
Festuca (calligera, arizonica, brachyphylla) Herbaceous Vegetation
Muhlenbergia montana - Hesperostipa comata Herbaceous Vegetation
Muhlenbergia montana Herbaceous Vegetation
Poa fendleriana Herbaceous Vegetation
MG049 Southern Rocky Mountain Montane Shrubland
G276 Southern Rocky Mountain *Cercocarpus*-Mixed [Dry] Foothill Shrubland Group
Cercocarpus intricatus Shrubland Alliance
Cercocarpus intricatus - (Quercus turbinella) Mixed Shrubland
Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance
Amelanchier utahensis Shrubland
Quercus X pauciloba Shrubland Alliance
G277 Southern Rocky Mountain Gambel Oak-Mixed [Mesic] Montane Shrubland Group
Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance
Fendlera rupicola Talus Shrubland
Fraxinus anomala - Rhus trilobata Talus Shrubland
Ostrya knowltonii Woodland
Ceanothus fendleri Shrubland Alliance
Ceanothus fendleri / Poa fendleriana Shrub Steppe
Quercus gambelii Shrubland Alliance
Quercus gambelii / Arctostaphylos pungens Shrubland

Quercus gambelii / *Amelanchier utahensis* Shrubland
Quercus gambelii / *Robinia neomexicana* / *Symphoricarpos rotundifolius* Shrubland
Quercus gambelii / *Poa fendleriana* Shrubland
Quercus gambelii / *Robinia neomexicana* Shrubland
Quercus gambelii Shrubland
Robinia neomexicana Shrubland
Symphoricarpos oreophilus Shrubland Alliance
D061- 2.C.1.d Western North America Interior Sclerophyllous Chaparral Shrubland
MG094 Cool Interior Chaparral
G282 Western North American Montane Sclerophyll Scrub Group
Alliance Undetermined
Arctostaphylos patula Shrubland
Purshia stansburiana Shrubland
MG091 Warm Interior Chaparral
G281 Arizonan Desert Margin Chaparral Group
Alliance Undetermined
Mortonia utahensis Shrubland
Arctostaphylos - Quercus turbinella Shrubland Alliance
Arctostaphylos pungens Shrubland
Quercus turbinella - Garrya flavescens - Arctostaphylos pungens Shrubland
Quercus turbinella - Coleogyne ramosissima Shrubland
Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland
Quercus turbinella - Juniperus osteosperma Shrubland
Quercus turbinella - Ptelea trifoliata - Fraxinus anomala Mesic Shrubland
2.C.5 Temperate & Boreal Freshwater Marsh
D031- 2.C.5.b Western North American Freshwater Marsh
MG075 Western North American Temperate Montane Wet Meadow & Low Shrub
G521 Vancouverian & Rocky Mountain Montane Wet Meadow Group
Alliance Undetermined
Carex athrostachya Herbaceous Vegetation [Park Special]
Carex vesicaria Herbaceous Vegetation
Carex aquatilis Herbaceous Vegetation
Juncus balticus Herbaceous Vegetation
D032- 2.C.5.c Western North American Warm Desert Freshwater Marsh
MG301 Western North American Ruderal Wet Meadow & Marsh
G524 Western North American Ruderal Wet Meadow & Marsh Group
Phragmites australis Western *North America Temperate* Semi-natural *Herbaceous Vegetation*
Poa pratensis Semi-natural *Seasonally Flooded* Herbaceous Vegetation
Cynodon dactylon Herbaceous Vegetation
MG076 Warm Desert Freshwater Shrubland, Meadow & Marsh
G533 North American Warm Desert Riparian Low Bosque & Shrubland Group
Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance
Baccharis emoryi / *Imperata brevifolia* Shrubland
Baccharis emoryi - Salix exigua Shrubland
Baccharis salicifolia Riparian Shrubland
Baccharis sarothroides Shrubland
Pluchea sericea Seasonally Flooded Shrubland
Salix exigua / *Barren* Shrubland
Salix exigua / *Equisetum X ferrissii* Shrubland [Park Special]
Vitis arizonica Shrubland
Prosopis glandulosa Shrubland Alliance
Prosopis glandulosa var. torreyana Shrubland

G531 Arid West Emergent Marsh Group
Alliance Undetermined
Aletes macdougalii Herbaceous Vegetation [Park Special]
Equisetum x ferrissii Herbaceous Vegetation
Schoenoplectus spp - Typha domingensis Marsh Alliance
Schoenoplectus americanus Western Herbaceous Vegetation
Schoenoplectus pungens Herbaceous Vegetation
Typha domingensis Western Herbaceous Vegetation
2.C.6 Salt Marsh
D036- 2.C.6.d Western North American Interior Alkaline-Saline Wetland
MG083 Warm Semi-Desert & Mediterranean Alkaline-Saline Wetland
G583 Intermountain Basins Alkaline-Saline Herb Wet Flat Group
Alliance Undetermined
Muhlenbergia asperifolia Herbaceous Vegetation
Suaeda moquinii Shrubland Alliance
Atriplex hymenelytra Shrubland
Suaeda moquinii Shrubland
3 Xeromorphic Scrub & Herb Vegetation (Semi-Desert)
3.A Warm Semi-Desert Scrub & Grassland
3.A.1 Warm Semi-Desert Scrub & Grassland
D039- 3.A.1.a North American Warm Desert Scrub & Grassland
MG088 Mojave-Sonoran Semi-Desert Scrub
Group Undetermined
Geraea canescens Ephemeral Herbaceous Vegetation
Tridens muticus Herbaceous Vegetation
G296 Mojave Mid-Elevation Mixed Desert Scrub Group
Coleogyne ramosissima Mojave Desert Shrubland Alliance
*Coleogyne ramosissima - Ephedra spp.*Warm Desert Shrubland
Coleogyne ramosissima - Purshia stansburiana Shrubland
*Ephedra nevadensis – Yucca baccata*Basalt Shrubland
Yucca baccata Shrubland
Ephedra fasciculata Mojave Desert Shrubland Alliance
Acacia greggii Shrubland
Canotia holacantha Grand canyon Shrubland
Ephedra fasciculata Shrubland
Ephedra fasciculata / Mixed Semi-Desert Grasses Shrubland
Parthenium incanum - (Ephedra fasciculata) Shrubland [Park Special]
Gutierrezia (sarothrae, microcephala) - Ephedra spp. - Agave utahensis Dwarf-Shrubland
Lycium andersonii - Ephedra (torreyana, viridis) Shrubland
Nolina (bigelovii-parryi-microcarpa) Mojave Desert Shrubland Alliance
Nolina microcarpa Shrubland
Opuntia bigelovii Mojave Desert Shrubland Alliance
Opuntia bigelovii Shrubland
Pleuraphis rigida Mojave Desert Grassland Alliance
Pleuraphis rigida Herbaceous Vegetation
Yucca brevifolia Mojave Desert Shrubland Alliance
Yucca brevifolia / Coleogyne ramosissima Wooded Shrubland
Yucca schidigera Mojave Desert Shrubland Alliance
Yucca schidigera - Larrea tridentata - Ambrosia dumosa Shrubland
G295 Sonoran-Mojave Creosotebush-White Bursage Desert Scrub Group
Ambrosia (dumosa, eriocentra) Dwarf-Shrubland Alliance
Ambrosia dumosa - Encelia farinosa Dwarf-Shrubland

Ambrosia dumosa - Ephedra (fasciculata, nevadensis) Dwarf-Shrubland
Ambrosia dumosa Dwarf-Shrubland
Ambrosia eriocentra - (Coleogyne ramosissima) Dwarf-Shrubland
Encelia (farinosa, resinifera) Shrubland Alliance
Encelia farinosa - Ephedra (fasciculata, nevadensis) Shrubland
Encelia resinifera Shrubland
Fouquieria splendens Shrubland Alliance
Fouquieria splendens / Encelia (farinosa, resinifera) Shrubland
Fouquieria splendens Shrubland
Larrea tridentata - Ambrosia spp. Shrubland Alliance
Krameria erecta Shrubland
Larrea tridentata - Ambrosia dumosa Shrubland
Larrea tridentata - Ambrosia dumosa - Fouquieria splendens Shrubland
Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi) Shrubland
Psorothamnus fremontii Shrubland
Larrea tridentata - Encelia spp. Shrubland Alliance
Larrea tridentata - Coleogyne ramosissima Shrubland
Larrea tridentata - Encelia farinosa - Fouquieria splendens Shrubland
Larrea tridentata - Encelia farinosa Shrubland
Larrea tridentata Shrubland
MG092 North American Warm-Desert Xero-Riparian
G541 North AmericanWarm Semi-Desert Shrub Wash-Arroyo Group
Acacia greggii - Chilopsis linearis Desert Wash Alliance
Acacia greggii Wash Shrubland
Acacia greggii - Larrea tridentata - (Hymenoclea salsola) Wash Shrubland *[Park Special]*
Chilopsis linearis Shrubland
Salazaria mexicana Shrubland
Possible Alliance
Bebbia juncea Shrubland
Brickellia longifolia Shrubland
Ericameria paniculata Wash Shrubland
Possible Alliance
Fallugia paradoxa Grand canyon Desert Wash Shrubland
Possible Alliance
Hymenoclea salsola Wash Shrubland
Isocoma acradenia Shrubland
MG512. North AmericanWarm Desert Ruderal & Planted Scrub & Grassland
G-676 Mojave-Sonoran Ruderal Grassland Group
Schismus (*arabicus*, *barbatus*) Semi-natural Herbaceous Vegetation
3.B.1 Cool Semi-Desert Scrub & Grassland
MG093 Cool Semi-Desert Saltbush Scrub
G300 Shadscale-Saltbush Cool Semi-Desert Scrub Group
Lycium pallidum Shrubland
Atriplex canescens Shrubland Alliance
Atriplex canescens Shrubland
Atriplex canescens / Muhlenbergia porteri Shrubland
Atriplex canescens / Pleuraphis jamesii Shrubland
Atriplex confertifolia Shrubland Alliance
Atriplex confertifolia Great Basin Shrubland
Atriplex obovata Dwarf-Shrubland Alliance
Atriplex obovata Talus Dwarf-Shrubland
MG095 Great Basin & Intermountain Xero-Riparian Scrub

G559 Cool Semi-Desert Shrub & Herb Wash-Arroyo Group
Ericameria nauseosa Desert Wash Shrubland
MG171 Great Basin & Intermountain Dry Shrubland & Grassland
G-NEW Great Basin and Intermountain Ruderal Dry Shrubland and Grassland Group
Bromus tectorum Semi-natural Herbaceous Vegetation
Erodium cicutarium Semi-natural Annual Herbaceous Vegetation
Salsola spp. Herbaceous Vegetation [Provisional]
Sphaeralcea ambigua Herbaceous Vegetation
G312 Colorado Plateau Blackbrush-Mormon-tea Shrubland Group
Coleogyne ramosissima Colorado Plateau Shrubland Alliance
Coleogyne ramosissima Shrubland
Ephedra spp. Colorado Plateau Shrubland Alliance
Ephedra torreyana - Opuntia basilaris Shrubland
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse *Vegetation*
Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland
G311 Intermountain Basins Semi-Desert Grassland Group
Dry Semi-Desert Grassland Alliance
Aristida purpurea Herbaceous Vegetation
Bouteloua eriopoda Coconino Plateau Shrub Herbaceous Vegetation
Bouteloua gracilis - Sporobolus cryptandrus Herbaceous Vegetation
Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation
Hesperostipa comata Great Basin Herbaceous Vegetation
Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii) Herbaceous Vegetation
Pleuraphis jamesii Herbaceous Vegetation
Sporobolus cryptandrus Great Basin Herbaceous Vegetation
G310 Intermountain Basins Semi-Desert Shrub -Steppe Group
Ericameria nauseosa - Gutierrezia Seral Shrubland Alliance
Ericameria nauseosa / *Bouteloua gracilis* Shrub Herbaceous Vegetation
Gutierrezia (microcephala, sarothrae) Dwarf-Shrubland
Opuntia polyacantha / *Pleuraphis jamesii* Shrubland
Krascheninnikovia lanata Dwarf-Shrubland Alliance
Krascheninnikovia lanata / *Hesperostipa comata* Dwarf-Shrubland
Krascheninnikovia lanata Dwarf-Shrubland
MG170 Western North America Dwarf Sage Shrubland & Steppe
G308 Intermountain Low & Black Sagebrush Shrubland & Steppe Group
Artemisia bigelovii Shrubland Alliance
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland
Artemisia bigelovii / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation
Artemisia bigelovii Shrubland
MG169 Western North America Tall Sage Shrubland & Steppe
G303 Intermountain West Dry Tall Sagebrush Shrubland Group
Artemisia tridentata Shrubland Alliance
Artemisia tridentata Shrubland
Artemisia tridentata / *Bouteloua gracilis* Shrubland
Artemisia tridentata - Ephedra spp. Shrubland
Artemisia tridentata - Purshia stansburiana Shrubland [Park Special]
Artemisia tridentata - (Ericameria nauseosa) / *Bromus tectorum* Semi-natural Shrubland
6 Lithomorphic Vegetation (Nonvascular & Sparse Vascular Rock Vegetation)
6.B Mediterranean, Temperate & Boreal Nonvascular & Sparse Vegetation
6.B.2 Temperate & Boreal Cliff, Scree & Rock Vegetation
D052- 6.B.2.b Western North American Temperate Cliff, Scree & Rock Vegetation

MG112 Southwestern North American Wet Cliff Vegetation
G545 Colorado Plateau Hanging Garden Seep Group
Betula occidentalis Desert Spring Shrubland
Celtis laevigata / *Cladium spp.* Saturated Seep Shrubland
Cladium californicum Seep
Cercis orbiculata Seep Shrubland
6.C Semi-Desert Nonvascular & Sparse Vascular Vegetation
6.C.1Warm Semi-Desert Cliff, Scree & Rock Vegetation
D054- 6.C.1.a North AmericanWarm Semi-Desert Cliff, Scree & Rock Vegetation
MG117 North AmericanWarm Semi-Desert Cliff, Scree & Rock Vegetation
G569 North AmericanWarm Semi-Desert Cliff, Scree & Rock Vegetation [Placeholder]
Peucephyllum schottii Sparse Vegetation
G-NEW *North American* Warm Semi-Desert Dunes and Sand Flats
Abronia elliptica Herbaceous Dune Vegetation [Park Special]
Prosopis glandulosa var. torreyana Sand Dune Shrubland [Park Special]
6.C.2 Cool Semi-Desert Cliff, Scree & Rock Vegetation
D055- 6.C.2.a North American Cool Semi-Desert Cliff, Scree & Rock Vegetation
MG118 Intermountain Basin Cliff, Scree & Rock Vegetation
G570 Intermountain Basins Cliff, Scree & Rock Vegetation [Placeholder]
Eriogonum corymbosum Badlands Sparse Vegetation
Psorothamnus fremontii - Acacia greggii [Shale] Sparse Vegetation [Park Special]
Ephedra trifurca Badlands Shrubland

Appendix D: Descriptions of National Vegetation Classification Standard vegetation Associations

This appendix contains National Vegetation Classification Standard - compliant descriptions of Associations encountered during the Grand Canyon National Park / Grand Canyon - National Monument Vegetation Classification and Mapping Project. Not all vegetation types encountered are described. Descriptions were written only when Associations had been sampled two or more times and when project ecologists felt confident that the samples captured a type of vegetation which represented a unit repeated across the project area. Several unique types, designated "Park Specials" were named but not described.

This classification was developed by NatureServe in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. These data were extracted from NatureServe. 2012. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. from data current as of 5 December 2012. For more information on the classification, refer to the descriptions document:

NatureServe. 2012. International Ecological Classification Standard: Terrestrial Ecological Classifications. Vegetation Associations of Grand Canyon National Park and Grand Canyon - Parashant National Monument. NatureServe Central Databases. Arlington, VA.

1. Forest to Open Woodland

1.B.2. Cool Temperate Forest
1.B.2.Nb. Rocky Mountain Cool Temperate Forest

M501. Central Rocky Mountain Dry Lower Montane & Foothill Forest
G215. Middle Rocky Mountain Montane Douglas-fir Forest & Woodland

Pseudotsuga menziesii / *Symphoricarpos oreophilus* Forest
Douglas-fir / Mountain Snowberry Forest
Identifier: CEGL000462

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Central Rocky Mountain Dry Lower Montane & Foothill Forest (M501)
Group	Middle Rocky Mountain Montane Douglas-fir Forest & Woodland (G215)
Association	*Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest

ELEMENT CONCEPT

Global Summary: This widespread forest association occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2900 m (2310-9500 feet). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects with moderate to very steep mid- and upper slopes and ridges. Soils are variable and range from deep silt loam to shallow, rocky substrates. Most stands have abundant litter on the ground, and some have high rock cover. The vegetation is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides, Juniperus scopulorum*, or *Juniperus occidentalis*, especially on drier sites. *Abies concolor* is typically not present. *Symphoricarpos oreophilus* dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on range and habitat and may include *Acer glabrum, Amelanchier* spp., *Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii*, or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

Global Environment: This widespread Douglas-fir forest occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2900 m (2310-9500 feet). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects on moderate to very steep mid- and upper slopes and ridges. Soils are variable and range from deep loamy sands, silt loams, silty clay loams, sandy clay loams and peat to shallow, rocky substrates. Parent materials are also variable and may include colluvium or residuum derived from calcareous shale, sandstone, granite, limestone, rhyolite and basalt. Most stands have abundant litter on the ground, and some have high rock cover.

VEGETATION DESCRIPTION

Global Vegetation: This forest is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides,*

Juniperus scopulorum, or *Juniperus occidentalis* in canopy or subcanopy, especially on drier sites. *Abies concolor* is typically not present. *Symphoricarpos oreophilus* is present and usually dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on location and habitat and may include sparse cover of *Acer glabrum, Amelanchier* spp., *Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii*, or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs. Associated graminoids may include *Bromus* spp., *Carex geyeri, Carex rossii, Elymus lanceolatus, Festuca idahoensis, Leucopoa kingii, Leymus cinereus, Koeleria macrantha*, and *Poa fendleriana, Poa secunda*. Common forbs include *Achillea millefolium, Arnica cordifolia, Artemisia frigida, Balsamorhiza sagittata, Thalictrum fendleri*, and *Vicia americana*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pseudotsuga menziesii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Global: *Pseudotsuga menziesii*, *Symphoricarpos oreophilus*

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This is a broadly defined *Pseudotsuga menziesii* association which includes a variety of stands from different environments that are tied together by a common widespread species, *Symphoricarpos oreophilus*.
Global Similar Associations:

- *Abies concolor* / *Symphoricarpos oreophilus* Forest (CEGL000263)
- *Pinus ponderosa* / *Symphoricarpos oreophilus* Forest (CEGL000205)
- *Populus tremuloides - Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest (CEGL000546)
- *Pseudotsuga menziesii* / *Cercocarpus montanus* Woodland (CEGL000898)
- *Pseudotsuga menziesii* / *Mahonia repens* Forest (CEGL000442)

Global Related Concepts:

- *Pseudotsuga menziesii - Symphoricarpos oreophilus* Habitat Type (Reed 1976) >
- *Pseudotsuga menziesii* / *Berberis repens* Habitat Type, *Symphoricarpos oreophilus* Phase (Mauk and Henderson 1984) ><
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* / *Carex geyeri* Habitat Type (Hess and Wasser 1982) <
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Association (Williams and Lillybridge 1983) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Association (Williams et al. 1990b) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Association (Johnson and Clausnitzer 1992) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Community Type (Johnson and Simon 1987) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest Association (Kittel et al. 1994) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Mauk and Henderson 1984) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Steele et al. 1983) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Komarkova et al. 1988b) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Steele et al. 1981) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Hess and Wasser 1982) <
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Youngblood and Mauk 1985) =

- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Pfister et al. 1977) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Plant Association (Lillybridge et al. 1995) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Plant Association (Williams and Lillybridge 1985) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Plant Association (Johnston 1987) =
- *Pseudotsuga menziesii*/*Symphoricarpos oreophilus* (Kittel et al. 1999b) =
- *Pseudotsuga menziesii*/*Symphoricarpos oreophilus* (Bourgeron and Engelking 1994) =
- *Pseudotsuga menziesii* Sparse Habitat Type (Muldavin et al. 1996) ><
- Douglas Fir-Pine Series (Diamond 1993) >

ELEMENT DISTRIBUTION

Global Range: This widespread montane forest association occurs in foothills, mountains and plateaus from southwestern Montana through Wyoming and Colorado to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington.
Nations: US
States/Provinces: AZ, CO:S4, ID:S3, MT:S3, NM:S4, OR:S3, TX:S1, UT:S5, WA:S3, WY:S2S3
TNC Ecoregions: 4:C, 6:?, 8:C, 9:C, 10:C, 18:C, 19:C, 20:C, 21:C, 28:?, 68:C
USFS Ecoregions (1994/95): 313A:CC, 315A:??, 341B:CC, 342D:CC, 342E:CC, M242C:CC, M313A:CC, M331A:CC, M331D:CC, M331E:CC, M331F:CC, M331G:CC, M331J:CC, M332A:CC, M332E:CC, M332F:CC, M332G:CC, M333A:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Capitol Reef, Craters of the Moon, Curecanti, Dinosaur, Fossil Butte, Grand Canyon, Grand Teton, Great Sand Dunes, Natural Bridges, Zion); USFS (Arapaho-Roosevelt, Bighorn, Bridger-Teton, Caribou-Targhee, Colville NF, Gunnison, Okanogan, Shoshone, Uncompahgre, Wallowa-Whitman, Wenatchee, White River NF)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz, mod. J. Drake, J. Coles, K.A. Schulz
References: Arno 1980, Bell et al. 2009, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Cogan et al. 2005, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Day and Wright 1985, Diamond 1993, Fischer and Bradley 1987, Friesen et al. 2010, Hess and Wasser 1982, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Johnston 1987, Jones and Ogle 2000, Kagan et al. 2004, Kittel et al. 1994, Kittel et al. 1999b, Komarkova et al. 1988b, Lillybridge et al. 1995, MTNHP 2002b, Mauk and Henderson 1984, Muldavin et al. 1996, Pfister et al. 1977, Reed 1976, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010b, Steele et al. 1981, Steele et al. 1983, TNHS unpubl. data, Tendick et al. 2010, Tendick et al. 2011b, Western Ecology Working Group n.d., Williams and Lillybridge 1983, Williams and Lillybridge 1985, Williams et al. 1990b, Wright et al. 1979, Youngblood and Mauk 1985

M020. Rocky Mountain Subalpine & High Montane Conifer Forest
G222. Rocky Mountain Subalpine & Montane Aspen Forest & Woodland

Populus tremuloides / *Juniperus communis* Forest

Quaking Aspen / Common Juniper Forest
Identifier: CEGL000587

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine & Montane Aspen Forest & Woodland (G222)
Association	*Populus tremuloides* / *Juniperus communis* Forest

ELEMENT CONCEPT

Global Summary: This *Populus tremuloides* forest association is known from the mountains of Utah, Colorado, Wyoming and Montana. It occurs on gentle to steep slopes (10-100%), on nearly all exposures from 2285 to 3000 m (7500-9800 feet) in elevation. It is also documented from swales, broad benches or dry flats acting as frost pockets, or where subject to cold-air drainage. Soils are derived primarily from sandstone or granite. The tree

canopy is dominated by *Populus tremuloides*. Scattered conifer trees occur, such as *Pseudotsuga menziesii, Abies lasiocarpa, Pinus contorta, Pinus ponderosa, Pinus flexilis, Picea engelmannii*, and *Picea pungens*. The shrub layer is dominated by *Juniperus communis*, although it also contains *Acer glabrum, Paxistima myrsinites, Rosa woodsii, Symphoricarpos oreophilus*, and sometimes *Artemisia tridentata*, and dwarf-shrubs *Arctostaphylos uva-ursi, Mahonia repens*, and *Vaccinium myrtillus*. The herbaceous layer is variable in expression, with graminoids dominant in some stands and forbs dominant in others. Graminoids commonly occurring include *Carex geyeri, Carex rossii, Elymus trachycaulus, Calamagrostis rubescens, Bromus ciliatus, Achnatherum occidentale (= Stipa occidentalis), Oryzopsis asperifolia, Danthonia parryi, Poa nemoralis*, or *Poa secunda (= Poa nevadensis)*. Forbs include *Achillea millefolium, Astragalus miser, Geranium viscosissimum, Lupinus argenteus*, and *Thalictrum fendleri*. Diagnostic characteristics of this association are canopy dominance by *Populus tremuloides* and a short-shrub layer with abundant *Juniperus communis*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This quaking aspen association occurs on the North Rim from approximately 2675 to 2750 m (8800-9025 feet) elevation in somewhat shaded or mesic environments. It occurs on the plateau and on adjacent upper sideslopes, mostly on moderate grades (8-10 degrees), on generally west-facing aspects. Soils are predominantly silt loams. This association hosts thick layers of litter and duff (about 80% of the ground cover), as well as a moderate load of downed wood (5-6%). Stands often occur in areas that have burned in the past.

Global Environment: This *Populus tremuloides* forest association is known from the mountains of Utah, Colorado, Wyoming and Montana. It occurs on gentle to steep slopes (10-100%), on nearly all exposures from 2285 to 3000 m (7500-9800 feet) in elevation. Distribution of these forests is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand (Mueggler 1988). Secondarily, its range is limited by the length of the growing season or low temperatures (Mueggler 1988). This forest type occurs in two differing environments: (1) warm, dry sites near the margin of bunchgrass meadows and (2) swales, broad benches or dry flats acting as frost pockets, or where subject to cold-air drainage. Soils are derived primarily from sandstone, limestone or granite parent material, and the ground surface may have a high percentage of boulders and gravel.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages about 25% in this association. Somewhat open canopies of *Populus tremuloides* (17%) with scattered *Pinus ponderosa* (2%) are common. The subcanopy typically supports a low cover of *Abies concolor* (3%), as well as sporadic *Picea engelmannii, Abies lasiocarpa*, and *Pinus ponderosa* individuals. *Juniperus communis* (3%) is a common and characteristic short shrub, while *Mahonia repens* (1%) is frequent as well. The understory is very sparse in this association. *Carex rossii* and *Elymus elymoides* are common grasses; however, graminoid cover averages less than 3% cover. The forb component is even sparser (1%) and is composed of various montane species, including *Fragaria virginiana, Geranium richardsonii, Goodyera oblongifolia*, and *Ligusticum porteri*. *Pteridium aquilinum* can be present at about 1% cover. Tree regeneration (20% cover) is abundant in this vegetation type, as *Abies concolor* (10%), *Picea engelmannii* (4%), and occasionally *Pseudotsuga menziesii* seedlings (up to 10%) are common. Based upon the two plots sampled, this association hosts below-average species richness for forested community types on the North Rim, with 20 species per 400-square-meter plot. This may be a result of the thick litter and duff layer on the forest layer, which can preclude the establishment of understory species.

Global Vegetation: Stands a have a somewhat closed to closed canopy of trees 5-20 m tall that is dominated or codominated by the cold-deciduous broad-leaved tree *Populus tremuloides*. Scattered conifer trees sometimes occur, such as *Pseudotsuga menziesii, Abies lasiocarpa, Pinus contorta, Pinus ponderosa, Pinus flexilis, Picea engelmannii*, and *Picea pungens*, but at least some stands appear to be persistent aspen clones. The shrub layer is dominated by *Juniperus communis*, although it also contains *Acer glabrum, Amelanchier alnifolia, Paxistima myrsinites, Rosa woodsii, Symphoricarpos oreophilus*, and sometimes *Artemisia tridentata*, and dwarf-shrubs *Arctostaphylos uva-ursi, Mahonia repens*, and *Vaccinium myrtillus*. The herbaceous layer is variable in expression, with graminoids dominant in some stands and forbs dominant in others. Common graminoids may include *Bromus porteri, Danthonia parryi, Elymus trachycaulus, Elymus glaucus, Bromus carinatus, Calamagrostis rubescens, Carex siccata (= Carex foenea), Carex geyeri, Carex rossii, Festuca thurberi, Poa fendleriana*, and *Hesperostipa comata*. The most common forbs present include *Thalictrum fendleri, Vicia americana, Achillea millefolium, Astragalus flexuosus, Astragalus miser, Fragaria virginiana, Pseudocymopterus montanus, Thermopsis divaricarpa, Lupinus argenteus, Campanula rotundifolia*, and *Arnica cordifolia*. Exotic species, such as *Taraxacum officinale, Poa pratensis, Bromus inermis*, and *Bromus tectorum*, are often

common in stands disturbed by grazing.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Pinus ponderosa*
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Tree subcanopy	Needle-leaved tree	*Abies concolor, Abies lasiocarpa, Picea engelmannii*
Short shrub/sapling	Needle-leaved shrub	*Juniperus communis*
Herb (field)	Dwarf-shurb	*Mahonia repens*
Herb (field)	Forb	*Fragaria virginiana, Geranium richardsonii, Goodyera oblongifolia, Ligusticum porteri*
Herb (field)	Graminoid	*Bromus ciliatus, Carex rossii, Carex siccata, Elymus elymoides, Poa fendleriana*
Herb (field)	Fern or fern ally	*Pteridium aquilinum*
Herb (field)	Other herbaceous	*Abies concolor, Picea engelmannii, Pinus ponderosa, Populus tremuloides, Pseudotsuga menziesii*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Shrub/sapling (tall & short)	Needle-leaved tree	*Juniperus communis*
Herb (field)	Forb	*Achillea millefolium, Thalictrum fendleri*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Juniperus communis*
Global: *Carex geyeri*, *Juniperus communis*, *Lupinus argenteus*, *Populus tremuloides*, *Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Ligusticum porteri* (G3G4), *Pinus aristata* (G3), *Senecio pudicus* (G3G4); **Invasive/Exotic**: *Bromus inermis* (invasive/exotic, High/Medium), *Bromus tectorum* (invasive/exotic, High), *Poa pratensis* (invasive, Medium), *Taraxacum officinale* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Abies lasiocarpa - Picea engelmannii* / *Juniperus communis* Woodland (CEGL000919) also has *Populus tremuloides* in the canopy, and *Juniperus communis* in the short-shrub stratum; however, it hosts a much more diverse tree canopy. The canopy can include up to seven different mixed-conifer tree species, and the conifer component is much more dominant than the *Populus tremuloides* component. These plots could have been classified as *Abies lasiocarpa - Picea engelmannii* / *Juniperus communis* Forest (CEGL000919); however, their *Populus tremuloides* component is predominant over the conifer component.

Global Similar Associations:

- *Populus tremuloides - Abies lasiocarpa* / *Juniperus communis* Forest (CEGL000527)
- *Populus tremuloides - Pinus contorta* / *Juniperus communis* Forest (CEGL000537)
- *Populus tremuloides - Pseudotsuga menziesii* / *Juniperus communis* Forest (CEGL000545)
- *Populus tremuloides* / *Juniperus communis* / *Carex geyeri* Forest (CEGL000588)
- *Populus tremuloides* / *Juniperus communis* / *Lupinus argenteus* Forest (CEGL000589)
- *Populus tremuloides* / *Shepherdia canadensis* Forest (CEGL000606)

Global Related Concepts:

- *Populus tremuloides* / *Juniperus communis* / *Astragalus miser* Community Type (Mueggler and Campbell 1986) <
- *Populus tremuloides* / *Juniperus communis* / *Carex geyeri* Community Type (Mueggler and Campbell 1986) <
- *Populus tremuloides* / *Juniperus communis* / *Sitanion hystrix* Community Type (Mueggler and Campbell 1986) <
- *Populus tremuloides* / *Juniperus communis* Plant Association (Baker 1984a) =
- *Populus tremuloides* / *Juniperus communis* Community Type (Powell 1988a) =
- *Populus tremuloides* / *Juniperus communis* Community Type (Youngblood and Mueggler 1981) >
- *Populus tremuloides* / *Juniperus communis* Plant Association (Johnston 1987) =
- *Populus tremuloides/Juniperus communis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.B.3.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled on the North Rim in the vicinity of Upper Little Park.
Global Range: This association is known from the mountains and high plateaus of Utah, Colorado, Wyoming and Montana.
Nations: US
States/Provinces: AZ, CO:S4, ID, MT, NV, UT, WY:S3
TNC Ecoregions: 9:C, 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331E:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Cedar Breaks, Dinosaur, Florissant Fossil Beds, Grand Canyon, Great Basin, Great Sand Dunes, Rocky Mountain); USFS (Arapaho-Roosevelt, Ashley, Bridger-Teton, Caribou-Targhee, Fishlake, Medicine Bow, Pike-San Isabel, Rio Grande, Shoshone, Wasatch-Cache)

ELEMENT SOURCES

Grand Canyon National Park Inventory Notes: These plots could have been classified as *Abies lasiocarpa - Picea engelmannii* / *Juniperus communis* Forest (CEGL000919); however, their *Populus tremuloides* component is predominant over the conifer component.
Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.02183, GRCA.03199.
Local Description Authors: K. Christie
Global Description Authors: G. Kittel, mod. S.L. Neid, K.A. Schulz, J. Coles
References: Baker 1984a, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Coles et al. 2008a, Curry 1962, Driscoll et al. 1984, Johnston 1987, Jones and Ogle 2000, MTNHP 2002b, Marr et al. 1973b, Mueggler 1988, Mueggler and Campbell 1986, Murphy 1982, Owns et al. 2004, Peet 1975, Peet 1981, Powell 1988a, Reid and Hall 2010, Salas et al. 2005, Salas et al. 2010b, Schulz and Hall 2011, Shepherd 1975, Tendick et al. 2011a, Tendick et al. 2011b, Western Ecology Working Group n.d., Youngblood and Mueggler 1981

Populus tremuloides - Ceanothus fendleri / *Carex* spp. Shrubland

Quaking Aspen - Fendler's Buckbrush / Sedge species Shrubland
Identifier: CEGL005504

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)

Group Rocky Mountain Subalpine & Montane Aspen Forest & Woodland (G222)
Association *Populus tremuloides - Ceanothus fendleri / Carex* spp. Shrubland

ELEMENT CONCEPT

Global Summary: This quaking aspen shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from 2512 to 2684 m (8241-8806 feet) elevation in areas that have recently experienced high-intensity fires. It typically occurs on plateaus, on gentle slopes (1-8 degrees), and on south- or southwest-facing aspects, but can also occur on steeper sideslopes (up to 30 degrees) as well. Soils are predominantly silty loams or sandy loams. This association lacks tree cover, as all of the trees have died in recent high-severity burns. A layer of regenerating *Populus tremuloides* characterizes this association. *Ceanothus fendleri* is a dominant and consistent component of the dwarf-shrub stratum, and *Mahonia repens* also occurs frequently. Dryland sedges are extremely frequent in this vegetation type, including *Carex rossii* and *Carex siccata*. Dominant forb species include *Achillea millefolium, Lotus utahensis*, and the fire-adapted *Gayophytum diffusum*. Other fire-loving species, including *Erigeron divergens, Chenopodium* sp., *Conyza canadensis, Pseudostellaria jamesiana, Pseudognaphalium macounii*, and *Arenaria lanuginosa*, occur sporadically.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This quaking aspen shrubland occurs on the North Rim from 2512 to 2684 m (8241-8806 feet) elevation in areas that have recently experienced high-intensity fires. It typically occurs on plateaus, on gentle slopes (1-8 degrees), and on south- or southwest-facing aspects. It can also occur on steeper sideslopes (up to 30 degrees) as well. Soils are predominantly silty loams or sandy loams. Ground cover has relatively little litter (42%) and high amounts of bare soil (26%) and gravel (14%). This vegetation type occurs in areas that severely burned in recent years.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association lacks tree cover, as all of the trees have died in recent high-severity burns. A layer of regenerating *Populus tremuloides* (up to 60% cover) characterizes this association. This layer can be taller and more reminiscent of a subcanopy, or it can be a shorter layer of *Populus tremuloides* seedlings. *Ceanothus fendleri* (2%) is a dominant and consistent component of the dwarf-shrub stratum, and *Mahonia repens* (1%) also occurs frequently. Dryland sedges are extremely frequent in this vegetation type. *Carex rossii* can occur at up to 20% cover, but more typically occurs at 5% cover, while *Carex siccata* can occur at up to 10% cover, but typically occurs at 5% cover. Dominant forb species include *Achillea millefolium, Lotus utahensis*, and the fire-adapted *Gayophytum diffusum*, all at very low covers. Other fire-loving species, including *Erigeron divergens, Chenopodium* sp., *Conyza canadensis, Pseudostellaria jamesiana, Pseudognaphalium macounii*, and *Arenaria lanuginosa*, occur sporadically. Forb cover averages about 8% across all stands. Based upon the 11 stands sampled, this association hosts below-average species richness for North Rim community types, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Ceanothus fendleri, Mahonia repens*
Herb (field)	Forb	*Achillea millefolium, Gayophytum diffusum, Lotus utahensis, Packera multilobata, Solidago velutina*
Herb (field)	Graminoid	*Carex rossii, Carex siccata*
Herb (field)	Other herbaceous	*Populus tremuloides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ceanothus fendleri*, *Populus tremuloides*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic),

Erigeron divergens (exotic), *Lactuca serriola* (exotic, Low/Insignificant), *Polygonum aviculare* (exotic, Low), *Sisymbrium altissimum* (exotic), *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Similar Associations:

- *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501)
- *Populus tremuloides* / *Carex siccata* Forest (CEGL000578)
- *Populus tremuloides* / *Robinia neomexicana* Woodland (CEGL005503)
- *Robinia neomexicana* Shrubland (CEGL005505)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim in areas that have recently experienced high-severity fires. It was sampled from the Walhalla Plateau, Kanabownits Canyon, near the head of Crystal Creek, and most commonly from the northeastern portion of the North Rim, in an area east of Highway 67 towards Point Imperial, north of the Point Imperial Road.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (11 plots): GRCA.02144, GRCA.02148, GRCA.02149, GRCA.02152, GRCA.03077, GRCA.03093, GRCA.03119, GRCA.03126, GRCA.03141, GRCA.03168, GRCA.03187.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Populus tremuloides* / *Carex siccata* Forest**

Quaking Aspen / Dry-spike Sedge Forest
Identifier: CEGL000578

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine & Montane Aspen Forest & Woodland (G222)
Association	*Populus tremuloides* / *Carex siccata* Forest

ELEMENT CONCEPT

Global Summary: This quaking aspen forest association occurs on the Colorado Plateau and Rocky Mountains of Arizona, Colorado and Wyoming. This description is based on information from Great Sand Dunes National Park and Preserve in Colorado. Additional global information will be added as it becomes available. This association is known from stream terraces at 2998 to 3079 m elevation. Terrain is gently sloping to steep with warmer southeast- to west-facing aspects. Soils are moderately well- to well-drained sandy loams derived from fluvial deposition. Ground cover is dominated by litter and duff, but there is a significant amount of large rock cover. These are moderately open thickets with 30-40% cover of *Populus tremuloides* and occasional *Picea engelmannii*. The short-shrub layer is dominated by *Rosa woodsii* and *Juniperus communis*. The herbaceous layer is dominated by *Carex siccata* with

10-30% cover. *Thermopsis montana* and *Fragaria virginiana* are the dominant forbs with 10-30% cover, although forb cover may be diverse.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This quaking aspen forest occurs on the North Rim at approximately 2700 m (8900 feet) elevation. It occurs on the high-level plateau on flat or very gentle slopes. Aspect may be variable across stands; however, the single classification plot sampled has a south-facing aspect. Soils are primarily silt loams. Stands have a very high ground cover of litter (90%). Stands likely occur in areas that have been burned many years ago.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages about 50% in this association. Fairly dense canopies of *Populus tremuloides* (40%) and sparse subcanopies of *Abies concolor* (4%) and other mixed-conifer tree species (low covers) are characteristic. Various shrubs occur sporadically; however, the shrub strata are not very pronounced. There may be sparse graminoid cover of *Bromus ciliatus* and *Carex siccata*. The forb layer can be particularly well-represented (up to 20% cover), by *Lotus utahensis, Solidago* sp., and other montane forb species. *Populus tremuloides* (5%) and *Abies lasiocarpa* (2%) seedlings occur frequently. The composition of this vegetation type can be quite similar to earlier successional *Populus tremuloides* associations, however, it hosts a mature canopy. These pure, mature stands seem uncommon in the park, but perhaps may be more abundant than plot data suggest. Based upon a single classification plot, this vegetation type hosts below-average species richness for forested types on the North Rim, with only 17 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Tree subcanopy	Needle-leaved tree	*Abies concolor, Picea engelmannii, Pinus ponderosa*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Sambucus nigra*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos rotundifolius*
Herb (field)	Dwarf-shurb	*Mahonia repens*
Herb (field)	Forb	*Cirsium wheeleri, Lotus utahensis*
Herb (field)	Graminoid	*Bromus ciliatus, Carex siccata*
Herb (field)	Other herbaceous	*Abies lasiocarpa, Picea engelmannii, Populus tremuloides*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Herb (field)	Forb	*Thermopsis montana*
Herb (field)	Graminoid	*Carex siccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Dactylis glomerata* (exotic, Medium/Insignificant)
Global: Vulnerable: *Cirsium wheeleri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is a very early-successional type and has only regenerating *Populus tremuloides*; no mature canopy layer yet exists. *Populus tremuloides* / *Robinia neomexicana* Woodland (CEGL005503) is very similar but perhaps is in a somewhat earlier successional phase. It has a mature canopy of *Populus tremuloides*, but also supports up to 30% *Robinia neomexicana* cover in the shrub strata.
Global Comments: Compare this association to *Populus tremuloides* / Tall Forbs Forest (CEGL000618).

Global Similar Associations:

- *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is a very early-successional type and has only regenerating *Populus tremuloides*; no mature canopy layer yet exists.
- *Populus tremuloides* / *Robinia neomexicana* Woodland (CEGL005503) is very similar but perhaps is in a somewhat earlier successional phase; it has a mature canopy of *Populus tremuloides*, but also supports up to 30%*Robinia neomexicana* cover in the shrub strata.
- *Populus tremuloides* / Tall Forbs Forest (CEGL000618)

Global Related Concepts:
- *Populus tremuloides/Carex foenea* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.B.3.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from a single classification plot, from near the northern boundary of the North Rim near the road towards the Nankoweap Trail.
Global Range: This forest association occurs on the Colorado Plateau and Rocky Mountains of Arizona, Colorado and Wyoming.
Nations: US
States/Provinces: AZ, CO:S4, WY
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331F:CC
Federal Lands: NPS (Grand Canyon, Great Sand Dunes); USFS (Pike-San Isabel)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.03152.
Local Description Authors: K. Christie
Global Description Authors: K.E. Sabo, mod. K.A. Schulz
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Driscoll et al. 1984, Powell 1988a, Reid and Hall 2010, Salas et al. 2010b, WNDD unpubl. data, Western Ecology Working Group n.d.

***Populus tremuloides* / *Muhlenbergia montana* Woodland [Park Special]**

Quaking Aspen / Mountain Muhly Woodland
Identifier: CEPS009519

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine & Montane Aspen Forest & Woodland (G222)
Association	*Populus tremuloides* / *Muhlenbergia montana* Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation quaking aspen association occurs on the North Rim at about 2750 m (8900 feet) elevation in shallow valley bottoms. It typically occurs in linear swathes that follow narrow drainage channels. It occurs on essentially flat slopes, typically on south-facing aspects, in silt loam soils.

Stands have high ground cover of littler (71%), as well as some bare soil (10%) and exposed gravel (5%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages about 50% in this association. The canopy is composed of homogenous stands of numerous, small-diameter *Populus tremuloides*, interspersed with very sporadic *Picea engelmannii* (1%). The subcanopy is absent, as are tall and short shrubs. *Juniperus communis* is common at very low cover values (1%). *Muhlenbergia montana* (15%), as well as patchy *Elymus elymoides* and *Poa fendleriana*, dominate a well-developed graminoid component. The forb component of the understory is also well-developed and averages about 10% cover. *Erigeron formosissimus* (5%) and *Pseudocymopterus montanus* (2%) are the most abundant species. Stands commonly support the regeneration of various conifer tree species. Based upon a single classification plot, this association hosts above-average species richness for forested North Rim community types, with 27 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Picea engelmannii*
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Herb (field)	Dwarf-shrub	*Juniperus communis*
Herb (field)	Forb	*Cirsium wheeleri, Erigeron formosissimus, Lotus wrightii, Potentilla hippiana, Pseudocymopterus montanus*
Herb (field)	Graminoid	*Elymus elymoides, Muhlenbergia montana, Poa fendleriana*
Herb (field)	Other herbaceous	*Abies concolor, Abies lasiocarpa, Picea engelmannii, Populus tremuloides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Muhlenbergia montana*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (18-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Populus tremuloides* / *Juniperus communis* Forest (CEGL000587) also supports a fairly dense canopy of *Populus tremuloides*; however, it essentially lacks an understory altogether. This association occurs in more mesic and shaded areas, usually on moderately steep sideslopes. It supports a thick layer of litter and duff, and consequently has a very sparse understory. Conversely, *Populus tremuloides* / *Muhlenbergia montana* Woodland occurs on flat slopes along valley bottoms and supports a thick, rich understory.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from a single classification plot, from near the northern boundary of the North Rim, along the road towards the Nankoweap Trail.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Inventory Notes: This stand could have been included in *Populus tremuloides* / *Juniperus communis* Forest (CEGL000587); however, a strong dominance of *Muhlenbergia montana* in the well-de-

veloped understory and its preference for different abiotic site conditions clearly separate this community type.
Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02218.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

Populus tremuloides / Robinia neomexicana Woodland

Quaking Aspen / New Mexico Locust Woodland
Identifier: CEGL005503

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine & Montane Aspen Forest & Woodland (G222)
Association	*Populus tremuloides / Robinia neomexicana* Woodland

ELEMENT CONCEPT

Global Summary: This quaking aspen woodland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from 2608 to 2689 m (8556-8822 feet) elevation on the plateau and on adjacent upper sideslopes in fairly recently burned areas. Slopes are typically moderate (10 degrees), aspects tend to be northwest-facing, and soils are silt loams or sandy loams. This vegetation type occurs in areas that have experienced mid- to high-severity fires several decades ago. *Populus tremuloides* ubiquitously dominates the canopy layer; however, individuals are commonly less than 5 m in height. Previously extant conifers have experienced close to 100% mortality in these stands, but in the case of several surviving individuals, the *Populus tremuloides* layer may appear as a subcanopy. Vigorous regeneration of *Robinia neomexicana* also characterizes this vegetation type. *Robinia neomexicana* can appear as either a tall shrub or short shrub, depending upon the duration since the last fire event. *Sambucus nigra* is another frequent short shrub. *Mahonia repens* commonly occurs, but other dwarf-shrubs are infrequent. *Carex rossii* and *Carex siccata* are common members of a graminoid component. Forb cover is typically fairly sparse; however, *Chenopodium* sp., *Machaeranthera canescens, Solidago velutina*, and *Chamerion angustifolium* are common. Tree seedlings are essentially absent, as the duration since fire events has allowed the *Populus tremuloides* to mature. This vegetation type generally occurs in a mosaic among other regenerating mixed-conifer types and occasionally among mature, intact mixed-conifer stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This quaking aspen woodland occurs on the North Rim from 2608 to 2689 m (8556-8822 feet) elevation in fairly recently burned areas. It occurs on the plateau and on adjacent upper sideslopes. Slopes are typically moderate (10 degrees), aspects tend to be northwest-facing, and soils are silt loams or sandy loams. Stands have some bare soil (6%), a moderate litter load (67%), and some dead, burned logs (11%) on the ground. This vegetation type occurs in areas that have experienced mid- to high-severity fires several decades ago. It is best developed in the vicinity of the Saddle Mountain fire.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages about 40% in this association. *Populus tremuloides* (up to 50% cover) ubiquitously dominates the canopy layer; however, individuals are commonly less than 5 m in height. Previously extant conifers have experienced close to 100% mortality in these stands, but in the case of several surviving individuals, the *Populus tremuloides* layer may appear as a subcanopy. Vigorous regeneration of *Robinia neomexicana* also characterizes this vegetation type, and it is usually present at 20-30% cover. *Robinia neomexicana* can appear either as a tall shrub or as a short shrub, depending upon the duration since the fire event. *Sambucus nigra* is another frequent short shrub, but usually only at 1-3% cover. *Mahonia repens* commonly occurs at about 2% cover, but other dwarf-shrubs are infrequent. *Carex rossii* and *Carex siccata* are common members of a graminoid component which usually averages about 3-4% cover. Forbs cover is typically fairly sparse; however, *Chenopodium* sp., *Machaeranthera canescens, Solidago velutina*, and *Chamerion angustifolium* are

common at about 1% cover each. Tree seedlings are essentially absent, as the duration since fire events has allowed the *Populus tremuloides* to mature. This vegetation type generally occurs in a mosaic among other regenerating mixed-conifer types and occasionally among mature, intact mixed-conifer stands. Based upon the three stands sampled, this association hosts below-average species richness for North Rim communities, with only 17 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	Populus tremuloides
Short shrub/sapling	Broad-leaved deciduous shrub	Robinia neomexicana, Sambucus nigra
Herb (field)	Dwarf-shurb	Mahonia repens
Herb (field)	Forb	Chamerion angustifolium, Machaeranthera canescens, Solidago velutina
Herb (field)	Graminoid	Carex rossii, Carex siccata

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Robinia neomexicana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus inermis* (exotic, High/Medium), *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Dactylis glomerata* (exotic, Medium/Insignificant), *Phleum pratense* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is another early-successional, post-fire vegetation type that supports thick stands of *Populus tremuloides* and *Robinia neomexicana*. In this association the *Populus tremuloides* are shorter and less mature, and the *Carex* spp. have higher cover.

Global Similar Associations:

- *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is another early-successional, post-fire vegetation type that supports thick stands of *Populus tremuloides* and *Robinia neomexicana*, but the *Populus tremuloides* are shorter and less mature, and the *Carex* spp. have higher cover.
- *Populus tremuloides* / *Carex siccata* Forest (CEGL000578)
- *Robinia neomexicana* Shrubland (CEGL005505)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the northeast portion of the North Rim, between Saddle Mountain and Point Imperial. It is best developed in the vicinity of the Saddle Mountain fire.

Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02098, GRCA.03131, GRCA.03193.

Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

G219. Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland

Abies lasiocarpa - Picea engelmannii / Carex siccata Forest

Subalpine Fir - Engelmann Spruce / Dry-spike Sedge Forest
Identifier: CEGL000303

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)
Association	*Abies lasiocarpa - Picea engelmannii / Carex siccata* Forest

ELEMENT CONCEPT

Global Summary: This high-elevation forest is codominated by *Abies lasiocarpa* and *Picea engelmannii* with occasional *Pseudotsuga menziesii* and *Populus tremuloides* trees. Shrub cover is sparse. Herbaceous cover is abundant but patchy near rock outcrops. Cover is dominated by graminoids, mostly *Carex siccata (= Carex foenea)* with *Poa fendleriana* or *Poa pratensis*. Forb cover is relatively low, usually consisting of *Campanula rotundifolia*, *Lathyrus lanszwertii var. leucanthus (= Lathyrus arizonicus), Mertensia franciscana*, *Oreochrysum parryi(= Solidago parryi)*, and *Vicia americana*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs on the North Rim at the highest elevations, from 2523 to 2758 m (8278-9049 feet). It occurs predominantly on sideslopes, and occasionally on the high-level plateau. Slopes are low to moderate and average 13 degrees. This association occurs across all aspects. Soils are primarily well-drained silt loams. Stands have a variable but normally large amount of surfacelitter (typically 64%) and some downed wood (typically 6%) on the soil surface. There is very little to no evidence of fire in this community.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: A mixture of *Picea engelmannii* (up to 15% cover) and *Abies lasiocarpa* (8-10% cover), with scattered *Populus tremuloides* dominate the canopy of this high-elevation community. The canopy can be fairly diverse with seven different tree species occurring in the canopy across all stands. *Populus tremuloides* (up to 3% cover) and *Picea engelmannii* (5% cover) are the major components of the subcanopy. Shrub cover is generally very low to nonexistent; however, *Juniperus communis* does occur at 2% cover. Graminoid swaths dominate the understory of this community. The dry sedges *Carex siccata* (up to 12% cover) and *Carex rossii* (1% cover) are common, as well as the grass *Bromus ciliatus* (1% cover). Forb cover is typically very low (0-3%); however, *Chamerion angustifolium* occurs very frequently. *Populus tremuloides, Picea engelmannii*, and *Abies lasiocarpa* seedlings are common at 2-5% cover, yet some stands may have up to 20% tree seedling cover. The species richness of this association (28 species per 400-square-meter plot) is typical for high-elevation, forested types on the North Rim.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Forb	Chamerion angustifolium
Herb (field)	Other herbaceous	Abies lasiocarpa, Picea engelmannii

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Abies lasiocarpa*, *Bromus ciliatus*, *Carex rossii*, *Carex siccata*,

Chamerion angustifolium, *Fragaria virginiana*, *Juniperus communis*, *Mahonia repens*, *Picea engelmannii*, *Populus tremuloides*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ligusticum porteri* (G3G4); **Other**: *Agoseris aurantiaca* (G5), *Chamerion angustifolium* (G5), *Chimaphila umbellata* (G5), *Goodyera oblongifolia* (G5?), *Hymenoxys subintegra* (endemic, G4), *Orthilia secunda* (G5), *Packera werneriifolia* (G5), *Pyrola chlorantha* (G5)
Global: Vulnerable: *Ligusticum porteri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (13-Nov-1997). This plant association is known only from a few high-elevation sites in the Pinaleno Mountains of Arizona. Catastrophic events such as spruce budworm epidemics and wildfire could threaten the persistence of this association because of the limited number of sites and acreage. Forest clearing reduces tree reproduction because of increased competition with graminoids. Logging activities also introduce various disease organisms and can contribute to the decline of spruce - fir forests such as these. Logging or thinning of these forests is not recommended.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:
Abies lasiocarpa - Picea engelmannii / Juniperus communis Woodland (CEGL000919) also supports a mixed canopy of *Abies lasiocarpa* and *Picea engelmannii*. It also hosts fairly sparse shrub and herbaceous layers; however, *Juniperus communis* occurs in essentially all stands, and *Carex siccata* is frequently present. In this association the shrub layer is more dominant than the graminoid component.
Global Related Concepts:

- *Abies biflora / Carex foenea* Plant Association (Stuever and Hayden 1997b) =
- *Abies lasiocarpa / Carex foenea* Habitat Type (Bassett et al. 1987) =
- *Abies lasiocarpa/Carex foenea* (Bourgeron and Engelking 1994) =
- *Abies lasiocarpa* Series (Moir and Ludwig 1979) >
- *Picea engelmannii / Carex foenea* Habitat Type (Muldavin et al. 1996) >
- Corkbark Fir-Engelmann Spruces Series (Dick-Peddie 1993) >
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim at the highest elevations. It was sampled from upper Bright Angel Creek, Thompson Canyon, and in the vicinity of the Basin.
Global Range: This plant association is restricted to elevations above 3050 m on the western side of Mount Graham, ridgelines and moderately steep southern aspect slopes in the Pinaleno Mountains in southeastern Arizona. It may also occur in the White Mountains of Arizona.
Nations: US
States/Provinces: AZ:S2
TNC Ecoregions: 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, M313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (7 plots): GRCA.02155, GRCA.02177, GRCA.02213, GRCA.03130, GRCA.03151, GRCA.03157, GRCA.03170.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: K.A. Schulz
References: Bassett et al. 1987, Bourgeron and Engelking 1994, DeVelice and Ludwig 1983b, Dick-Peddie 1993, Driscoll et al. 1984, Moir and Ludwig 1979, Muldavin et al. 1986, Muldavin et al. 1996, Reid and Hall 2010, Stuever and Hayden 1997b, Western Ecology Working Group n.d.

Abies lasiocarpa - Picea engelmannii / Juniperus communis Woodland

Subalpine Fir - Engelmann Spruce / Common Juniper Woodland
Identifier: CEGL000919

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Rocky Mountain Subalpine & High Montane Conifer Forest (M020)
Group	Rocky Mountain Subalpine Dry-Mesic Spruce - Fir Forest & Woodland (G219)
Association	*Abies lasiocarpa - Picea engelmannii / Juniperus communis* Woodland

ELEMENT CONCEPT

Global Summary: This spruce-fir woodland association occurs in localized areas within the subalpine to upper montane zones of the western United States. The primary elevation range for the association is between 2530 and 3200 m (8300-11,500 feet). It occurs on gentle to somewhat steep mid- to upper slopes of all aspects and on benches or at lower elevations on dry stream terraces with cold-air drainage. Soils are variable but generally rocky and well-drained with substantial areas of lichen-covered bedrock or bare soil. This association is among the driest types of *Abies lasiocarpa* forests and woodlands. The canopy is relatively open and dominated by *Abies lasiocarpa* with *Picea engelmannii* often codominant. Seral species in the tree canopy can include *Pinus contorta, Pinus flexilis, Picea pungens*, and *Populus tremuloides*, with *Pseudotsuga menziesii* occurring on relatively warmer sites. The shrub layer is often sparse but characterized by large, widely spaced patches of *Juniperus communis*. Additional shrub species occur and can include *Shepherdia canadensis, Vaccinium scoparium, Ribes montigenum, Symphoricarpos oreophilus*, and occasionally *Mahonia repens, Vaccinium myrtillus*, or *Vaccinium caespitosum*. The herbaceous layer is likewise sparse. Species occurring most frequently include *Arnica cordifolia, Lupinus argenteus, Fragaria virginiana, Chamerion angustifolium (= Epilobium angustifolium)*, and *Antennaria* spp. Diagnostic characteristics of this association include *Abies lasiocarpa* and *Picea engelmannii* in the tree canopy and *Juniperus communis* patches in the understory with greater cover than other shrub species.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs on the North Rim at the highest elevations, from 2460 to 2771 m (8071-9091 feet). It occurs predominantly on mid-level sideslopes. Slopes range from 2 to 36 degrees, with an average slope of 14 degrees. This vegetation type occurs across all aspects but is most common on north- or east-facing slopes. Soils are moderately well-drained or rapidly-drained silt loams. Litter (71%) dominates ground cover, yet a relatively high amount of downed wood (10%) also exists. This community displays no evidence of fire history.

Global Environment: This spruce-fir woodland association occurs in localized areas within the subalpine to upper montane zones of the western United States. The primary elevation range for the association is between 2530 and 3200 m (8300-11,500 feet), but it occurs at lower elevations, 2600-2800 m (8700-9200 feet), on the north Kaibab Plateau. It occurs on gentle to somewhat steep mid- to upper slopes of all aspects and on benches or at lower elevations on dry stream terraces with cold-air drainage. Soils are variable but generally rocky and well-drained with substantial areas of lichen-covered bedrock or bare soil.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: *Picea engelmannii* (up to 12% cover) and *Populus tremuloides* (5% cover) are the dominant members of the canopy in this high-elevation, mixed-conifer community. *Abies lasiocarpa* also occurs occasionally in the canopy, at times up to 17% cover. *Picea engelmannii* (4%) and *Abies lasiocarpa* (2%) comprise the subcanopy as well, sometimes with up to 10% cover each. *Juniperus communis* is present in essentially all stands at 4% cover, otherwise the shrub layer is quite sparse as dead and downed wood predominates the ground cover. While never very dense, the presence of *Shepherdia canadensis* is characteristic of this vegetation type. *Carex rossii, Bromus ciliatus*, and *Carex siccata* are common; however, graminoid cover is extremely sparse (1%). *Goodyera oblongifolia, Oreochrysum parryi*, and *Chamerion angustifolium* are common, yet forb cover is similarly sparse. Members of the Pyrolaceae are particularly well-represented here, especially *Chimaphila umbellata*. *Populus tremuloides* seedlings are ubiquitous (up to 10% cover), while *Abies lasiocarpa* and *Picea engelmannii* seedlings are also common at 2-4% cover. Some stands display heavy *Abies lasiocarpa* regeneration with up to 16% cover. This

association commonly supports moss cover, sometimes up to 7%. The species richness of this association (26 species per 400-square-meter plot) is typical for high-elevation, forested types on the North Rim.

Global Vegetation: The canopy of this spruce-fir woodland is relatively open and dominated by *Abies lasiocarpa* with *Picea engelmannii* often codominant. Seral species in the tree canopy can include *Pinus contorta, Pinus flexilis, Picea pungens*, and *Populus tremuloides*, with *Pseudotsuga menziesii* occurring on relatively warmer sites. The shrub layer is often sparse but characterized by large, widely spaced patches of *Juniperus communis*. Additional shrub species occur and can include *Shepherdia canadensis, Vaccinium scoparium, Ribes montigenum, Symphoricarpos oreophilus*, and occasionally *Mahonia repens, Vaccinium myrtillus*, or *Vaccinium caespitosum*. The herbaceous layer is likewise sparse. Species occurring most frequently include *Arnica cordifolia, Lupinus argenteus, Fragaria virginiana, Chamerion angustifolium (= Epilobium angustifolium)*, and *Antennaria* spp.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Needle-leaved shrub	*Juniperus communis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Shepherdia canadensis*
Herb (field)	Forb	*Chimaphila umbellata*
Herb (field)	Graminoid	*Agrostis scabra*
Herb (field)	Other herbaceous	*Abies lasiocarpa*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies lasiocarpa var. lasiocarpa, Picea engelmannii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Abies lasiocarpa*, *Carex rossii*, *Carex siccata*, *Fragaria virginiana*, *Juniperus communis*, *Oreochrysum parryi*, *Picea engelmannii*, *Poa fendleriana*, *Populus tremuloides*
Global: *Abies lasiocarpa* var. *lasiocarpa*, *Juniperus communis* var. *montana*, *Picea engelmannii*, *Vaccinium scoparium*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ligusticum porteri* (G3G4); **Invasive/Exotic**: *Taraxacum officinale* (exotic); **Other**: *Chamerion angustifolium* (G5), *Chimaphila umbellata* (G5), *Goodyera oblongifolia* (G5?), *Hymenoxys subintegra* (endemic, G4), *Orthilia secunda* (G5), *Packera werneriifolia* (G5), *Pyrola chlorantha* (G5), *Pyrola picta* (G4G5), *Zigadenus elegans* (G5)
Global: Vulnerable: *Ligusticum porteri* (G3G4), *Pinus aristata* (G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Similar Associations:

- *Abies concolor* / *Juniperus communis* Forest (CEGL000249)
- *Abies lasiocarpa - Picea engelmannii* / *Carex siccata* Forest (CEGL000303) also supports a mixed canopy and subcanopy of *Abies lasiocarpa* and *Picea engelmannii*. It hosts a fairly sparse shrub layer. *Juniperus communis* can occur, and *Carex siccata>/i> dominates the understory.*
- *Picea engelmannii* / *Juniperus communis* Forest (CEGL005925)
- *Pinus contorta* / *Juniperus communis* Woodland (CEGL000764)
- *Populus tremuloides - Abies lasiocarpa* / *Juniperus communis* Forest (CEGL000527)

Global Related Concepts:

- *Abies lasiocarpa - Picea engelmannii / Juniperus communis* Plant Association (Johnston 1987) =
- *Abies lasiocarpa / Berberis repens* Habitat Type, *Juniperus communis* Phase (Mauk and Henderson 1984) ><
- *Abies lasiocarpa / Calamagrostis rubescens* Habitat Type (Pfister et al. 1977) ?
- *Abies lasiocarpa / Juniperus communis* (Henderson et al. 1989) =
- *Abies lasiocarpa / Juniperus communis* (Jones and Ogle 2000) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Komarkova et al. 1988b) >
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Steele et al. 1983) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Moir and Ludwig 1979) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Steele et al. 1981) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Larson and Moir 1987) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Roberts 1980) =
- *Abies lasiocarpa / Juniperus communis* Habitat Type (Youngblood and Mauk 1985) =
- *Abies lasiocarpa / Shepherdia canadensis* Habitat Type (Hoffman and Alexander 1976) ><
- *Abies lasiocarpa-(Pinus contorta)/Juniperus communis-Lomatium martindalei* Woodland (Crawford et al. 2009) <
- *Abies lasiocarpa/Juniperus communis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.c. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim at the highest elevations. It is most predominant on the eastern North Rim, east of Highway 67/Upper Little Park. It occurs from the northern park boundary south to Fuller Canyon/the Point Imperial road. Several scattered stands occur near the North Rim Entrance Station west of Highway 67.
Global Range: This spruce-fir woodland association occurs in localized areas within the subalpine to upper montane zones of the western United States from Montana to Washington south to Arizona and New Mexico.
Nations: US
States/Provinces: AZ:S2, CO, ID:S3?, MT:S3, NM?, NV?, OR?, UT:S2?, WA:S3, WY:S2?
TNC Ecoregions: 1:C, 4:?, 8:C, 9:C, 10:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M242A:CC, M242C:C?, M331A:CC, M331B:C?, M331D:CC, M331E:CC, M331F:C?, M331I:C?, M332A:CC, M332D:CC, M332E:CC, M332F:CC, M341C:CC
Federal Lands: NPS (Cedar Breaks, Grand Canyon, Great Sand Dunes, Rocky Mountain); USFS (Bighorn, Challis, Dixie, Fishlake, Gunnison, Medicine Bow, Olympic NF, Salmon, Shoshone, Uinta)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (22 plots): GRCA.02142, GRCA.02150, GRCA.02156, GRCA.02174, GRCA.02175, GRCA.02179, GRCA.02185, GRCA.02209, GRCA.02210, GRCA.02212, GRCA.02214, GRCA.02217, GRCA.02219, GRCA.03106, GRCA.03121, GRCA.03124, GRCA.03150, GRCA.03153, GRCA.03195, GRCA.03196, GRCA.03198, GRCA.03200.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: S.L. Neid
References: Bourgeron and Engelking 1994, Clagg 1975, Crawford et al. 2009, Driscoll et al. 1984, Henderson et al. 1986, Henderson et al. 1989, Hoffman and Alexander 1976, Johnston 1984, Johnston 1987, Jones and Ogle 2000, Komarkova et al. 1988b, Larson and Moir 1987, MTNHP 2002b, Mauk and Henderson 1984, Moir and Ludwig 1979, Pfister et al. 1977, Reid and Hall 2010, Roberts 1980, Salas et al. 2005, Salas et al. 2010b, Steele et al. 1981, Steele et al. 1983, Tendick et al. 2011a, Tirmenstein 1999a, WNDD unpubl. data, WNHP unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985.

M022. Southern Rocky Mountain Lower Montane Forest
G225. Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest

Abies concolor / Symphoricarpos oreophilus Forest

White Fir / Mountain Snowberry Forest
Identifier: CEGL000263

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)
Association	*Abies concolor* / *Symphoricarpos oreophilus* Forest

ELEMENT CONCEPT

Global Summary: This forest association has been reported from mountains in Colorado, Utah, New Mexico and Arizona along the Mogollon Rim. Elevation ranges from 2075-3200 m (6800-10,500 feet). Stands are found on cool, dry sites often occurring on moderate to steep mid slopes with northern aspects, but they also occur on southern and western slopes at the higher elevations. Parent material often is limestone and Tertiary sandstone. Soil surface textures are sandy loam to loam and contain little gravel. The upper tree canopy is typically dominated by either *Pinus ponderosa* or *Pseudotsuga menziesii* with scattered *Abies concolor*. This association is characterized by the presence of successfully reproducing *Abies concolor*, which may also dominate or codominate the tree canopy or shrub layers. Associated trees include *Pinus flexilis, Populus angustifolia*, and *Populus tremuloides*. The sparse to moderately dense short-shrub layer is characteristically dominated by *Symphoricarpos oreophilus* often with *Rosa woodsii, Amelanchier alnifolia*, or several other shrubs present. The herbaceous layer is sparse. Common graminoids are *Carex rossii* and *Poa fendleriana*. Forbs are noticeably sparse.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2432 to 2611 m (7979-8566 feet) elevation. It tends to occur on mid-level sideslopes or plateaus, on south- or east-facing slopes. Slopes tend to be low to moderate. Soils are well-drained or rapidly drained silt loams. Stands have a high percentage of litter (63-85%) and a relatively small amount of downed wood (4-10%) on the soil surface. Stands show little to no history of recent fire.

Global Environment: This coniferous forest association has been reported from mountains in New Mexico and Arizona along the Mogollon Rim, Colorado and Utah. Elevation ranges from 1740-3200 m (6800-10,500 feet). Stands are found on cool, dry sites often occurring on moderate to steep mid slopes with northern aspects, but they also occur on southern and western slopes at the higher elevations. Parent material often is limestone and Tertiary sandstone. Soil surface textures are sandy loam to loam and contain little gravel. Litter depth averages 2.5 cm. Bare soil averages 7% and exposed rock averages 3%.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Low cover of *Abies concolor* (2-3%), *Pinus ponderosa* (3-4%), and *Populus tremuloides* (2-3%) dominate the canopy layer of this mixed-conifer association. *Abies concolor* (3-5%) is also the predominant component of the subcanopy, while various other mixed-conifer tree species also occasionally occur. *Symphoricarpos oreophilus* is the dominant component of either the short-shrub or dwarf-shrub strata at up to 5% cover. Other shrub species occur occasionally but at low cover (usually 2% or less). *Carex siccata* and *Elymus elymoides* are frequent graminoids, but only at trace amounts of cover. *Carex rossii* can occur occasionally at up to 4% cover. A variety of montane forbs occur at low cover, and *Solidago* seems to be fairly common. The fern *Pteridium aquilinum* occurs frequently at 1-2% cover. *Populus tremuloides* (at up to 4% cover) and *Abies concolor* (at 2% cover) are common tree seedlings, while *Pseudotsuga menziesii* and *Pinus ponderosa* can also occur. This association hosts the highest species richness of all high-elevation, forested community types in Grand Canyon National Park, with 33-34 species per 400-square-meter plot. This pattern requires further study, as this species richness average is only based upon two classification plots.

Global Vegetation: Stands have a moderately dense to dense, evergreen needleleaf tree canopy typically dominated by either *Pseudotsuga menziesii* or *Pinus ponderosa* with scattered *Abies concolor*. This association is characterized by the presence of successfully reproducing *Abies concolor*, which may also dominate or codominate the tree canopy or shrub layers. Associated trees, including *Pinus flexilis, Pinus aristata, Populus angustifolia*, and *Populus tremuloides*, may also be present. The sparse to moderately dense short-shrub layer is dominated or codominated by *Symphoricarpos oreophilus* often with *Rosa woodsii, Amelanchier alnifolia*, or several other shrubs present including *Acer glabrum, Amelanchier utahensis, Jamesia americana, Juniperus communis, Mahonia repens, Physocarpus*

monogynus, Prunus virginiana, Quercus gambelii, or *Ribes cereum*. The herbaceous layer is sparse. Common graminoids are *Carex rossii* and *Poa fendleriana*. Forbs are noticeably sparse, but may include *Balsamorhiza sagittata*, *Eriogonum racemosum, Lathyrus lanszwertii*, or *Thalictrum fendleri*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*
Herb (field)	Dwarf-shurb	*Symphoricarpos oreophilus*
Herb (field)	Fern or fern ally	*Pteridium aquilinum*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Short shrub/sapling	Broad-leaved deciduous tree	*Amelanchier alnifolia*
Short shrub/sapling	Broad-leaved deciduous shrub	*Rosa woodsii, Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Pinus ponderosa*, *Populus tremuloides*, *Pteridium aquilinum*, *Symphoricarpos oreophilus*

Global: *Abies concolor*, *Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Other: *Pyrola chlorantha* (G5)
Global: Vulnerable: *Pinus aristata* (G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: Two similar associations, *Abies concolor* / *Erigeron eximius* and *Abies concolor* / Sparse, are described by DeVelice et al. (1986) for northern New Mexico and southern Colorado.
Global Similar Associations:

- *Abies concolor - Pseudotsuga menziesii* / *Erigeron eximius* Forest (CEGL000247)
- *Abies concolor* / *Juniperus communis* Forest (CEGL000249) *Abies concolor*, *Pinus ponderosa*, and to some degree *Populus tremuloides* also dominate the canopy of this dry, mixed-conifer association; however, *Juniperus communis* dominates the shrub layer.
- *Abies concolor* / *Mahonia repens* Forest (CEGL000251) has a similar canopy composition; however, it has an extremely sparse to nonexistent shrub layer. *Mahonia repens* is the dominant dwarf-shrub.
- *Pinus ponderosa* / *Symphoricarpos oreophilus* Forest (CEGL000205)
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Forest (CEGL000462)

Global Related Concepts:

- *Abies concolor - Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Plant Association (Johnston 1987) =
- *Abies concolor - Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Plant Association (Johnston 1984) =

- *Abies concolor* / *Symphoricarpos oreophilus* (Freeman and Dick-Peddie 1970) **?**
- *Abies concolor* / *Symphoricarpos oreophilus* Habitat Type (Youngblood and Mauk 1985) **=**
- *Abies concolor* / *Symphoricarpos oreophilus* Plant Association (Larson and Moir 1987) **=**
- *Abies concolor* / *Symphoricarpos oreophilus* Plant Association (Stuever and Hayden 1997b) **=**
- *Abies concolor/Symphoricarpos oreophilus* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) **>**
- White-fir / Snowberry (Roberts et al. 1992) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled in two points on the North Rim: one near Big Spring Canyon and another on the edge of the Walhalla Plateau near Vista Encantada.
Global Range: This coniferous forest association has been reported from mountains and high plateaus in New Mexico, Colorado, Utah, and in Arizona along the Mogollon Rim.
Nations: US
States/Provinces: AZ:S4, CO:SU, NM:S5, NV, UT:S5, WY
TNC Ecoregions: 11:C, 18:C, 19:C, 20:C, 21:P
USFS Ecoregions (1994/95): 313A:CC, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Cedar Breaks, Grand Canyon, Great Basin, Great Sand Dunes, Zion); USFS (Pike-San Isabel, San Juan)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.03081, GRCA.03176.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: L.D. Engelking
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Cogan et al. 2004, DeVelice et al. 1986, Driscoll et al. 1984, Edwards 1987, Freeman and Dick-Peddie 1970, Johnston 1984, Johnston 1987, Lamb 1975, Larson and Moir 1987, Reid and Hall 2010, Roberts et al. 1992, Salas et al. 2010b, Schulz and Hall 2011, Stuever and Hayden 1997b, Tendick et al. 2011a, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

***Picea pungens* / *Carex siccata* Forest**

Blue Spruce / Dry-spike Sedge Forest
Identifier: CEGL000387

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Rocky Mountain Douglas-fir - White Fir - Blue Spruce Mesic Forest (G225)
Association	*Picea pungens* / *Carex siccata* Forest

ELEMENT CONCEPT

Global Summary: This blue spruce forest association occurs from Arizona and New Mexico north to Wyoming. This description is based on information from Grand Canyon National Park in Arizona, and additional global information will be added as it becomes available. This high-elevation association occurs on the North Rim from 2347 to 2683 m (7700-8802 feet) elevation in mesic environments. It occurs in canyons, cold-air drainage channels, and on adjacent sideslopes. Slopes are low to moderate (up to 30 degrees) and are usually west- or south-facing. Soils are primarily silt loams. Stands have a high cover of litter, some bare soil, and occasionally significant moss cover. There is minor evidence of fire in several stands; however, the mesic nature of this association and its typical positioning along cold-air drainages have precluded any significant influence from fire. *Picea pungens, Pinus ponderosa*, and occasionally low cover of *Populus tremuloides* dominate the canopy of this mesic, mixed-conifer community. *Picea pungens, Populus tremuloides*, and *Abies concolor* are common components of the subcanopy. Shrub layers are typically sparse. *Juniperus communis* is the most frequent and abundant short shrub, while *Rosa woodsii* occurs occasionally as a dwarf-shrub with extremely low cover. *Carex siccata* clearly dominates the herbaceous layer. *Poa fendleriana* and *Bromus ciliatus* are also common graminoids, typically at low cover. Forb cover is very sparse in

this vegetation type. *Antennaria parvifolia, Achillea millefolium*, and *Fragaria virginiana* are common components of the understory. Seedlings of *Populus tremuloides* are ubiquitous and seedlings of *Abies concolor* and *Picea pungens* are also very common. This association essentially hosts the highest species richness of all high-elevation, forested community types in Grand Canyon National Park, with 32 species per 400-square-meter plot. This may be a result of the vicinity of this vegetation type, which occurs in cold-air drainages, to the adjacent meadow communities (which are often particularly species-rich).

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2347 to 2683 m (7700-8802 feet) elevation in mesic environments. It occurs in canyons, cold-air drainage channels, and on adjacent sideslopes. Slopes are low to moderate (up to 30 degrees) and are usually west- or south-facing. Soils are primarily silt loams. Stands have a high cover of litter (typically 73%), some bare soil (5%), and occasionally significant moss cover (up to 13%). There is minor evidence of fire in several stands; however, the mesic nature of this association and its typical positioning along cold-air drainages have precluded any significant influence from fire.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: *Picea pungens* (up to 25% cover), *Pinus ponderosa* (up to 10% cover), and occasionally low cover of *Populus tremuloides* dominate the canopy of this mesic, mixed-conifer community. *Picea pungens* (up to 25% cover), *Populus tremuloides* (up to 8% cover), and *Abies concolor* (up to 6% cover) are common components of the subcanopy. Shrub layers are typically sparse. *Juniperus communis* (3% cover) is the most frequent and abundant short shrub, while *Rosa woodsii* occurs occasionally as a dwarf-shrub with extremely low cover. *Carex siccata* clearly dominates the herbaceous layer at 5% cover, but in some stands occurs at up to 20% cover. *Poa fendleriana* and *Bromus ciliatus* are also common graminoids, typically at low cover. Forb cover is very sparse in this vegetation type. *Antennaria parvifolia, Achillea millefolium*, and *Fragaria virginiana* are common components of the understory. Seedlings of *Populus tremuloides* are ubiquitous and seedlings of *Abies concolor* and *Picea pungens* are also very common (all at 1-2% cover). This association essentially hosts the highest species richness of all high-elevation, forested community types in Grand Canyon National Park, with 32 species per 400-square-meter plot. This may be a result of the vicinity of this vegetation type, which occurs in cold-air drainages, to the adjacent meadow communities (which are often particularly species-rich).

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Picea pungens*
Herb (field)	Forb	*Antennaria parvifolia, Fragaria virginiana*
Herb (field)	Graminoid	*Carex siccata*

Global

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	Picea pungens
Herb (field)	Graminoid	Carex siccata

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Antennaria parvifolia*, *Bromus ciliatus*, *Carex rossii*, *Carex siccata*, *Elymus elymoides*, *Fragaria virginiana*, *Juniperus communis*, *Packera multilobata*, *Picea pungens*, *Pinus ponderosa*, *Poa fendleriana*, *Populus tremuloides*, *Rosa woodsii*
Global: *Abies concolor*, *Bromus ciliatus*, *Carex rossii*, *Carex siccata*, *Juniperus communis*, *Picea pungens*, *Pinus ponderosa*, *Populus tremuloides*, *Rosa woodsii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ligusticum porteri* (G3G4); **Invasive/Exotic**: *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic); **Other**: *Campanula rotundifolia* (G5), *Goodyera oblongifolia* (G5?), *Hymenoxys*

subintegra (endemic, G4), *Pyrola chlorantha* (G5), *Pyrola picta* (G4G5)
Global: Vulnerable: *Ligusticum porteri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Similar Associations:
- *Picea pungens* / *Festuca arizonica* Woodland (CEGL000895) has *Festuca arizonica* rather than *Carex siccata* as the dominant component of the understory.

Global Related Concepts:
- *Picea pungens* / *Carex siccata* Habitat Type (Larson and Moir 1987) =
- *Picea pungens*/*Carex foenea* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim in mesic canyons, cold-air drainage channels, and on adjacent sideslopes. It occurs in Kanabownits Canyon, Walla Valley, Crystal Creek, The Basin, Outlet Canyon, Thompson Canyon, Fuller Canyon, and Bright Angel Creek.
Global Range: This association occurs from Arizona and New Mexico north to Wyoming.
Nations: US
States/Provinces: AZ:S2, CO:S2, NM:S4, WY
TNC Ecoregions: 19:C, 20:C, 21:P
USFS Ecoregions (1994/95): 313A:CC, 331J:??, M313A:CC, M313B:C?, M331F:CC, M331G:CC
Federal Lands: NPS (Grand Canyon); USFS (Apache-Sitgreaves?, Cibola?, Gila?)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (14 plots): GRCA.02128, GRCA.02139, GRCA.02193, GRCA.03078, GRCA.03082, GRCA.03087, GRCA.03101, GRCA.03108, GRCA.03133, GRCA.03156, GRCA.03159, GRCA.03166, GRCA.03171, GRCA.03183.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: L. Dickson and K. Christie, mod. M.J. Russo
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, DeVelice 1983, DeVelice and Ludwig 1983a, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Larson and Moir 1987, Moir and Ludwig 1979, Reid and Hall 2010, USFS 1983b, WNDD unpubl. data, Western Ecology Working Group n.d.

G228. Southern Rocky Mountain Ponderosa Pine Forest & Woodland

Pinus ponderosa / *Arctostaphylos patula* Woodland

Ponderosa Pine / Greenleaf Manzanita Woodland
Identifier: CEGL000842

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Arctostaphylos patula* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association has been reported from the mountains and plateaus in Colorado, Utah and California. Elevation ranges from 1770-2590 m (5800-8500 feet). Sites are dry, warm, mid to lower slopes, benches and ridges often with southerly aspects. Soils are typically sandy loams but vary from sand to silt loam.

Parent materials are sandstone, limestone and occasionally basalt and andesite. The tree canopy is typically open (about 30% cover), but can range from 10-80% cover and is dominated by *Pinus ponderosa*. Scattered *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer. Others shrub species present may include *Amelanchier utahensis, Ceanothus* spp., *Cercocarpus montanus, Mahonia repens, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids such as *Carex rossii, Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Leymus salinus (= Elymus salinus)*, and *Poa fendleriana*. Forbs are sparse and may include *Achillea millefolium, Balsamorhiza sagittata*, and *Eriogonum racemosum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine woodland occurs on the North Rim from 2543 to 2579 m (8343-8458 feet) elevation. It occurs on the high-level plateau, on gentle slopes (1 to 6 degrees), on west- or south-facing aspects. It occurs predominantly in sandy loam soils. Stands usually have a high cover of litter (at least 68%), but occasionally this vegetation type can occur in rockier areas, close to the rim. These stands can have up to 25% bedrock cover and up to 37% gravel cover, but are much less typical for the association. Stands sometimes occur in areas with a history of low-intensity fire.

Global Environment: This woodland association has been reported from the Colorado Plateau and eastern Sierra Nevada, from mountains and plateaus in Colorado, Utah and California. Elevation ranges from 1770-2600 m (5800-8500 feet). Sites are dry, warm, mid- to lower slopes, benches and ridgetops often with southerly aspects. Slopes are level to moderate. Soils are typically sandy loams but vary from sand to silt loam. Parent materials are sandstone, limestone and occasionally basalt and andesite.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages about 10% in this association, as open canopies of *Pinus ponderosa* (10%) predominate. The subcanopy is extremely sparse to non-existent, but both *Abies concolor* and *Pinus ponderosa* can occur at 1-2% cover. *Arctostaphylos patula* (22%) is the dominant short shrub and is characteristic of this vegetation type. *Ceanothus fendleri* occurs occasionally at trace covers, yet dwarf-shrubs are very infrequent. *Poa fendleriana* (2%) and occasionally *Carex rossii* (2%) are the primary elements of a sparse graminoid component. *Antennaria parvifolia* and *Pedicularis centranthera* are frequent forbs; however, total forb cover is also very low (less than 2%). *Abies concolor* seedlings occasionally occur at trace covers. Based upon the four stands sampled, this association hosts the lowest species richness of all high-elevation community types in Grand Canyon National Park, with 15 species per 400-square-meter plot.

Global Vegetation: This woodland association is characterized by a tree canopy dominated by *Pinus ponderosa* that is typically open (about 30% cover) but can range from 10-80% cover. Scattered *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer. Others shrub species present may include *Amelanchier utahensis, Ceanothus* spp., *Cercocarpus intricatus, Cercocarpus montanus, Fraxinus anomala, Juniperus communis, Mahonia repens, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids such as *Carex rossii, Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Leymus salinus (= Elymus salinus)*, and *Poa fendleriana*. Forbs are sparse and may include *Achillea millefolium, and Balsamorhiza sagittata*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos patula*
Herb (field)	Dwarf-shurb	*Ceanothus fendleri*
Herb (field)	Forb	*Achillea millefolium, Antennaria parvifolia, Collinsia parviflora, Heterotheca villosa, Pedicularis centranthera, Solidago velutina*
Herb (field)	Graminoid	*Carex rossii, Poa fendleriana*

Herb (field)	Other herbaceous	*Abies concolor, Pinus ponderosa*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus scopulorum, Pinus ponderosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos patula*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Arctostaphylos patula*
Global: *Arctostaphylos patula*, *Pinus ponderosa*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Cryptantha abata* (G3), *Helianthella microcephala* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: Stands of *Arctostaphylos patula* Shrubland (CEGL002696) have experienced high-intensity fire events, and the canopy layer has been completely removed. Before fires, stands were likely examples *Pinus ponderosa* / *Arctostaphylos patula* Woodland (CEGL000842).
Global Comments: This plant association is seral in California.
Global Similar Associations:

- *Abies concolor* / *Arctostaphylos patula* Forest (CEGL000242)
- *Arctostaphylos patula* Shrubland (CEGL002696) has experienced high-intensity fire events, and the canopy layer has been completely removed; before fires, stands were likely examples Pinus ponderosa / Arctostaphylos patula Woodland (CEGL000842).
- *Pseudotsuga menziesii* / *Arctostaphylos patula* Woodland (CEGL000423)

Global Related Concepts:

- *Pinus ponderosa* / *Arctostaphylos patula* Habitat Type (Roberts et al. 1992) **?**
- *Pinus ponderosa* / *Arctostaphylos patula* Habitat Type (Youngblood and Mauk 1985) **?**
- *Pinus ponderosa* / *Arctostaphylos patula* Plant Association (Johnston 1987) **?**
- *Pinus ponderosa*/*Arctostaphylos patula* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the eastern edge of the North Rim. Stands were sampled from near Greenland Lake, Vista Encantada, and on a finger of the rim extending towards Seiber Point.

Global Range: This coniferous woodland association has been reported from the Colorado Plateau (western Colorado and southern Utah) and the eastern Sierra Nevada.
Nations: US
States/Provinces: AZ, CA?, CO:S1, NV, UT:S5, WY
TNC Ecoregions: 6:?, 11:C, 12:P, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331:C, M341A:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Capitol Reef, Cedar Breaks, Grand Canyon, Great Basin, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (4 plots): GRCA.02167, GRCA.03080, GRCA.03143, GRCA.03194.
Local Description Authors: K. Christie

Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Driscoll et al. 1984, Graybosch and Buchanan 1983, Johnston 1987, Reid and Hall 2010, Roberts et al. 1992, Romme et al. 1993, Schulz and Hall 2011, Tendick et al. 2011a, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Pinus ponderosa / *Artemisia tridentata ssp. vaseyana* Woodland

Ponderosa Pine / Mountain Big Sagebrush Woodland
Identifier: CEGL002794

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Artemisia tridentata ssp. vaseyana* Woodland

ELEMENT CONCEPT

Global Summary: This open ponderosa pine woodland is described from the southern Rocky Mountains on sites at 2200 to 2865 m (7215-9400 feet) elevation on dry, moderate to somewhat steep slopes with southerly to easterly aspects. Stands often occur adjacent to sagebrush shrublands. Soils are well-drained or rapidly drained sandy loams and loamy sands derived from granite or sandstone. The vegetation is characterized by an open tree canopy (10-30% cover) dominated by *Pinus ponderosa* with a moderately dense short-shrub layer dominated by *Artemisia tridentata ssp. vaseyana* (10-30% cover). Tree canopy may have low cover of *Pinus edulis, Juniperus osteosperma*, or *Juniperus scopulorum*. The shrub layer may be diverse. Associated shrubs and dwarf-shrubs may include *Amelanchier utahensis, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Mahonia repens, Opuntia fragilis, Paxistima myrsinites, Purshia tridentata, Ribes cereum*, and *Symphoricarpos oreophilus*, usually with <5% cover each. The herbaceous layer ranges from sparse to moderately dense and is typically dominated by graminoids (to 40% cover). Common associates include *Achnatherum hymenoides, Bouteloua gracilis, Elymus* spp., *Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa secunda*, and introduced species *Bromus inermis, Bromus tectorum*, and *Poa pratensis*. Forbs are less significant and few species contribute >1% cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine woodland association occurs in Grand Canyon-Parashant National Monument at 1900 m (6250 feet) elevation. It generally occurs on the high-level plateaus. Slopes are very gentle (1%) and are typically north- or northeast-facing. Soils are moderately well-drained clays or silt clays that typically obscure the underlying geology. Stands have a high cover of litter (58%), which is mostly composed of *Pinus ponderosa* needles and bare soil (35%). There is evidence of fire in some stands.

Global Environment: This open ponderosa pine woodland is described from the southern Rocky Mountains on sites at 2200 to 2865 m (7215-9400 feet) elevation on dry, moderate to somewhat steep slopes (10-49%) with southerly to easterly aspects. Stands often occur adjacent to sagebrush shrublands. Soils are well-drained or rapidly drained sandy loams and loamy sands derived from granite or sandstone. The ground cover is a mosaic of bedrock, gravel, sandy soils, organic litter and duff under trees and boulders.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 7% in this sparse woodland association. This community type supports an open canopy of *Pinus ponderosa* (6% cover) and a subcanopy of *Juniperus osteosperma* (1%). The short shrub *Artemisia tridentata ssp. vaseyana* (6%) dominates the shrub strata, while both tall and dwarf-shrubs are virtually absent. A well-developed graminoid layer (25%) is typically dominated by *Pseudoroegneria spicata* (13%), *Bromus tectorum* (8%), and *Elymus elymoides* (5%). *Chamaesyce albomarginata* (1%), *Lepidium* sp. (1%), and *Tragopogon dubius* (up 1%) are the most frequent forbs in what is usually a fairly sparse layer (3%). Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter plot.

Global Vegetation: This woodland association is characterized by an open tree canopy (10-30% cover) dominated by *Pinus ponderosa* with a moderately dense short-shrub layer dominated by *Artemisia tridentata ssp. vaseyana* (10-30% cover). Tree canopy may have low cover of *Pinus edulis, Juniperus osteosperma*, or *Juniperus scopulorum*. The shrub layer may be diverse. Other shrubs and dwarf-shrubs may include *Amelanchier utahensis, Artemisia frigida, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Mahonia repens, Opuntia fragilis, Paxistima myrsinites, Purshia tridentata, Ribes cereum*, and *Symphoricarpos oreophilus*, usually with <5% cover each. The herbaceous layer ranges from sparse to moderately dense and is typically dominated by graminoids (to 40% cover). Common associates include *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Elymus scribneri, Elymus trachycaulus, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa secunda*, and introduced species *Bromus inermis, Bromus tectorum*, and *Poa pratensis*. Forbs are less significant and few species contribute >1% cover. Possible forbs include *Antennaria* spp., *Achillea millefolium, Artemisia ludoviciana, Eriogonum umbellatum, Heterotheca villosa, Potentilla effusa*, and *Symphyotrichum campestre var. campestre*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata ssp. vaseyana*
Herb (field)	Graminoid	*Pseudoroegneria spicata*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa var. scopulorum*
Short shrub/sapling	Dwarf-shrub	*Artemisia tridentata ssp. vaseyana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata* ssp. *vaseyana*, *Bromus tectorum*, *Chamaesyce albomarginata*, *Elymus elymoides*, *Juniperus osteosperma*, *Pinus ponderosa*, *Pseudoroegneria spicata*, *Tragopogon dubius*
Global: *Artemisia tridentata* ssp. *vaseyana*, *Pinus ponderosa* var. *scopulorum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Ceratocephala testiculata* (exotic), *Convolvulus arvensis* (exotic, Medium/Low), *Malva neglecta* (exotic, Medium/Insignificant), *Tragopogon dubius* (exotic, Medium/Low)
Global: Invasive/Exotic: *Bromus inermis* (invasive/exotic, High/Medium), *Bromus tectorum* (invasive/exotic, High), *Poa pratensis* (invasive, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (26-May-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus ponderosa* / Sparse Understory Woodland (CEGL002384) hosts a similar assemblage of species; however, it has higher *Pinus ponderosa* (11%) and much lower *Artemisia tridentata* (up to 1%) cover. *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848) can occur in similar areas and can host a similar assemblage of species, including *Artemisia tridentata* (2%); however, *Bouteloua gracilis* dominates the graminoid understory.
Global Similar Associations:

- *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848) can occur in similar areas and can host a similar assemblage of species, including *Artemisia tridentata*, but *Bouteloua gracilis* dominates the graminoid understory.

- *Pinus ponderosa* / Sparse Understory Woodland (CEGL002384) has a similar assemblage of species, but, it has higher cover of *Pinus ponderosa* and much lower cover of *Artemisia tridentata*.

Global Related Concepts:
- *Pinus ponderosa* / *Festuca idahoensis* Habitat Type, *Artemisia tridentata* Phase (Mauk and Henderson 1984) ><
- DRISCOLL FORMATION CODE:I.A.9.b. (Driscoll et al. 1984) >
- Ponderosa pine/bitterbrush-Dark soils with no clay layer (Johnston and Huckaby 2001) ><

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, it was sampled from the Shivwits Plateau to the east of Lake Flat.
Global Range: This association is known from the east side of Rocky Mountain National Park and Dinosaur National Park (Douglas Mountain) in Colorado and may extend into northern Utah.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331E:CC, M331I:CC

Federal Lands: NPS (Canyon de Chelly, Dinosaur, Grand Canyon, Grand Canyon-Parashant, Rocky Mountain)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.04156, GRCA.04157.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: CONHP 2010, Coles et al. 2008a, Driscoll et al. 1984, Johnston and Huckaby 2001, Mauk and Henderson 1984, Reid and Hall 2010, Salas et al. 2005, Thomas et al. 2010, Western Ecology Working Group n.d.

***Pinus ponderosa* / *Carex siccata* Woodland**

Ponderosa Pine / Dry-spike Sedge Woodland
Identifier: CEGL005506

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Carex siccata* Woodland

ELEMENT CONCEPT

Global Summary: This ponderosa pine / sedge woodland is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from 2351 to 2695 m (7713-8842 feet) elevation on various landforms, but most commonly on gentle, east- or south-facing sideslopes that range from 1 to 18 degrees and are usually fairly gentle. Soils are well-drained sandy loams or silty loams. Litter ubiquitously dominates the ground cover, but a small amount of downed wood does exist. This association occurs in areas with a low-intensity fire regime, and some stands have burned recently. Open stands of *Pinus ponderosa* dominate the canopy and subcanopy. *Abies concolor* occurs sporadically. *Ceanothus fendleri* and *Mahonia repens* are occasionally present, but the shrub strata are notably sparse. *Carex siccata* is the most dominant and abundant component of the understory. Forb composition is variable, and at least 70 different species can occur at low covers. Notable species include *Achillea millefolium, Lotus utahensis, Lupinus argenteus*, and *Geranium richardsonii*. *Pteridium aquilinum* occurs occasionally. *Populus tremuloides* seedlings are ubiquitous at low cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / sedge woodland occurs on the North Rim from 2351 to 2695 m (7713-8842 feet) elevation. It occurs on various landforms, but most commonly on gentle, east- or south-facing sideslopes. Slopes range from 1 to 18 degrees and are usually fairly gentle (8%). Soils are well-drained

sandy loams or silty loams. Litter ubiquitously dominates the ground cover (86%), but a small amount of downed wood (3%) does exist. This association occurs in areas with a low-intensity fire regime, and some stands have burned recently.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 17% in this association. Open stands of *Pinus ponderosa* of up to 25% cover (typically 11%) dominate the canopy of this vegetation type. The subcanopy is also predominantly composed of *Pinus ponderosa*; however, conifer species including *Abies concolor* do occur sporadically (at less than 4% cover). *Ceanothus fendleri* and *Mahonia repens* are occasionally present, but the shrub strata are notably sparse. *Carex siccata* is the most dominant and abundant component of the understory. It typically occurs at 8% cover, but occasionally can be quite thick (up to 30% cover). Forb composition is variable, and at least 70 different species can occur at low covers. Total forb cover is typically 3-4%. Notable species include *Achillea millefolium* (up to 2% cover), *Lotus utahensis* (up to 2% cover), *Lupinus argenteus* (up to 7% cover), and *Geranium richardsonii* (up to 2% cover). *Pteridium aquilinum* (5%) occurs occasionally. *Populus tremuloides* seedlings are ubiquitous at low cover (1-5%). Based upon the 11 stands sampled, this association has slightly above-average species richness (27 species per 400-square-meter plot) for forested community types in Grand Canyon National Park.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	Pinus ponderosa
Herb (field)	Graminoid	Carex siccata
Herb (field)	Fern or fern ally	Pteridium aquilinum
Herb (field)	Other herbaceous	Pinus ponderosa, Populus tremuloides

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Lactuca serriola* (exotic, Low/Insignificant), *Taraxacum officinale* (exotic), *Verbascum thapsus* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) occurs in perhaps slightly more xeric sites and is characterized by the dominance of *Poa fendleriana* in the understory. *Carex siccata* is essentially absent.

Global Similar Associations:

- *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) occurs in perhaps slightly more xeric sites and is characterized by the dominance of *Poa fendleriana* in the understory; *Carex siccata* is essentially absent.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled in scattered locations across the North Rim. It is known from the Walhalla Plateau, along the Widforss Trail, south of The Basin, in the vicinity of Kanabownits Canyon, and from Walla Valley.

Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (11 plots): GRCA.02096, GRCA.02100, GRCA.02108, GRCA.02137, GRCA.02169, GRCA.02199, GRCA.03090, GRCA.03091, GRCA.03103, GRCA.03165, GRCA.03173.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Pinus ponderosa / *Poa fendleriana* Woodland

Ponderosa Pine / Muttongrass Woodland
Identifier: CEGL005507

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Poa fendleriana* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is currently known from El Malpais National Monument in New Mexico, Grand Canyon-Parashant National Monument, Lake Mead National Recreation Area and Grand Canyon National Park in Arizona. This association occurs between 1900 and 2537 m (6250-8323 feet) in elevation on moderately steep slopes of volcanic cinder cones, plateaus, and gentle sideslopes across all aspects. The ground surface is dominated by pumice gravels and scattered grasses and litter at El Malpais and predominantly litter in Arizona. These open-canopied (10-25% cover) tall woodlands are dominated by *Pinus ponderosa* with short-statured conifers such as *Juniperus scopulorum* or *Pinus edulis* sometimes present in the subcanopy. Shrubs are few and sparse, although *Quercus gambelii, Mahonia repens*, and *Ceanothus fendleri* are common, and the understory is characterized by scattered bunch grasses. *Poa fendleriana* is the dominant and can be well-represented to abundant, and *Koeleria macrantha* is common along with deer sedges (e.g., *Carex geophila* and *Carex rossii*). Forbs are scattered and variable and may include *Achillea millefolium, Allium cernuum, Antennaria parvifolia, Artemisia dracunculus, Artemisia ludoviciana, Bahia dissecta, Glandularia bipinnatifida, Hymenopappus filifolius, Hymenoxys richardsonii, Lactuca serriola, Lithospermum multiflorum*, and *Mentzelia multiflora var. integra*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / muttongrass woodland occurs throughout Grand Canyon National Park in fairly xeric, plateau environments. In Grand Canyon-Parashant National Monument/Lake Mead, it occurs at approximately 1900 m (6250 feet) elevation across all aspects on the flat plateau or on gentle sideslopes (typically 3degrees). On the South Rim, it occurs from 2034 to 2237 m (6673-7339 feet) elevation across all aspects on the flat plateau or on gentle sideslopes (typically 5 degrees). On the North Rim, it occurs from 2170 to 2537 m (7119-8323 feet) elevation on the plateau or on gentle sideslopes (with an average of 7-degree slope, but often much flatter). On the North Rim, this association seems to occur on all aspects as well, expect those which are prominently north-facing. Soils are composed of silt clays, silt loams, and sandy or silty loams. Litter ubiquitously dominates the ground cover throughout the park. It averages 94% in Parashant, 77% on the South Rim (with 8% bare ground), and 85% on the North Rim. This association occurs in areas with low-intensity fire regimes.
Global Environment: This association occurs between 1900 and 2537 m (6250-8323 feet) in elevation on moderately steep slopes of volcanic cinder cones, plateaus, and gentle sideslopes across all aspects. The ground surface is dominated by pumice gravels and scattered grasses and litter at El Malpais and predominantly litter in Arizona. Soils are composed of cinder, silt clays, silt loams, and sandy or silty loams.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 20% in this association. Open canopies of *Pinus ponderosa* (typically 15% cover, but sometimes up to 40%) on dry plateaus characterize this vegetation type. A subcanopy of *Pinus ponderosa* may or may not be present. When it occurs, the subcanopy typically occupies about 9% cover, but in areas that have not burned, the subcanopy cover can be as high as 40%. Various shrub species occur occasionally, but this association lacks a defined shrub layer. *Quercus gambelii, Mahonia repens*, and *Ceanothus*

fendleri are common shrub components, but almost always at less than 3% cover. The ubiquitous *Poa fendleriana* occurs is all stands (typically at 3% cover, but sometimes at up to 8%) and is characteristic of the sparse understory in this association. Other graminoids, including *Carex geophila, Elymus elymoides, Bouteloua gracilis*, and *Muhlenbergia montana*, may be present but are typically less dominant than *Poa fendleriana*. At least 125 different forb species may be present, but the forb stratum itself is somewhat sparse, usually encompassing 3-4% cover. Tree regeneration is quite uncommon; however, a trace cover of *Pinus ponderosa* seedlings occurs in about half of the stands. Based upon the 38 stands sampled, this association hosts below-average species diversity for forested communities in Grand Canyon, with only 18 species per 400-square-meter plot. The often heavy ground cover of conifer litter likely contributes to this pattern, as it precludes the establishment of forbs.

Global Vegetation: These open-canopied (10-25% cover) tall woodlands are dominated by *Pinus ponderosa* with short-statured conifers such as *Juniperus scopulorum* or *Pinus edulis* sometimes present in the subcanopy. Subcanopy cover may be quite high (up to 40%) in the absence of fire. This association generally lacks a shrub layer, although *Quercus gambelii, Mahonia repens*, and *Ceanothus fendleri* are common, and the understory is characterized by scattered bunch grasses. *Poa fendleriana* is the dominant and can be well-represented to abundant, and *Koeleria macrantha* is common along with deer sedges (e.g., *Carex geophila* and *Carex rossii*). Forbs are scattered and variable and may include *Achillea millefolium, Allium cernuum, Antennaria parvifolia, Artemisia dracunculus, Artemisia ludoviciana, Bahia dissecta, Glandularia bipinnatifida, Hymenopappus filifolius, Hymenoxys richardsonii, Lactuca serriola, Lithospermum multiflorum*, and *Mentzelia multiflora var. integra*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Herb (field)	Forb	*Eriogonum racemosum*
Herb (field)	Graminoid	*Carex geophila, Elymus elymoides, Poa fendleriana*
Herb (field)	Other herbaceous	*Pinus ponderosa*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Global: *Pinus ponderosa*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Pinus ponderosa* / *Carex siccata* Woodland (CEGL005506) also supports an open canopy of *Pinus ponderosa*, lacks shrub layers, and is typically more mesic or occurs at higher elevations. *Carex siccata*, as opposed to *Poa fendleriana*, is the dominant graminoid.

Global Similar Associations:

- *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848)
- *Pinus ponderosa* / *Carex siccata* Woodland (CEGL005506) also supports an open canopy of *Pinus ponderosa*, lacks shrub layers, and is typically more mesic or occurs at higher elevations; *Carex siccata*, as opposed to *Poa*

fendleriana, is the dominant graminoid.

- *Pinus ponderosa* / Sparse Understory Woodland (CEGL002384)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is the most predominant ponderosa pine woodland in Grand Canyon National Park and occurs throughout the park. It was sampled in Grand Canyon-Parashant National Monument/Lake Mead from the Pleasant Valley area, between Mountain Dellenbaugh and Yellow John Mountain. It was sampled from across the South Rim, including near Desert View, southeast of Grandview Point, southwest of Shoshone Point, and in the vicinity of Bright Angel Wash to the southwest of the developed area. It was sampled across the North Rim, from Powell Plateau, Fire Point, Swamp Point, Walla Valley, The Dragon, near Tiyo Point, Widforss Point, and on the Walhalla Plateau where it is extremely prevalent.
Global Range: This association is currently documented from El Malpais National Monument, Grand Canyon National Park, Grand Canyon-Parashant National Monument, and Lake Mead National Recreation Area, but is likely widespread throughout similar environments in the Southwest.
Nations: US
States/Provinces: AZ, NM
TNC Ecoregions: 19:C, 21:C
USFS Ecoregions (1994/95): 313B:CC
Federal Lands: NPS (El Malpais, Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (38 plots): GRCA.02089, GRCA.02094, GRCA.02104, GRCA.02107, GRCA.02115, GRCA.02121, GRCA.02124, GRCA.02129, GRCA.02131, GRCA.02134, GRCA.02136, GRCA.02154, GRCA.02157, GRCA.02159, GRCA.02162, GRCA.02172, GRCA.02173, GRCA.02190, GRCA.02198, GRCA.02222, GRCA.02228, GRCA.02230, GRCA.02234, GRCA.02235, GRCA.03067, GRCA.03071, GRCA.03086, GRCA.03094, GRCA.03095, GRCA.03098, GRCA.03104, GRCA.03135, GRCA.03140, GRCA.03149, GRCA.03202, GRCA.03210, GRCA.04158(LAME), GRCA.04159(LAME).
Local Description Authors: K. Christie
Global Description Authors: A. Kennedy and E. Muldavin, mod. M.E. Hall
References: Muldavin et al. 2011a, Reid and Hall 2010, Western Ecology Working Group n.d.

***Pinus ponderosa / Pteridium aquilinum* Woodland**

Ponderosa Pine / Bracken Fern Woodland
Identifier: CEGL002944

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Pteridium aquilinum* Woodland

ELEMENT CONCEPT

Global Summary: This association has only been described from Zion National Park. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / brackenfern woodland occurs on the North Rim from 2520 to 2542 m (8268-8340 feet) elevation. It occurs on south- and east-facing sideslopes and plateaus. Slopes are typically low to moderate (up to 16 degrees), and soils are well-drained sandy loams. Stands have very high litter cover (typically 88%). This vegetation type tends to occur in smaller patches among a mosaic of various other mixed-conifer communities. Stands typically show evidence of low- to mid-intensity fires, as evidenced by burned *Populus tremuloides* snags.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 20% in this association. *Pinus*

ponderosa (at up to 13% cover) solely comprises the canopy. *Abies concolor* and *Populus tremuloides* are common components of the subcanopy but at low covers (up to 3%). Both tall and short shrubs are lacking; however, the dwarf-shrub*Ceanothus fendleri* occasionally occurs in trace amounts. *Carex siccata* (6%) and *Poa fendleriana* (2%) are common; however, graminoids are never as abundant as *Pteridium aquilinum* in this association. The abundant *Pteridium aquilinum* can occur at up to 25% cover, but must occupy at least 15% cover to characterize this association. *Lotus utahensis* and *Packera multilobata* are common forbs, and the total forb layer usually occupies about 5% cover. *Populus tremuloides* regeneration is very common, and seedlings may be present at up to 10% cover. Based upon the three stands sampled, this association displays typical species-richness for forested communities on the North Rim, with 25 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tree subcanopy	Needle-leaved tree	*Abies concolor*
Tree subcanopy	Broad-leaved deciduous tree	*Populus tremuloides*
Herb (field)	Forb	*Lotus utahensis, Packera multilobata*
Herb (field)	Graminoid	*Carex siccata, Poa fendleriana*
Herb (field)	Fern or fern ally	*Pteridium aquilinum*
Herb (field)	Other herbaceous	*Populus tremuloides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Pteridium aquilinum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Lactuca serriola* (exotic, Low/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled on the North Rim on the plateau near the head of Bright Angel Creek and the Widforss Trail, and also from the plateau between Kanabownits Canyon and Crystal Creek.
Global Range: This association has currently only been described from Zion National Park in southwestern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02109, GRCA.02187, GRCA.03175.
Local Description Authors: K. Christie
Global Description Authors:
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

Pinus ponderosa / Purshia stansburiana Woodland

Ponderosa Pine / Stansbury's Cliffrose Woodland
Identifier: CEGL000854

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa / Purshia stansburiana* Woodland

ELEMENT CONCEPT

Global Summary: These woodlands occur in central Arizona near the southern limit of *Pinus ponderosa*, and may also occur in central New Mexico north into Colorado, Utah, Wyoming and Idaho. Elevation ranges from 2240-2440 m. Sites often have a rough and rocky topography, but include flat and undulating terrain. Substrates are rocky, shallow, sandy textured soils typically derived from limestone, but also the association may also occur on sandstone and igneous parent materials. Stands have an open (>10% cover) tree canopy that is dominated by the needle-leaved evergreen tree, *Pinus ponderosa*. Other tree species present may include *Pinus edulis, Juniperus osteosperma, Juniperus scopulorum, Quercus gambelii*, and occasionally *Pseudotsuga menziesii*. The short-shrub layer has 5-25% cover with the deciduous shrub *Purshia stansburiana (= Purshia mexicana var. stansburiana)* being diagnostic of this type. Other common shrub species include *Artemisia nova, Purshia tridentata, Rhus trilobata, Quercus gambelii, Mahonia repens, Yucca baccata* and *Yucca glauca*. The relatively sparse (5-25% cover) herbaceous layer is dominated by graminoids such as *Muhlenbergia montana, Bouteloua* spp., *Aristida arizonica, Poa fendleriana*, and *Elymus elymoides* with scattered forbs such as *Heterotheca villosa, Solidago* spp., *Eriogonum racemosum*, and *Tradescantia pinetorum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / cliffrose woodland occurs on the North Rim at about 2350 m (7700 feet) elevation in xeric areas at the transition between pinyon-juniper and ponderosa pine woodlands. It occurs on the high-level plateau, on flat or gentle slopes, across all aspects. It occurs near the rim or on fingers of the rim that extend towards the canyon. Soils are typically rapidly-drained silt loams. Stands have a high cover of litter (about 85%) and some exposed rock and gravel (about 10%). This community experiences a "rim effect" microclimate which is much more representative of lower elevations than of the North Rim proper.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover is typically very sparse in this association, averaging less than 10% cover. The sparse canopy is comprised of *Pinus ponderosa* (5%), while *Pinus edulis* and *Juniperus osteosperma* make up the similarly sparse subcanopy. The tall-shrub stratum is particularly well-developed in this association and averages about 11% cover. The characteristic *Purshia stansburiana* (5%), as well as *Cercocarpus ledifolius* (2%), *Quercus turbinella* (2%), *Quercus gambelii* (1%), and *Cercocarpus montanus* (1%), are frequent. *Arctostaphylos pungens* (2%) is also common in the short-shrub layer. Various lower elevation dwarf-shrubs, including *Ericameria nauseosa* and *Opuntia polyacantha*, are present at up to 1% cover each. Graminoid cover is typically about 4%, with *Poa fendleriana* being the most abundant component (2% cover). A suite of typically lower-elevation forbs include *Eriogonum racemosum, Hymenopappus filifolius, Phlox austromontana*, and *Tetraneuris acaulis*. This vegetation type has a strong association with lower-elevation communities and seems to be experiencing a xeric "rim effect" microclimate, as is evidenced by the assemblage of species present. Based upon the single classification plot sampled, this vegetation type hosts above-average species richness for North Rim community types, with 32 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*

Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus ledifolius, Cercocarpus montanus, Purshia stansburiana, Quercus turbinella*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos pungens*
Herb (field)	Dwarf-shurb	*Ericameria nauseosa, Escobaria vivipara, Opuntia polyacantha, Tetradymia canescens*
Herb (field)	Forb	*Eriogonum racemosum, Hymenopappus filifolius, Phlox austromontana, Tetraneuris acaulis*
Herb (field)	Graminoid	*Bouteloua gracilis, Carex geophila, Elymus elymoides, Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Purshia stansburiana*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Cirsium wheeleri* (G3G4), *Draba rectifructa* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (19-Sep-2000). This association has only been described from Arizona on the Sitgreaves National Forest near Pinedale, and the higher elevation plateaus of Grand Canyon National Park, but these woodlands likely occur extensively along the Mogollon Rim. This type appear stable with over 20 occurrences estimated. Threats include overgrazing by livestock and introduced plant species. The role of fire in this woodland type is not known. The ranges of the dominant/diagnostic species extends into New Mexico, Colorado, Wyoming, Utah and Idaho, and the association may occur there, but information is not available. In Utah, *Purshia stansburiana* hybridizes with *Purshia tridentata* and *Purshia glandulosa* which may make distinguishing these woodlands from similar associations difficult. More survey is needed to determine the extent of this association. The rank was changed from G3 to G3? to emphasize the uncertainty about the extent and condition of these woodlands.

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: In Utah, *Purshia stansburiana* hybridizes with *Purshia tridentata* and *Purshia glandulosa* which may make distinguishing these woodlands from similar associations difficult. More survey is needed to determine the extent of this association.
Global Similar Associations:

- *Purshia stansburiana* Shrubland (CEGL002957)

Global Related Concepts:

- *Pinus ponderosa* / *Purshia stansburiana* Woodland (Stuever and Hayden 1997b) >
- *Pinus ponderosa*/*Cowania mexicana* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from a single classification plot and was sampled on the North Rim on an unnamed point between Grama Point and Point Sublime.
Global Range: This association has been described from sites on the Sitgreaves National Forest and Grand Canyon National Park in central and north-central Arizona, and likely occurs elsewhere on the Mogollon Rim.
Nations: US
States/Provinces: AZ:S3, CO?, ID?, NM?, UT?
TNC Ecoregions: 19:C, 21:C
USFS Ecoregions (1994/95): M313A:CC
Federal Lands: NPS (Grand Canyon); USFS (Apache-Sitgreaves)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot):

GRCA.03180.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, FEIS 1996, Larson and Moir 1987, Reid and Hall 2010, Stuever and Hayden 1997a, Stuever and Hayden 1997b, Warren et al. 1982, Western Ecology Working Group n.d.

Pinus ponderosa / *Quercus gambelii* Woodland

Ponderosa Pine / Gambel Oak Woodland
Identifier: CEGL000870

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Quercus gambelii* Woodland

ELEMENT CONCEPT

Global Summary: This major ponderosa pine woodland is widespread and has been reported from foothills, mountains and plateaus from Colorado to Texas, west to Arizona and Nevada. Elevation ranges from 1830-2800 m (6000-9200 feet). Stands often occur along drainages, on lower and middle slopes and benches on all aspects. Soils are typically shallow and rocky, ranging from sandy loams to clay loams. At El Malpais National Monument in western New Mexico, it generally occurs on rolling lava plateaus, steep sideslopes of volcano craters, on gentle toeslopes of low cinder hills, or on sandstone outcrops. Substrates are derived from basalt or sandstone, with rock, gravel, and occasional patches of sandy soil. Litter is often abundant in patches. *Pinus ponderosa* dominates or sometimes codominates the sparse to moderately dense tree canopy with *Pinus edulis* and *Juniperus* spp. *Pseudotsuga menziesii* is accidental and *Abies concolor* is not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the typically moderately dense tall-shrub layer consisting of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more treelike, and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Artemisia tridentata ssp. vaseyana, Pinus edulis*, and *Juniperus osteosperma* are often present. At El Malpais, *Forestiera pubescens* is the most commonly occurring shrub, along with occasional *Ribes cereum*. Other common shrub species may include *Amelanchier* spp., *Mahonia repens*, and *Rosa woodsii*. The herbaceous layer is generally sparse and composed of mostly graminoids and scattered forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / Gambel oak woodland occurs on both the South Rim and North Rim of Grand Canyon National Park. On the South Rim, it occurs from 2205 to 2230 m (7234-7316 feet) elevation, and on the North Rim it occurs from 2170 to 2553 m (7119-8376 feet). In both locations this vegetation type inhabits upper sideslopes or plateaus, often on moderately steep slopes (typically 16 degrees). It tends to occur on north-facing aspects, in sandy loam or silty loam soils. Stands have a high cover of ground litter (83%). Many stands occur in areas which have experienced low-intensity fire regimes in the past; there is little evidence of recent burns in this community type.
Global Environment: This woodland association is widespread and has been reported from foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Nevada. Elevation ranges from 1830-2800 m (6000-9200 feet). Stands often occur along drainages, on lower and middle slopes and benches on all aspects. Slopes are typically gentle or moderate, but may also be steep (>45%). Soils are typically shallow and rocky ranging from sandy loams to clay loams. Parent materials are commonly sandstones, but fractured limestone, basalt, andesite, and alluvium are also reported. At El Malpais National Monument in western New Mexico, it gently occurs on rolling lava plateaus, steep sideslopes of volcano craters, on gentle toeslopes of low cinder hills, or on sandstone outcrops. Substrates are derived from basalt or sandstone, with rock, gravel, and occasional patches of sandy soil. High litter cover (70-90%) about 5 cm deep is common in many stands. Rock outcrops (about 10%) and some bare soil are not uncommon. This conifer woodland transitions to *Quercus gambelii* shrubland in drier sites and at lower elevations. This community is the highest elevation *Pinus ponderosa* / oak woodland present in Trans-Pecos Texas. It typically

grades downslope to *Pinus ponderosa* / *Quercus hypoleucoides* Woodland (CEGL000872).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 20% in this association. *Pinus ponderosa* (17%) is the sole component of the open canopy, while both *Pinus ponderosa* and *Abies concolor* occur occasionally in the subcanopy (at up to 4% cover each). *Quercus gambelii* is the dominant and characteristic tall shrub of this vegetation type, and typically occupies over 10% cover. Some stands have as little as 4% cover of *Quercus gambelii*, while others have up to 25%. In more recently burned areas, *Quercus gambelii* may exists as a short shrub (less than 2 m tall). The short-shrub stratum typically averages about 6-7% per stand. Species vary but can include *Amelanchier utahensis* and scattered *Robinia neomexicana*. Dwarf-shrubs are infrequent to absent. *Poa fendleriana* (6%) is the most abundant graminoid, while both *Elymus elymoides* (2%) and *Bromus tectorum* (trace cover) frequently occur. Forb cover averages about 6%, and at least 70 different forb species can occur. *Erigeron flagellaris, Packera multilobata*, and *Eriogonum racemosum* are common components of the understory, and the less frequently *Lathyrus laetivirens* and *Solidago velutina* can occur at relatively high covers. Tree regeneration is essentially absent from this community type. Based upon the seven stands sampled, this association has slightly above-average species richness for wooded community types with 28 species per 400-square-meter plot.

Global Vegetation: This broadly defined coniferous woodland is widespread and is characterized by a sparse to moderately closed evergreen needle-leaved tree canopy dominated by *Pinus ponderosa*, or sometimes codominated by *Pinus edulis* and scattered *Juniperus scopulorum, Juniperus monosperma*, or *Juniperus osteosperma*. In southern stands *Juniperus deppeana* and *Pinus strobiformis* may be present to codominant. *Pseudotsuga menziesii* is accidental and *Abies concolor* is not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the typically moderately dense tall-shrub layer, which consists of dense clumps of oak. This community must have at least 5% cover of *Quercus gambelii*, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more treelike, and *Symphoricarpos oreophilus* will be present with significant cover in a short-shrub layer. At lower elevations, scattered *Artemisia tridentata ssp. vaseyana, Pinus edulis*, and *Juniperus osteosperma* are often present. At El Malpais, *Forestiera pubescens* is the most commonly occurring shrub, along with occasional *Ribes cereum*. Other common shrub species may include *Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Juniperus communis, Mahonia repens, Robinia neomexicana, Rosa woodsii*, and *Shepherdia rotundifolia*. The herbaceous layer is generally sparse (<10% cover) but may equal the shrub cover. It is composed of mostly graminoids, such as *Bouteloua gracilis, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia longiligula, Muhlenbergia montana, Poa fendleriana, Schizachyrium scoparium*, and *Carex* spp., especially *Carex geyeri* and *Carex rossii*. Scattered forbs include *Artemisia ludoviciana, Balsamorhiza sagittata, Eriogonum* spp., *Erigeron* spp., *Hymenoxys* spp., *Lithospermum multiflorum, Packera multilobata*, and *Wyethia amplexicaulis*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Herb (field)	Forb	*Erigeron flagellaris, Eriogonum racemosum, Lupinus argenteus, Machaeranthera canescens, Packera multilobata*
Herb (field)	Graminoid	*Elymus elymoides, Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tall shrub/sapling	Broad-leaved deciduous tree	*Quercus gambelii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Quercus gambelii*
Global: *Pinus ponderosa*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Pinus ponderosa* / *Robinia neomexicana* Woodland (CEGL005374) also supports an open canopy of *Pinus ponderosa* and a prominent tall-shrub layer; however, *Robinia neomexicana*, as opposed to *Quercus gambelii*, dominates the stratum. *Quercus gambelii* occurs occasionally but at less than 5% cover. This community occurs in more recently burned areas, as *Robinia neomexicana* regenerates vigorously post-fire.
Global Comments: This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report seven phases for this plant association: the *Quercus gambelii, Festuca arizonica, Muhlenbergia longiligula, Pinus edulis, Muhlenbergia montana, Bouteloua gracilis*, and *Robinia neomexicana* phases. More classification review is needed to further define the relationships between these phases and other similar plant associations.
Global Similar Associations:

- *Abies concolor - (Pseudotsuga menziesii)* / *Quercus gambelii* / *Carex rossii* Forest (CEGL005351)
- *Abies concolor - (Pseudotsuga menziesii)* / *Quercus gambelii* / *Thalictrum fendleri* Forest (CEGL005352)
- *Abies concolor* / *Quercus gambelii* Forest (CEGL000261)
- *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland (CEGL000791)
- *Pinus monophylla - Juniperus osteosperma - Quercus gambelii* / *Artemisia tridentata* Woodland (CEGL000837)
- *Pinus monophylla - Quercus gambelii* / *Artemisia tridentata* Woodland (CEGL000838)
- *Pinus ponderosa* / *Robinia neomexicana* Woodland (CEGL005374) also supports an open canopy of *Pinus ponderosa* and a prominent tall-shrub layer; however, *Robinia neomexicana*, as opposed to *Quercus gambelii*, dominates the stratum.
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest (CEGL000452)

Global Related Concepts:

- *Pinus ponderosa* / *Poa fendleriana* Community Type (Hanks et al. 1983) =
- *Pinus ponderosa* / *Quercus gambelii* / *Carex geyeri* Habitat Type (Hess and Wasser 1982) =
- *Pinus ponderosa* / *Quercus gambelii* / *Carex geyeri* Habitat Type (Wasser and Hess 1982) =
- *Pinus ponderosa* / *Quercus gambelii* Community (Blackburn et al. 1969e) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (Fitzhugh et al. 1987) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (Alexander et al. 1987) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (DeVelice et al. 1986) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (Muldavin et al. 1996) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (Youngblood and Mauk 1985) =
- *Pinus ponderosa* / *Quercus gambelii* Habitat Type (Alexander et al. 1984a) =
- *Pinus ponderosa* / *Quercus gambelii* Plant Association (Stuever and Hayden 1997b) =
- *Pinus ponderosa* / *Quercus gambelii* Plant Association (Johnston 1987) =
- *Pinus ponderosa* / *Quercus gambelii* Plant Association (Larson and Moir 1987) =
- *Pinus ponderosa* / *Quercus gambelii* Plant Community (Roberts et al. 1992) =
- *Pinus ponderosa*/*Quercus gambelii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- Ponderosa Pine Series (Diamond 1993) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled from the South Rim along the East Rim Drive, in the vicinity of Buggein Hill and Buggein Tank. It was sampled on the North Rim from the Cape Royal parking area, Uncle Jim Point, Powell Plateau, and Fire Point.
Global Range: This ponderosa pine woodland association is widespread in the southern Rocky Mountains and southwestern U.S. and occurs in foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Ari-

zona and Nevada.
Nations: US
States/Provinces: AZ:S3?, CO:S4, NM:S5, NV, TX:S3, UT:S5, WY
TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 21:C, 22:C, 24:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313C:CC, 313D:CC, 321A:CC, 331I:CC, 331J:CC, 341B:CC, 341F:CC, 341G:CC, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M331I:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Canyon de Chelly, Capitol Reef, Capulin Volcano, Curecanti, El Malpais, El Morro, Grand Canyon, Grand Canyon-Parashant, Guadalupe Mountains, Sunset Crater Volcano, Walnut Canyon, Zion); USFS (Apache-Sitgreaves, Arapaho-Roosevelt, Cibola, Gila, Lincoln, San Juan, White River NF)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (7 plots): GRCA.02087, GRCA.02091, GRCA.02111, GRCA.02117, GRCA.02130, GRCA.02231, GRCA.02232.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles and M.E. Hall
References: Alexander et al. 1984a, Alexander et al. 1987, Bader 1932, Blackburn et al. 1969d, Blackburn et al. 1969e, Bourgeron and Engelking 1994, Bradley et al. 1992, Bunin 1975c, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Clary 1992, Cogan et al. 2004, Coles et al. 2010, DeVelice et al. 1986, Diamond 1993, Dixon 1935, Donart et al. 1978a, Driscoll et al. 1984, Fitzhugh et al. 1987, Hanks et al. 1983, Hansen et al. 2004a, Hansen et al. 2004c, Hanson and Ball 1928, Harmon 1980, Helm 1977, Hess and Wasser 1982, Johnston 1987, Johnston and Hendzel 1985, Larson and Moir 1987, Madany and West 1980b, Marr et al. 1973a, Muldavin et al. 1996, Muldavin et al. 2011a, Muldavin et al. 2011d, Nixon 1967b, Peet 1975, Peet 1981, Reid and Hall 2010, Roberts et al. 1992, Romme et al. 1993, Salas and Bolen 2010a, Savage and Swetnam 1990, Schmoll 1935, Somers et al. 1980, Steinhoff 1978, Stuever and Hayden 1997b, TNHS unpubl. data, Tendick et al. 2010, Tendick et al. 2011b, Terwilliger et al. 1979a, Thomas et al. 2010, USFS 1983b, WNDD unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Wright et al. 1973, Youngblood and Mauk 1985

***Pinus ponderosa* / *Robinia neomexicana* Woodland**

Ponderosa Pine / New Mexico Locust Woodland
Identifier: CEGL005374

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / *Robinia neomexicana* Woodland

ELEMENT CONCEPT

Global Summary: This association is only known to occur at Bandelier National Monument in north-central New Mexico. The current description is based on data received from there and will be updated when additional inventory data are available. This mid-elevation association occurs on sites with moderate to high solar exposure that increases with elevation. Sites vary from gentle on rolling mesatops (5-20% slope) to moderate slopes on the shoulders and upper slopes of canyons (up to 30% slope). Soils are primarily mapped as well-developed, finer-textured Alfisols or Mollisols derived from rhyolitic colluvium and slope alluvium, and occasionally as rocky Inceptisols or rock outcrop. The ground surface is characterized by scattered bunch grasses and sedges intermixed with litter and bare soil. Most stands occur on sites that have been burned by wildfire within the last 30 years. Elevation ranges from 2050 to 2630 m (6700-8625 feet).
This is a tall coniferous woodland that ranges from open woodland to closed-canopied forest with canopy coverage ranging from 20 to >60%. *Pinus ponderosa* is dominant in the overstory, and seedlings and saplings may be present in the understory. Other conifers such as *Pseudotsuga menziesii, Pinus flexilis*, and *Juniperus monosperma* are rare or incidental. A well-developed shrub layer is diagnostic, with *Robinia neomexicana* dominant and well-represented with cover as high as 40%. *Quercus gambelii* may be present but cover is less than 5%. Other common shrubs that may be present include *Ceanothus fendleri* and *Rosa woodsii*. The herbaceous layer is also well-developed and diverse. Dominant graminoids include *Elymus elymoides, Koeleria macrantha, Muhlenbergia montana*, and *Poa fendleriana*.

Numerous *Carex* species may also be present. Sites that were artificially seeded after fire may be dominated (up to 90% cover) by introduced species such as *Bromus inermis*, *Elymus trachycaulus ssp. trachycaulus*, *Festuca idahoensis*, and *Pascopyrum smithii*. While forbs are diverse, composition is variable and usually less than 5% total cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine / New Mexico locust woodland occurs on the North Rim from 2334 to 2694 m (7657-8839 feet) elevation. It mostly occurs on flat or gentle slopes (1 to 6 degrees) of the plateau, on south-facing aspects. It can also occasionally occur on steeper sideslopes (up to 25 degrees) on south-facing aspects. Soils are typically silt loam or sandy loam. Stands typically have a high ground cover of litter (81%). This association occurs in areas that have experienced recent, low-intensity burns.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover is typically less than 15% in this association. A very open canopy of *Pinus ponderosa* occurs in all stands, while the subcanopy is essentially non-existent. *Robinia neomexicana* is the dominant and characteristic shrub in this vegetation type. It almost always occurs as a short shrub but can rarely occur as a tall shrub (greater than 2 m). *Robinia neomexicana* averages 13% cover but can occur at up to 35% cover in some stands. The dwarf-shrub stratum is essentially absent. *Poa fendleriana* (2%) and *Carex rossii* (2%) are the dominant graminoids. Forb composition is quite variable, and at least 65 different species can occur. Forb cover averages 3-4%. *Pinus ponderosa* and *Populus tremuloides* seedlings occur occasionally at about 1% cover each. Based upon the 11 stands sampled, this association has slightly below-average species richness for wooded communities in Grand Canyon National Park, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Robinia neomexicana*
Herb (field)	Dwarf-shurb	*Mahonia repens*
Herb (field)	Forb	*Eriogonum racemosum*
Herb (field)	Graminoid	*Carex rossii, Poa fendleriana*
Herb (field)	Other herbaceous	*Pinus ponderosa, Populus tremuloides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Robinia neomexicana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Conyza canadensis* (exotic), *Lactuca serriola* (exotic, Low/Insignificant), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jan-2009).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus ponderosa* / *Quercus gambelii* Woodland (CEGL000870) also supports an open canopy of *Pinus ponderosa* and a prominent tall-shrub layer; however, *Quercus gambelii*, as opposed to *Robinia neomexicana*, dominates the stratum. This is a later-successional community type and occurs in areas that have not burned as recently.
Global Similar Associations:

- *Pinus ponderosa* / *Quercus gambelii* Woodland (CEGL000870) also supports an open canopy of *Pinus ponderosa* and a prominent tall-shrub layer; however, *Quercus gambelii*, as opposed to *Robinia neomexicana*, dominates the stratum; it is a later-successional community type and occurs in areas that have not burned recently.

Global Related Concepts:

- *Pinus ponderosa* / *Quercus gambelii* Cover Type (Balice et al. 1997) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs throughout the North Rim, and no apparent geographical distribution pattern exits. It occurs in areas that have recently experienced low-intensity fires. It was sampled from the Walhalla Plateau, on the eastern edge of the North Rim from the Walhalla Glades, from Point Imperial, The Dragon, Galahad Point, Kanabownits Canyon, Rainbow Plateau, and Swamp Ridge.
Global Range: This association is only known to occur at Bandelier National Monument in north-central New Mexico.
Nations: US
States/Provinces: AZ, NM
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC
Federal Lands: NPS (Bandelier, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (11 plots): GRCA.02122, GRCA.02138, GRCA.02191, GRCA.03068, GRCA.03069, GRCA.03102, GRCA.03110, GRCA.03112, GRCA.03114, GRCA.03128, GRCA.03181.
Local Description Authors: K. Christie
Global Description Authors: K.S. King after A. Browder and E. Muldavin
References: Balice et al. 1997, Hibner 2009, Muldavin et al. 2011b, Reid and Hall 2010, Western Ecology Working Group n.d.

Pinus ponderosa / Sparse Understory Woodland

Ponderosa Pine / Sparse Understory Woodland
Identifier: CEGL002384

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Forest & Woodland (G228)
Association	*Pinus ponderosa* / Sparse Understory Woodland

ELEMENT CONCEPT

Global Summary: This open woodland association has been described from Capitol Reef and Bryce Canyon national parks. It occurs on the bottoms and sides of intermittent stream drainages, in depressions between small hills and in valleys. Sites are gentle to moderately steep (2- to 27-degree slopes), occur between 2111 and 2592 m in elevation, and are oriented to all aspects. The unvegetated ground surface has low to high cover of litter and duff, low to high cover of small rocks, sparse to low amounts of bare soil, and sparse to moderate cover of downed wood. Litter and duff depths range from 0.2-2.8 cm in one stand. Soils are moderately well-drained and are derived from Navajo sandstone, the Kaiparowitz, Claron and Straight Cliff formations, and are often re-deposited as alluvium. Total vegetation cover ranges up to 65% and is characterized by an open canopy, typically 15-20 m tall, of *Pinus ponderosa* trees that range in cover from 4-60%. A subcanopy layer of 2- to 5-m tall *Pinus edulis*, *Juniperus osteosperma, Juniperus scopulorum*, and *Pseudotsuga menziesii* trees provides sparse cover. Shrubs that may be present include *Artemisia frigida, Arctostaphylos patula, Chrysothamnus viscidiflorus, Purshia tridentata, Tetradymia canescens, Artemisia nova, Symphoricarpos oreophilus*, and *Gutierrezia sarothrae*. The herbaceous layer is floristically diverse and provides sparse cover. Common graminoids include *Poa fendleriana*, *Carex rossii, Leymus salinus (= Elymus salinus)*, and *Muhlenbergia montana*. Forbs commonly present are *Stephanomeria minor (= Stephanomeria tenuifolia, Erysimum capitatum (= Erysimum asperum)*, and *Lithospermum multiflorum*. Tree saplings may provide sparse cover stand and include *Pinus ponderosa* and *Juniperus scopulorum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine woodland association occurs in Grand Canyon-Parashant National Monument on the high-level plateau at 1850 to 1900 m (6100-6200 feet) elevation. It occurs on essentially flat slopes, and thus aspect seems to have little influence on its distribution. Soils are moderately well-drained silty clays. Litter (90%) overwhelmingly dominates the ground cover. This community type typically occurs in areas that have experienced past fire events.
Global Environment: It occurs on the bottoms and sides of intermittent stream drainages, in depressions between small hills and in valleys. Sites are gentle to moderately steep (2- to 27-degree slopes), occur between 2111 and 2592 m in elevation, and are oriented to all aspects. The unvegetated ground surface has low to high cover of litter and duff, low to high cover of small rocks, sparse to low amounts of bare soil, and sparse to moderate cover of downed wood. Litter and duff depths range from 0.2-2.8 cm in one stand. Soils are moderately well-drained and are derived from Navajo sandstone, the Kaiparowitz, Claron and Straight Cliff formations, and are often re-deposited as alluvium.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This community is characterized by an open canopy of *Pinus ponderosa* (8-12%) and a stark lack of shrub, graminoid, and forb components in the understory. Often, scattered *Juniperus osteosperma* (2%) and *Pinus ponderosa* (2%) form a sparse subcanopy. While shrubs are essentially lacking, sporadic *Quercus gambelii* and *Artemisia tridentata* may occur in some stands at trace covers. Graminoids are similarly sparse; *Elymus elymoides* often occurs at trace cover, and *Eragrostis cilianensis* (trace) occurs in some stands. Forb cover usually averages about 1% (but may occasionally be somewhat higher). *Phlox* sp., *Penstemon linarioides*, and *Portulaca oleracea* are common members of the understory. Based upon the 5 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.
Global Vegetation: Total vegetation cover ranges up to 65% and is characterized by an open canopy, typically 15-20 m tall, of *Pinus ponderosa* trees that range in cover from 4-60%. A subcanopy layer of 2- to 5-m tall *Pinus edulis, Juniperus osteosperma, Juniperus scopulorum*, and *Pseudotsuga menziesii* trees provides sparse cover. Shrubs that may be present include *Artemisia frigida, Arctostaphylos patula, Chrysothamnus viscidiflorus, Purshia tridentata, Tetradymia canescens, Artemisia nova, Symphoricarpos oreophilus*, and *Gutierrezia sarothrae*. The herbaceous layer is floristically diverse and provides less than 5% total cover. Common graminoids include *Poa fendleriana, Carex rossii, Leymus salinus (= Elymus salinus)*, and *Muhlenbergia montana*. Forbs commonly present are *Stephanomeria minor (= Stephanomeria tenuifolia, Erysimum capitatum (= Erysimum asperum)*, and *Lithospermum multiflorum*. Tree saplings may provide sparse cover and include *Pinus ponderosa* and *Juniperus scopulorum*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma, Pinus ponderosa*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Elymus elymoides*, *Juniperus osteosperma*, *Penstemon linarioides*, *Pinus ponderosa*, *Portulaca oleracea*
Global: *Pinus ponderosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Convolvulus arvensis* (exotic, Medium/Low), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Mar-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) also supports an open canopy of *Pinus ponderosa*, sparse to non-existent shrub strata, and a fairly sparse understory; however, *Poa fendleriana* (3%) is common in the relatively well-developed graminoid layer. *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848) also supports an open canopy of *Pinus ponderosa*, lacks shrub strata, and has a fairly sparse understory; however, *Bouteloua gracilis* (2%) is common in a relatively well-developed graminoid layer.
Global Comments: This association is similar to *Pinus ponderosa* Sparse Woodland [Park Special] from Bryce Canyon, which differs in the very sparse canopy (<5% total cover).
Global Similar Associations:

- *Pinus ponderosa* / *Artemisia tridentata ssp. vaseyana* Woodland (CEGL002794)
- *Pinus ponderosa* / *Bouteloua gracilis* Woodland (CEGL000848) also supports an open canopy of *Pinus ponderosa*, lacks shrub strata, and has a fairly sparse understory; however, *Bouteloua gracilis* is common in a relatively well-developed graminoid layer.
- *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) also supports an open canopy of *Pinus ponderosa*, sparse to non-existent shrub strata, and a fairly sparse understory; however, *Poa fendleriana* is common in the relatively well-developed graminoid layer.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is from Grand Canyon-Parashant National Monument, where it was sampled on the Shivwits Plateau east of Mount Dellenbaugh.
Global Range: This association is known from Capitol Reef and Bryce Canyon national parks. It is likely to occur in isolated canyons throughout the Colorado Plateau.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Capitol Reef, Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.04160, GRCA.04181, GRCA.04185, GRCA.04212, GRCA.04228.
Local Description Authors: K. Christie
Global Description Authors: G. Kittel
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2011b, Western Ecology Working Group n.d.

G229. Southern Rocky Mountain Ponderosa Pine Savanna

Pinus ponderosa / *Bouteloua gracilis* Woodland

Ponderosa Pine / Blue Grama Woodland
Identifier: CEGL000848

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain Ponderosa Pine Savanna (G229)
Association	*Pinus ponderosa* / *Bouteloua gracilis* Woodland

ELEMENT CONCEPT

Global Summary: This widespread woodland occurs at foothill and lower montane elevations from the southern

Rocky Mountains, extending east onto southern Great Plains escarpments, south to the mountains of western Texas, and west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Sites occur on dry, gentle to steep slopes of all aspects, but are more common on southern and western aspects, especially at higher elevations, which ranges from 1740-2610 m (5700-8550 feet). Substrates are quite variable and include shallow sandy loam soils derived from granitic parent materials, coarse cinder soils, and clayey soil with or without high coarse fragment content. The ground surface is typically characterized by scattered grass patches and litter amid exposed soil. The vegetation is characterized by an open to moderately dense evergreen, needle-leaved tree canopy 10-30 m tall that is typically dominated by *Pinus ponderosa*. Some stands may be codominated by *Pinus edulis*. *Juniperus* spp. may be important subdominants. The shrub canopy is variable and usually low in cover. *Ericameria nauseosa, Fallugia paradoxa*, and *Gutierrezia sarothrae* are the most common shrub elements. The typically moderately dense herbaceous layer has greater cover than the shrub layer and is dominated by graminoids. The warm-season, sod-forming shortgrass *Bouteloua gracilis* dominates the herbaceous layer; *Poa fendleriana, Elymus elymoides*, and *Muhlenbergia montana* are all frequent associates but subordinate. Forb cover is typically sparse or well-represented and most commonly includes semi-arid woodland and plains grassland species such as *Artemisia carruthii, Sphaeralcea coccinea, Bahia dissecta, Hymenoxys richardsonii, Glandularia bipinnatifida, Lotus wrightii*, and *Heterotheca villosa*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ponderosa pine woodland occurs in Grand Canyon-Parashant National Monument/Lake Mead from 1884 to 1902 m (6181-6240 feet) elevation in fairly xeric environments. It occurs on the high-level plateau and on gentle sideslopes. Slopes are very gentle (1-2%) and are typically south- or west-facing. Soils are moderately or well-drained silt clays. Stands have a high cover of litter (76%), which is mostly composed of *Pinus ponderosa* needles, and sometimes moderate cover of basaltic rock or gravel (up to 22%). There is evidence of low-intensity fire in some stands.

Global Environment: This widespread woodland occurs at foothill and lower montane elevations from the southern Rocky Mountains, extending east onto southern Great Plains escarpments, south to the mountains of western Texas, and west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona and Utah. Elevation ranges from 1740-2610 m (5700-8550 feet). Sites occur on dry, gentle to steep slopes of all aspects, but are more common on southern and western aspects, especially at higher elevations. Substrates are quite variable and include shallow sandy loam soils derived from granitic parent materials, coarse cinder soils, and clayey soil with or without high coarse fragment content.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 12% in this association. This community type supports open canopies of *Pinus ponderosa* (7% cover) and a mixed subcanopy of *Juniperus osteosperma* (6%), *Pinus ponderosa* (1%), and *Pinus monophylla* (1%). *Artemisia tridentata* (2%) and *Gutierrezia sarothrae* (2%) are the dominant components of the sparse short-shrub and dwarf-shrub layers, respectively. *Bouteloua gracilis* is the most abundant and characteristic graminoid at 2% cover, but potentially occurs at much higher cover in wetter years. *Chamaesyce albomarginata (= Euphorbia albomarginata), Penstemon linarioides*, and *Phlox* sp. are common components of the extremely sparse forb layer (1% cover). Seedlings of *Pinus monophylla* are often present at low covers (0-1%) as well.

Global Vegetation: This plant association is characterized by an open to moderately dense evergreen, needle-leaved tree canopy 10-30 m tall that is typically dominated by *Pinus ponderosa*. Some stands may be codominated by *Pinus edulis*. *Juniperus monosperma, Juniperus osteosperma, Juniperus deppeana*, or *Juniperus scopulorum* may be important subdominants. The shrub canopy is variable and usually low in cover. *Ericameria nauseosa, Fallugia paradoxa*, and *Gutierrezia sarothrae* are the most common shrub elements. Other shrubs may include scattered *Artemisia tridentata, Ceanothus fendleri, Cercocarpus montanus, Chrysothamnus viscidiflorus, Purshia tridentata, Quercus grisea, Rhus trilobata*, and *Tetradymia canescens*. The typically moderately dense herbaceous layer has greater cover than the shrub layer and is dominated by graminoids. The warm-season, sod-forming shortgrass *Bouteloua gracilis* dominates the herbaceous layer. Common graminoid associates include *Aristida* spp., *Bouteloua hirsuta, Carex geophila, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, or *Schizachyrium scoparium*. *Quercus gambelii* may be present in the sparse shrub layer (<10% cover) with low cover (<5%). Forb cover is typically sparse and may include species such as *Antennaria* spp., *Artemisia ludoviciana, Artemisia carruthii,*

Sphaeralcea coccinea, Bahia dissecta, Hymenoxys richardsonii, Glandularia bipinnatifida, Lotus wrightii, Heterotheca villosa, Erigeron spp., *Eriogonum racemosum, Chaetopappa ericoides, Packera neomexicana*, and *Penstemon* spp.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Pinus ponderosa*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Forb	*Chamaesyce albomarginata*
Herb (field)	Graminoid	*Bouteloua gracilis, Poa fendleriana*
Herb (field)	Other herbaceous	*Pinus monophylla*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa*
Herb (field)	Graminoid	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Global: *Bouteloua gracilis*, *Pinus ponderosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Convolvulus arvensis* (exotic, Medium/Low), *Eragrostis cilianensis* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION

Status: Standard

Classification Confidence: 1 - Strong

Grand Canyon National Park Comments: *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) also supports an open canopy of *Pinus ponderosa*, sparse to non-existent shrub strata, and a sparse understory; however, *Poa fendleriana*, as opposed to *Bouteloua gracilis*, is the major graminoid component.

Global Comments: This ponderosa pine woodland is a broadly defined plant association. Stuever and Hayden (1997b) report 6 phases: the *Bouteloua gracilis, Schizachyrium scoparium, Andropogon hallii, Artemisia tridentata, Quercus grisea*, and *Quercus gambelii* phases. Hanks et al. (1983) described 4 phases of the *Pinus ponderosa* / *Bouteloua gracilis* Habitat Type from northern Arizona. More classification review is needed to further define the relationships between these phases and other similar plant associations. Alexander et al. (1987), DeVelice et al. (1986), and Muldavin et al. (1996) also described phases of this Habitat Type that need further review and cross-walking to the USNVC. Youngblood and Mauk (1985) included stands of this association in their broadly defined *Pinus ponderosa* / *Muhlenbergia montana* Habitat Type.

Global Similar Associations:

- *Pinus ponderosa* / *Artemisia tridentata ssp. vaseyana* Woodland (CEGL002794)
- *Pinus ponderosa* / *Muhlenbergia montana* Woodland (CEGL000862)
- *Pinus ponderosa* / *Poa fendleriana* Woodland (CEGL005507) also supports an open canopy of *Pinus ponderosa*, sparse to non-existent shrub strata, and a sparse understory; however, *Poa fendleriana*, as opposed to *Bouteloua gracilis*, is the major graminoid component.
- *Pinus ponderosa* / Sparse Understory Woodland (CEGL002384)

Global Related Concepts:

- *Pinus edulis - P. ponderosa* / *Bouteloua gracilis - Carex* spp. Plant Community (Francis 1986) =

- *Pinus ponderosa - Juniperus / Bouteloua gracilis* Plant Association (Johnston 1987) =
- *Pinus ponderosa / Bouteloua gracilis* Habitat Type (Fitzhugh et al. 1987) =
- *Pinus ponderosa / Bouteloua gracilis* Habitat Type (Alexander et al. 1987) =
- *Pinus ponderosa / Bouteloua gracilis* Habitat Type, *Bouteloua gracilis* Phase (DeVelice et al. 1986) =
- *Pinus ponderosa / Bouteloua gracilis* Habitat Type, *Bouteloua gracilis* Phase (Muldavin et al. 1996) =
- *Pinus ponderosa / Bouteloua gracilis* Habitat Type, *Pinus edulis* Phase (Hanks et al. 1983) =
- *Pinus ponderosa / Bouteloua gracilis* Plant Association (Stuever and Hayden 1997b) =
- *Pinus ponderosa / Bouteloua gracilis* Plant Association (Johnston 1987) =
- *Pinus ponderosa / Bouteloua gracilis* Plant Association (Larson and Moir 1987) =
- *Pinus ponderosa / Carex* spp. - *Bouteloua gracilis* Plant Community (Francis 1986) =
- *Pinus ponderosa / Muhlenbergia montana* Habitat Type (Youngblood and Mauk 1985) =
- *Pinus ponderosa/Bouteloua gracilis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- Ponderosa Pine Series (Diamond 1993) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs in Grand Canyon-Parashant National Monument/ Lake Mead near Lake Flat and Pleasant Valley, to the northeast of Mount Dellenbaugh.
Global Range: This ponderosa pine woodland occurs in the southern Rocky Mountains, extending east on southern Great Plains escarpments as far as Oklahoma, south to the mountains of western Texas, west to the Colorado Plateau and Mogollon Rim of New Mexico, Arizona, and southern Utah.
Nations: US
States/Provinces: AZ:S4, CO:S4, NM:S4, OK, TX:S3, UT, WY
TNC Ecoregions: 9:C, 19:C, 20:C, 21:C, 24:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 321A:CC, 331:C, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M331J:CC
Federal Lands: NPS (Bandelier, Canyon de Chelly, El Malpais, Grand Canyon, Grand Canyon-Parashant, Sunset Crater Volcano, Walnut Canyon); USFS (Cibola)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.04127, GRCA.04170, GRCA.04199.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. K.S. King and M.E. Hall
References: Alexander et al. 1987, Bourgeron and Engelking 1994, Bradley et al. 1992, Bruner 1931, CONHP 2010, CONHP unpubl. data 2003, DeVelice et al. 1986, Diamond 1993, Driscoll et al. 1984, Fitzhugh et al. 1987, Francis 1986, Hanks et al. 1983, Hansen et al. 2004a, Hansen et al. 2004c, Hibner 2009, Hoagland 2000, Johnston 1987, Larson and Moir 1987, Madany and West 1980b, Muldavin et al. 1996, Muldavin et al. 2011a, Muldavin et al. 2011b, Reid and Hall 2010, Savage and Swetnam 1990, Stuever and Hayden 1997b, TNHS unpubl. data, Thomas et al. 2010, WNDD unpubl. data, Western Ecology Working Group n.d., Wright and Bailey 1980, Youngblood and Mauk 1985

G226. Southern Rocky Mountain White Fir - Douglas-fir Dry Forest

Abies concolor - Pseudotsuga menziesii / Carex rossii Forest

White Fir - Douglas-fir / Ross' Sedge Forest
Identifier: CEGL000431

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest

ELEMENT CONCEPT

Global Summary: This minor forest association has been described from the southern Rocky Mountains in

northern Colorado and New Mexico and possibly Arizona. Stands are found on gentle to typically steep (5-65%), north- to northwest-facing slopes with shallow, coarse-textured, well-drained colluvium at elevations of 1670-2930 m. Stands are recognized by the moderately dense tree canopy dominated by *Pseudotsuga menziesii*, although *Pinus ponderosa* and *Juniperus scopulorum* may be present with nearly equal cover. The short-shrub layer is sparse and represented by widely scattered *Juniperus communis* and *Physocarpus monogynus*. *Carex rossii* is the only significant graminoid (4-15% cover), although *Carex inops, Carex occidentalis, Koeleria macrantha, Leucopoa kingii (= Festuca kingii)*, and *Poa fendleriana* may be present. Common forbs include *Achillea millefolium var. occidentalis (= Achillea lanulosa), Campanula rotundifolia, Cystopteris fragilis, Fragaria virginiana, Heuchera bracteata, Pulsatilla patens ssp. multifida (= Pulsatilla ludoviciana), Saxifraga rhomboidea*, and *Thalictrum fendleri*. Overstory shade is needed for successful regeneration of *Pseudotsuga*. These forests were originally subject to a high natural fire frequency. Recently, fire-suppression activities have resulted in unnaturally high sapling densities, as well as increased fuel loads. Sapling densities have resulted in a decreasing reproductive success of the shade-intolerant *Pinus ponderosa* relative to *Pseudotsuga menziesii*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2516 to 2634 m (8522-8642 feet) elevation. It occurs most commonly on south-facing aspects of plateaus and sideslopes; however, there is some variation as to the landform, topographic position, and aspect on which it is found. Slopes are gentle with an average grade of 8 degrees. This association occurs in well-drained or rapidly drained silt loams and sandy loams. Soil obscures surface geology. Litter ubiquitously dominates ground cover (75-88%), and a small amount of wood (2-6%) also occurs. This association occurs in areas essentially devoid of gravel, rock, and bedrock, as well as moss cover. There is evidence of low severity fires on most plots.

Global Environment: This minor forest association has been described from the mountains of northern Colorado and northern New Mexico and ranges from 1670 to 2930 m (5700-9640 feet) in elevation. Stands are found on gentle shoulder and toeslopes to steep sideslopes of mountains and canyons (5-65%) often on cooler northeast- to northwest-facing slopes and on southerly slopes at higher elevations. Ground cover is dominated by leaf litter with some exposed soil and rock. Substrates are shallow, well-drained, coarse-textured, often skeletal colluvial soils derived from gneiss, granite, schist, volcanic andesite, rhyolite, and rhyolitic tuffs (Hess 1981, Hess and Alexander 1986).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Open, sparse canopies of *Abies concolor* (2-13%) and *Pinus ponderosa* (5-8%) dominate this dry, mixed-conifer association. There is a distinct subcanopy of *Abies concolor* (3-8%); with a small component of *Pinus ponderosa* as well as scattered *Populus tremuloides* regeneration. This association essentially lacks a shrub layer; however, *Robinia neomexicana* and *Mahonia repens* infrequently occur. *Carex rossii* characteristically dominates the understory at low cover (up to 5%), while *Poa fendleriana* (up to 5%) and *Elymus elymoides* (up to 1%) are also frequent. *Pedicularis centranthera, Lotus utahensis*, and *Eriogonum racemosum* are the most common forbs; however, over 40 species can occur at very low cover. Seedlings of *Abies concolor, Pinus ponderosa*, and *Populus tremuloides* are quite frequent, although at extremely low cover. This association has among the lowest species richness for high-elevation community types within Grand Canyon National Park, with an average of 22 species per plot (400 square meters).

Global Vegetation: This minor forest association is characterized by a moderately dense tree canopy dominated by *Pseudotsuga menziesii*, although *Pinus ponderosa*, *Abies concolor*, and *Juniperus scopulorum* may be present with nearly equal cover. Remnant early-seral *Populus tremuloides* tree can be present in the canopy. The short-shrub layer is sparse and represented by widely scattered *Juniperus communis* and *Physocarpus monogynus*. The *Carex rossii*-dominated herbaceous layer characterizes the understory with 4-15% cover (Hess 1981, Hess and Alexander 1986). Other graminoids present include *Carex inops, Carex occidentalis, Leucopoa kingii (= Festuca kingii), Koeleria macrantha*, and *Poa fendleriana*. Forbs are sparse, but may be diverse, and include *Achillea millefolium var. occidentalis (= Achillea lanulosa), Campanula rotundifolia, Cystopteris fragilis, Fragaria virginiana, Heuchera bracteata, Pulsatilla patens ssp. multifida (= Pulsatilla ludoviciana), Saxifraga rhomboidea*, and *Thalictrum fendleri*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
Herb (field)	Graminoid	*Carex rossii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Carex rossii*, *Muhlenbergia montana*, *Pedicularis centranthera*, *Pinus ponderosa*, *Poa fendleriana*, *Pseudostellaria jamesiana*
Global: *Abies concolor*, *Carex rossii*, *Pinus ponderosa*, *Poa fendleriana*, *Pseudotsuga menziesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Other: *Pyrola picta* (G4G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2? (10-Dec-1999). This minor association has been described from the mountains of Colorado and may also occur in New Mexico and Arizona. Less than 20 occurrences are estimated to occur across this association's range. Stands may be restricted to steep north- to northwest-facing slopes. More survey work is needed to determine the full extent of this plant association, thus the rank is G2?.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This forest association is based on quantitative data from several classification studies, primarily along Colorado's Front Range that described *Pseudotsuga menziesii*-dominated conifer forests (Hess 1981, Peet 1981, Wasser and Hess 1982, Hess and Alexander 1986). The concept of this association was broadened to include *Abies concolor - Pseudotsuga menziesii* mixed-canopy stands with an abundant herbaceous layer dominated by *Carex rossii* that occur in northern New Mexico (Muldavin et al. 2006) and moved to the *Abies concolor* Forest Alliance (A.152). The similar *Pseudotsuga menziesii* / *Physocarpus monogynus* Forest (CEGL000449) has higher shrub coverage (14-35%) by *Physocarpus monogynus*. Also, *Pinus ponderosa* / *Carex rossii* Forest (CEGL000183) may occur in adjacent stands, but that association is dominated by *Pinus ponderosa* and does not occur on north to northwest exposures. Over time and with continued effective fire suppression, these *Pinus ponderosa* stands may convert to *Pseudotsuga menziesii*-dominated stands.
Global Similar Associations:
- *Abies concolor - Pseudotsuga menziesii* / *Carex siccata* Forest (CEGL000244) is perhaps slightly more mesic and can have very low cover of *Picea*, and *Populus tremuloides* tends to be more prominent in both the canopy and regenerational layers. *Carex rossii* can be present here; however, *Carex siccata* is the dominant graminoid.
- *Abies concolor - Pseudotsuga menziesii* / *Robinia neomexicana* Woodland (CEGL000891) is another dry, mixed-conifer type, but it has a well-developed shrub layer of *Robinia neomexicana* and *Populus tremuloides*. Both *Carex rossii* and *Carex siccata* are present in the understory.
- *Pinus ponderosa* / *Carex rossii* Forest (CEGL000183)
- *Pseudotsuga menziesii* / *Leucopoa kingii* Woodland (CEGL000904)
- *Pseudotsuga menziesii* / *Muhlenbergia montana* Forest (CEGL000443)
- *Pseudotsuga menziesii* / *Physocarpus monogynus* Forest (CEGL000449)

Global Related Concepts:
- *Abies concolor* / *Carex rossii* Forest (Muldavin et al. 2006) <
- *Pseudotsuga menziesii* / *Carex rossii* Forest (Muldavin et al. 2006) <
- *Pseudotsuga menziesii* / *Carex rossii* Habitat Type (Hess and Alexander 1986) =
- *Pseudotsuga menziesii* / *Carex rossii* Habitat Type (Wasser and Hess 1982) =
- *Pseudotsuga menziesii* / *Carex rossii* Habitat Type (Hess 1981) =
- *Pseudotsuga menziesii* / *Carex rossii* Plant Association (Johnston 1987) =
- *Pseudotsuga menziesii*/*Carex rossii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >
- Xeric *Pinus ponderosa* Forest (B3) (Peet 1975) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled on the North Rim from the Walhalla Plateau, Fuller Canyon, and Thompson Canyon.
Global Range: This montane forest association has been described from the southern Rocky Mountains of northern Colorado, northern New Mexico and possibly northern Arizona. More survey is needed to locate stands in southern Colorado.
Nations: US
States/Provinces: AZ, CO:S2, NM, NV, WY
TNC Ecoregions: 11:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC, M331I:CC, M341A:CC
Federal Lands: NPS (Bandelier, Grand Canyon, Great Basin); USFS (Arapaho-Roosevelt, Roosevelt)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (6 plots): GRCA.02153, GRCA.02170, GRCA.02206, GRCA.03079, GRCA.03145, GRCA.03146.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: R.J. Rondeau, mod. K.A. Schulz
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Driscoll et al. 1984, Hess 1981, Hess and Alexander 1986, Johnston 1987, Muldavin et al. 2006, Muldavin et al. 2011b, NMNHP unpubl. data, Peet 1975, Peet 1981, Reid and Hall 2010, Schulz and Hall 2011, WNDD unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d.

Abies concolor / Cercocarpus ledifolius Woodland

White Fir / Curl-leaf Mountain-mahogany Woodland
Identifier: CEGL000885

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor / Cercocarpus ledifolius* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association has only been described in Utah. It is most frequently found in the Pine Valley Mountains of southwestern Utah, but also occurs on the Wasatch, Paunsaugunt and Tavaputs plateaus, the Tushar and Pahvant mountains of the Fishlake National Forest, and Bryce Canyon National Park. This community ranges from 2130-2860 m (7000-9400 feet) elevation on gentle to steep, straight or convex slopes with northern exposures. This association is found primarily on andesitic volcanics but also on other igneous and sedimentary substrate. Surface soils are mostly loam and silt loam. *Abies concolor* is the climax tree for this association, although few mature stands have been observed. *Pseudotsuga menziesii* and *Pinus ponderosa* dominate the sites as the major seral species, with *Pinus flexilis* and *Juniperus scopulorum* occurring more infrequently and in smaller amounts as minor seral species. The shrub layer is often dense, with *Cercocarpus ledifolius, Quercus gambelii, Amelanchier alnifolia, Mahonia repens (= Berberis repens)*, and *Symphoricarpos oreophilus* commonly present. *Carex rossii* and *Poa fendleriana* are the most characteristic graminoids. Forbs are negligible.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This uncommon white fir woodland occurs on the North Rim at roughly 2400 m (7900 feet) elevation in rimrock environments. It is documented from a high-level sideslope derived from limestone. Slopes are steep (44 degrees) and are typically north-facing. Soils are well-drained sandy loams. Stands have approximately 30% cover of limestone-derived bedrock, rock, and gravel, as well as 60% litter cover. This association favors steep, rocky environments on the edge of the rim, and it usually occurs in small, scattered patches.
Global Environment: This community ranges from 2130-2860 m (7000-9400 feet) elevation on gentle to steep, straight or convex slopes with northern exposures. This association is found primarily on andesitic volcanics but

also on other igneous and sedimentary substrate. Surface soils are mostly loam and silt loam. Most sites have high amounts of exposed rock and bare soil with litter accumulations averaging 2.6 cm.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 38% in this association. *Abies concolor* ubiquitously dominates the tree canopy at approximately 36% cover. *Cercocarpus ledifolius* is the major component of the tall-shrub stratum (3% cover), while *Amelanchier utahensis* and *Holodiscus dumosus* are also present at 1% cover. Common short shrubs include *Chamaebatiaria millefolium*, *Fendlerella utahensis*, and *Shepherdia rotundifolia* (all at roughly 1% cover). Dwarf-shrubs include *Symphoricarpos rotundifolius* (1%), while *Poa fendleriana* is the most abundant graminoid (2% cover). Common forbs include *Heuchera rubescens* and *Penstemon barbatus*. Seedlings of *Abies concolor* and *Pseudotsuga menziesii* occur at low cover (1%). This community seems to host below-average species richness for North Rim vegetation types (with 18 species per 400-square-meter plot); however, this value is based upon a single classification plot.

Global Vegetation: *Abies concolor* is the climax tree for this association, although few mature stands have been observed. *Pseudotsuga menziesii* and *Pinus ponderosa* dominate the sites as the major seral species, with *Pinus flexilis* and *Juniperus scopulorum* occurring more infrequently and in smaller amounts as minor seral species. The shrub layer is often dense, with *Cercocarpus ledifolius*, *Quercus gambelii*, *Amelanchier alnifolia*, *Mahonia repens (= Berberis repens)*, and *Symphoricarpos oreophilus* commonly present. *Carex rossii* and *Poa fendleriana* are the most characteristic graminoids. Forbs are negligible.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies concolor*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis, Holodiscus dumosus*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus ledifolius*
Short shrub/sapling	Broad-leaved deciduous shrub	*Chamaebatiaria millefolium, Fendlerella utahensis, Shepherdia rotundifolia*
Herb (field)	Dwarf-shurb	*Symphoricarpos rotundifolius*
Herb (field)	Graminoid	*Poa fendleriana*
Herb (field)	Other herbaceous	*Abies concolor, Pseudotsuga menziesii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Cercocarpus ledifolius*, *Chamaebatiaria millefolium*, *Fendlerella utahensis*, *Heuchera rubescens*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Shepherdia rotundifolia* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Grand Canyon National Park Comments: This association is quite uncommon in Grand Canyon National Park and is characterized by dominance of *Cercocarpus ledifolius* in the tall-shrub stratum. This association is more common farther north in Utah.

Global Similar Associations:

- *Cercocarpus ledifolius* / *Quercus gambelii* Woodland (CEGL005359)
- *Pseudotsuga menziesii* / *Cercocarpus ledifolius* Woodland (CEGL000897)

Global Related Concepts:

- *Abies concolor/Cercocarpus ledifolius* (Bourgeron and Engelking 1994) =

- DRISCOLL FORMATION CODE:II.A.2.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is documented by a single classification plot from near Cape Final on the North Rim.
Global Range: This association has only been described in Utah. It is most frequently found in the Pine Valley Mountains of southwestern Utah, but also occurs on the Wasatch, Paunsaugunt and Tavaputs plateaus, the Tushar and Pahvant mountains of the Fishlake National Forest, and Bryce Canyon National Park.
Nations: US
States/Provinces: AZ, NV, UT:S4?, WY
TNC Ecoregions: 9:C, 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M331D:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Grand Canyon, Great Basin); USFS (Fishlake)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02105.
Local Description Authors: K. Christie
Global Description Authors: L.D. Engelking
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Mauk and Henderson 1984, Reid and Hall 2010, Schulz and Hall 2011, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Abies concolor - Pseudotsuga menziesii / Carex siccata Forest

White Fir - Douglas-fir / Dry-spike Sedge Forest
Identifier: CEGL000244

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor - Pseudotsuga menziesii / Carex siccata* Forest

ELEMENT CONCEPT

Global Summary: This high-elevation forest is codominated by *Abies concolor* and *Pseudotsuga menziesii* with infrequent *Abies lasiocarpa*. Shrub cover is usually low, but *Acer glabrum* can be common on moister sites. The ground is covered by a dense sod dominated by *Carex siccata (= Carex foenea)* often with *Bromus ciliatus var. richardsonii (= Bromus richardsonii), Poa pratensis, Carex rossii*. Common forbs include *Achillea millefolium var. occidentalis (= Achillea lanulosa), Campanula rotundifolia, Fragaria virginiana ssp. glauca (= Fragaria ovalis), Geranium richardsonii, Hymenoxys hoopesii (= Helenium hoopesii), Lathyrus lanszwertii var. leucanthus (= Lathyrus lanszwertii var. arizonicus), Pteridium aquilinum, Pseudocymopterus montanus, Senecio wootonii*, and *Vicia americana*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2339 to 2710 m (7674-8891 feet) elevation. It tends to occur on south- and west-facing slopes of plateaus or sideslopes; however, stands also occur locally in more mesic areas such as in drainages or in shaded areas. This association usually occurs on high levels or low slopes; slopes range from 2 to 22 degrees, with an average of 10 degrees. Soils are primarily well-drained or rapidly drained silt loams and sandy loams. A high percentage of litter (70-90%) dominates the ground cover, and downed wood (0-15%) is also common. This association occurs in areas essentially devoid of gravel, rock, and bedrock, as well as moss cover. One-third of the sampled plots display a history of fire, and this community seems to support a relatively heavy fuel load in unburned stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Open canopies of *Pinus ponderosa* (up to 10%), *Populus tremuloides* (up

to 10%), with scattered *Abies concolor* (2-15%) and *Pseudotsuga menziesii* (2-7%) dominate this dry, mixed-conifer association. There is a distinct and extremely frequent subcanopy of *Abies concolor* (1-20%). *Pseudotsuga menziesii* (1-5%) and *Populus tremuloides* (1-8%) occur in the subcanopy as well, while *Picea* is quite infrequent. This association can have a sparse shrub layer composed of a variety of species, including *Juniperus communis, Mahonia repens*, and *Ceanothus fendleri*. *Carex siccata* dominates the understory of this association with an average of 4% cover, but it can occur at up to 12% cover in some areas. *Poa fendleriana* (to 4%) and *Bromus ciliatus* (to 3%) are also common components. *Carex rossii* occurs but never with the frequency or dominance of *Carex siccata*. *Achillea millefolium, Pedicularis centranthera, Fragaria virginiana, Packera multilobata*, and *Lotus utahensis* are the most common forbs, all of which occur at low cover (0-3%). Seedlings of *Populus tremuloides* (0-12%) and *Abies concolor* (1-8%) are ubiquitous and occur on essentially all plots, while seedlings of *Pinus ponderosa* and *Pseudotsuga menziesii* occur about half of the time at 0 to 1% cover. Forest litter (81%) ubiquitously dominates the ground cover, and downed wood (6%) is also frequent. Very little rock or gravel, and essentially no moss cover exists. Species richness is typical for high-elevation forested communities on the North Rim, with an average of 27 species per 400-square-meter plot.

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Bromus ciliatus*, *Carex rossii*, *Carex siccata*, *Mahonia repens*, *Pedicularis centranthera*, *Pinus ponderosa*, *Poa fendleriana*, *Populus tremuloides*, *Pseudotsuga menziesii*, *Pteridium aquilinum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ligusticum porteri* (G3G4); **Invasive/Exotic**: *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic); **Other**: *Corallorhiza maculata* (G5), *Goodyera oblongifolia* (G5?), *Pyrola chlorantha* (G5), *Pyrola picta* (G4G5), *Ribes viscosissimum* (G5)
Global: Vulnerable: *Ligusticum porteri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (13-Nov-1997). This plant association is known only from the higher elevations of the Pinaleno and Santa Catalina mountains, below the elevational zone where *Abies lasiocarpa* occurs. Catastrophic events such as spruce budworm epidemics and wildfire could threaten the persistence of this association because of the limited number of sites and acreage. Forest clearing reduces tree reproduction because of increased competition with graminoids. Grazing potential for livestock is high so there is the possibility for livestock-related disturbance such as overgrazing and introduction of exotic species.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:

- *Abies concolor - (Pseudotsuga menziesii) / Thalictrum fendleri* Forest (CEGL005353)
- *Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest (CEGL000431) is perhaps slightly more xeric. It lacks *Picea* in the subcanopy, and *Populus tremuloides* tends to be more prominent in both the canopy and regeneration layers. *Carex siccata* is essentially absent from the understory.
- *Abies concolor - Pseudotsuga menziesii / Robinia neomexicana* Woodland (CEGL000891) is another dry, mixed-conifer type, but it has a well-developed shrub layer of *Robinia neomexicana* and *Populus tremuloides*. Both *Carex rossii* and *Carex siccata* are present in the understory.

Global Related Concepts:

- *Abies concolor / Carex siccata* Habitat Type (Muldavin et al. 1996) =
- *Abies concolor/Carex foenea* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs throughout much of the North Rim. It seems to be primarily bound by Kanabownits Canyon on the north and west, and by Thompson Canyon on the east. It also occurs to the east between Fuller Canyon and Bright Angel Creek. Other scattered sampling localities include Swamp

Ridge, near Point Sublime, near Point Imperial, and along the Ken Patrick Trail.
Global Range: This plant association is known only from a 370-m elevational band near the summits of mountains in two small mountain ranges in southeastern Arizona, the Pinaleno and Santa Catalina mountains.
Nations: US
States/Provinces: AZ:S2
TNC Ecoregions: 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, M313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (18 plots): GRCA.02093, GRCA.02125, GRCA.02181, GRCA.02182, GRCA.02186, GRCA.02188, GRCA.02203, GRCA.02208, GRCA.03083, GRCA.03085, GRCA.03088, GRCA.03092, GRCA.03115, GRCA.03116, GRCA.03158, GRCA.03164, GRCA.03174, GRCA.03191.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, DeVelice and Ludwig 1983b, Dick-Peddie 1993, Driscoll et al. 1984, Moir and Ludwig 1979, Muldavin et al. 1986, Muldavin et al. 1987, Muldavin et al. 1996, Reid and Hall 2010, Western Ecology Working Group n.d.

Abies concolor - Pseudotsuga menziesii / Robinia neomexicana Woodland

White Fir - Douglas-fir / New Mexico Locust Woodland
Identifier: CEGL000891

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor - Pseudotsuga menziesii / Robinia neomexicana* Woodland

ELEMENT CONCEPT

Global Summary: This high-elevation white fir woodland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from 2454 to 2664 m (8051-8740 feet) elevation on sideslopes, often at high levels, or on plateaus. It occurs on fairly steep slopes up to 40 degrees (17 degrees average) and occurs across all aspects. Soils are rapidly drained sandy loams and silt loams. This vegetation type occurs in areas which have recently burned at low to moderate severity. Codominant stands of *Pinus ponderosa*, *Abies concolor*, and *Populus tremuloides* characterize the tree canopy of this dry, mixed-conifer association. *Abies concolor* is the most frequent component of the subcanopy, and *Populus tremuloides* regeneration is also common. *Pseudotsuga menziesii* and *Pinus ponderosa* also occur occasionally in the subcanopy. The presence of successional or regenerating *Robinia neomexicana* as either a tall shrub (>2 m) or short shrub (<2 m) characterizes the shrub layer and appears to be more dominant than *Populus tremuloides* in areas with high volcanic ash or tuff in the substrate. The dwarf-shrub *Mahonia repens* is frequent at very low cover. *Carex siccata* is the most abundant graminoid; both *Poa fendleriana* and *Carex rossii* are frequent. *Pseudostellaria jamesiana*, *Fragaria virginiana*, and *Phacelia heterophylla* are the most frequent forbs. *Pteridium aquilinum* is fairly common.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2454 to 2664 m (8051-8740 feet) elevation. This type tends to occur on sideslopes, often at high levels, or on plateaus. It occurs on fairly steep slopes up to 40 degrees (17 degrees average) and occurs across all aspects. Soils are rapidly drained sandy loams and silt loams. Stands have a high percentage of litter (typically 78%) and a relatively small percentage of wood (typically 5 to 6%) on the soil surface. This vegetation type occurs in areas which have recently burned at low to moderate severity. This association is most extensive on the eastern portion of the North Rim in the vicinity of the Saddle Mountain fire.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Codominant stands of *Pinus ponderosa* (up to 12% cover), *Abies concolor* (up to 9% cover), and *Populus tremuloides* (up to 15% cover) characterize the tree canopy of this dry, mixed-conifer association. *Abies concolor* (up to 11% cover) is the most frequent component of the subcanopy, and *Populus tremuloides* regeneration is also common at up to 20% cover. *Pseudotsuga menziesii* and *Pinus ponderosa* also occur occasionally in the subcanopy. The presence of successional or regenerational *Robinia neomexicana* characterizes the shrub layer. *Robinia neomexicana* is essentially always present in this community, either as a tall shrub (>2 m) or as a short shrub (<2 m). It can occur at up to 22% cover, but typically has about 11% cover. It appears to be more dominant than *Populus tremuloides* as a regenerational component in areas with high volcanic ash or tuff in the substrate. The dwarf-shrub *Mahonia repens* is frequent at very low cover. *Carex siccata* is the most abundant graminoid with an average of 5% cover; both *Poa fendleriana* and *Carex rossii* are frequent at about 1% cover. *Pseudostellaria jamesiana, Fragaria virginiana*, and *Phacelia heterophylla* are the most frequent forbs. *Pteridium aquilinum* is fairly common at about 3% cover. Seedlings of *Populus tremuloides* and *Abies concolor* occur in all 11 plots sampled. Species richness is typical for high-elevation, treed communities on the North Rim, with an average of 27 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Robinia neomexicana*
Herb (field)	Forb	*Pseudostellaria jamesiana, Thalictrum fendleri*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Carex rossii*, *Carex siccata*, *Fragaria virginiana*, *Mahonia repens*, *Phacelia heterophylla*, *Pinus ponderosa*, *Poa fendleriana*, *Populus tremuloides*, *Pseudostellaria jamesiana*, *Pteridium aquilinum*, *Robinia neomexicana*, *Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ligusticum porteri* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (exotic, High), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic); **Other**: *Goodyera oblongifolia* (G5?), *Orthilia secunda* (G5), *Pterospora andromedea* (G5)
Global: Vulnerable: *Ligusticum porteri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4Q (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Similar Associations:

- *Abies concolor - Pseudotsuga menziesii / Carex rossii* Forest (CEGL000431) has less *Pinus ponderosa* in the canopy and does not have a well-defined shrub layer of *Robinia neomexicana*. It is more successionally stable and is not as closely associated with recent fire activity.
- *Abies concolor - Pseudotsuga menziesii / Carex siccata* Forest (CEGL000244) has less *Pinus ponderosa* in the canopy and does not have a well-defined shrub layer of *Robinia neomexicana*. It is more successionally stable and is not as closely associated with recent fire activity.

Global Related Concepts:

- *Abies concolor / Robinia mexicana* Habitat Type (Fitzhugh et al. 1987) =
- *Abies concolor/Robinia neomexicana* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known primarily from the eastern portion of the North

Rim in the vicinity of the Saddle Mountain fire. It occurs mostly from Fuller Canyon east to the rim, and from the northern boundary of the park near Saddle Mountain south to Vista Encantada. A few scattered stands were sampled from near Big Springs Canyon, Kanabownits Canyon, and from the Dragon.
Global Range: This association is currently described from Grand Canyon National Park in Arizona. It is also reported from New Mexico. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ:S3, NM:S3S4
TNC Ecoregions: 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313E:CC, 331J:CC, M313A:CC, M313B:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (11 plots): GRCA.02145, GRCA.02147, GRCA.02166, GRCA.02196, GRCA.02215, GRCA.03073, GRCA.03123, GRCA.03132, GRCA.03142, GRCA.03144, GRCA.03167.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: L. Dickson and K. Christie
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Fitzhugh et al. 1987, Larson and Moir 1987, Moir and Ludwig 1979, Reid and Hall 2010, Western Ecology Working Group n.d.

Abies concolor / Juniperus communis Forest

White Fir / Common Juniper Forest
Identifier: CEGL000249

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor / Juniperus communis* Forest

ELEMENT CONCEPT

Global Summary: This montane forest association occurs on a wide variety of aspects, slopes and landforms and is found in southern Utah on the Markagunt, Sevier and Paunsaugunt plateaus, in the Escalante and Tushar mountains and in the southern Rocky Mountains in northern New Mexico. Sites range between 2400 and 2850 m (7900-9360 feet) in elevation. Soils are often gravelly, rapidly drained loams (sandy to silty clay loams) and silts. Litter accumulations tend to be high but may be non-uniform and patchy. The vegetation is characterized by an open to closed tree canopy (10-70% cover) that is dominated or codominated by *Abies concolor* with a sparse to moderately dense understory dominated by clumps of the short shrub *Juniperus communis*. *Pseudotsuga menziesii* is frequently a codominant with other trees such as *Picea pungens, Pinus flexilis, Pinus strobiformis* (southern latitudes), *Populus tremuloides*, and *Juniperus scopulorum*. *Abies lasiocarpa* and *Pinus ponderosa* are accidental in the tree canopy and have relatively low cover. Other shrubs include scattered *Symphoricarpos oreophilus, Shepherdia canadensis, Rosa woodsii, Ribes cereum, Paxistima myrsinites, Mahonia repens (= Berberis repens)*, or *Ceanothus martinii*. *Acer glabrum* is typically absent. The herbaceous layer is generally depauperate but can range as high as 10% cover in some stands. *Carex rossii, Carex inops ssp. heliophila, Bromus anomalus*, and *Poa fendleriana* are the most consistent species.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2566 to 2715 m (8419-8907 feet) elevation. It occurs on plateaus and mid to high-level sideslopes, on all aspects. Slopes average 9 degrees, but are often almost flat. Soils are primarily well-drained or rapidly drained silt loams. Litter (68-87%) dominates the ground cover, while a small amount of wood (2-10%) also exists.
Global Environment: This montane forest association occurs on a wide variety of aspects, slopes and landforms such as low to high slopes of ridges, hills, mesas, plateaus, valleys, ravines, canyons, saddles and rolling mesatops. Sites range between 2410 and 2850 m (7900-9360 feet) in elevation. Soils are often gravelly, rapidly drained loams (sandy to silty clay loams) and silts. Litter accumulations tend to be high but may be non-uniform and patchy.

Parent materials include limestone, basaltic and andesitic volcanics, rhyolite, rhyolitic tuffs, and the Pink and White members of the Claron Formation (soft limestone).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: *Pseudotsuga menziesii* (up to 13% cover), *Abies concolor* (up to 10% cover), and *Populus tremuloides* (up to 12% cover) dominate the canopy of this mixed-conifer association. *Pseudotsuga menziesii* (typically 3%), *Abies concolor* (typically 4%), and varying amounts of *Populus tremuloides* (to up 20%) comprise the subcanopy. *Juniperus communis* is consistently the dominant shrub in this typically sparse stratum (usually 3-4% cover). *Carex siccata, Bromus ciliatus*, and *Carex rossii* are frequent components of a sparse herbaceous layer. *Fragaria virginiana, Goodyera oblongifolia, Lotus utahensis, Erigeron speciosus*, and *Antennaria parvifolia* are common forbs, all of which occur at less than 4% cover. Tree seedlings are less abundant than in other mixed-conifer types, with *Abies concolor, Populus tremuloides*, and *Pseudotsuga menziesii* all commonly present at 2-3% cover. Species richness is typical for high-elevation forested communities on the North Rim, with an average of 26 species per 400-square-meter plot on the five plots sampled in the park.
Global Vegetation: This mixed montane forest has an open to closed tree canopy (10-70% cover). *Abies concolor* is the indicated late-seral tree and usually dominates mature stands. *Pseudotsuga menziesii, Picea pungens, Pinus flexilis, Pinus strobiformis* (southern latitudes), and *Populus tremuloides* are seral associates. *Abies lasiocarpa* and *Pinus ponderosa* are accidental in the tree canopy and have relatively low cover. Some stands may have scattered saplings of *Abies concolor, Pseudotsuga menziesii, Pinus flexilis, Populus tremuloides*, or *Juniperus scopulorum*. The undergrowth is characterized by a clumpy, typically open to moderately dense, short-shrub layer of *Juniperus communis* (5-65% cover). Other shrubs, such as *Symphoricarpos oreophilus, Shepherdia canadensis, Rosa woodsii, Ribes cereum, Paxistima myrsinites, Mahonia repens (= Berberis repens)*, or *Ceanothus martinii*, may be present with low cover. *Acer glabrum* is typically absent. The herbaceous layer is generally depauperate but can range as high as 10% cover in some stands. *Carex rossii, Carex inops ssp. heliophila, Bromus anomalus, Elymus elymoides*, and *Poa fendleriana* are the most consistent graminoids. Among forbs, mesic species such as *Fragaria vesca, Pyrola chlorantha*, and *Thalictrum fendleri* are the most frequent and abundant.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Needle-leaved shrub	*Juniperus communis*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	Needle-leaved shrub	*Juniperus communis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Antennaria parvifolia*, *Bromus ciliatus*, *Carex rossii*, *Carex siccata*, *Erigeron speciosus*, *Fragaria virginiana*, *Goodyera oblongifolia*, *Juniperus communis*, *Lotus utahensis*, *Populus tremuloides*, *Pseudotsuga menziesii*
Global: *Abies concolor*, *Carex inops* ssp. *heliophila*, *Carex rossii*, *Juniperus communis*, *Pinus ponderosa*, *Pseudotsuga menziesii*, *Thalictrum fendleri*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Other: *Cystopteris reevesiana* (G4?), *Goodyera oblongifolia* (G5?), *Orthilia secunda* (G5), *Pterospora andromedea* (G5), *Pyrola chlorantha* (G5), *Pyrola picta* (G4G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate
Global Similar Associations:
- *Abies concolor / Mahonia repens* Forest (CEGL000251) has very sparse to nonexistent shrub and herb layers. *Mahonia repens* consistently occurs at low cover values, while *Juniperus communis* is extremely infrequent.
- *Abies concolor / Symphoricarpos oreophilus* Forest (CEGL000263) *Symphoricarpos oreophilus* dominates the shrub layers of this mixed-conifer association.
- *Abies lasiocarpa - Picea engelmannii / Juniperus communis* Woodland (CEGL000919)

Global Related Concepts:
- *Abies concolor / Juniperus communis* Forest (Muldavin et al. 2006) =
- *Abies concolor / Juniperus communis* Habitat Type (Youngblood and Mauk 1985) =
- *Abies concolor / Juniperus communis* Plant Community (Roberts et al. 1992) =
- *Abies concolor/Juniperus communis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim, and all sampled plots occur in the vicinity of Thompson Canyon.
Global Range: This conifer forest is found in Utah on the Markagunt, Sevier and Paunsaugunt plateaus and the Escalante and Tushar mountains and in the southern Rocky Mountains in northern New Mexico.
Nations: US
States/Provinces: AZ, NM, UT:S4?, WY
TNC Ecoregions: 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Bandelier, Bryce Canyon, Cedar Breaks, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.02204, GRCA.02216, GRCA.03160, GRCA.03161, GRCA.03192.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: L.D. Engelking, mod. K.A. Schulz and G. Kittel
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Fischer and Bradley 1987, Muldavin et al. 2006, Muldavin et al. 2011b, Reid and Hall 2010, Roberts et al. 1992, Tendick et al. 2011a, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

Abies concolor / Mahonia repens Forest

White Fir / Creeping Oregon-grape Forest
Identifier: CEGL000251

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Abies concolor / Mahonia repens* Forest

ELEMENT CONCEPT

Global Summary: This white fir forest occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada. Stands are found on a variety of generally cool and dry sites with gentle to steep slopes (3-50%). Landforms include valleys and plateaus, low and midslopes of hills, mesas, ravines, and canyonsides, and exposed ridge and mountain summits at elevations ranging from 2230 to 2930 m (7300-9600 feet). Aspect is variable, but stands often occur on cooler northerly aspects, especially at mid to lower elevations. Substrates are rapidly drained coarse- to fine-textured loam soils derived from limestone, sandstone, shale, and rhyolitic volcanics. The vegetation is characterized by a moderate to closed tree canopy (25-72% cover) that is generally dominated or codominated by *Abies concolor* or is at least present in the tree canopy and dominates

understory regeneration. *Pseudotsuga menziesii* is often present to codominant in the canopy. Other trees may be present in the canopy or subcanopy with low to moderate cover, such as *Pinus ponderosa, Pinus flexilis, Populus tremuloides*, and *Picea engelmannii* (accidental). The understory is characterized by the sparse to occasionally moderately dense, low-diversity understory with 1-10% cover of the diagnostic dwarf-shrub *Mahonia repens*. If the shrub layer is moderately dense, then it is dominated by *Mahonia repens*. Other shrubs may be present and include a few scattered *Symphoricarpos oreophilus*, *Arctostaphylos patula*, *Holodiscus dumosus*, *Paxistima myrsinites*, *Rosa woodsii*, or *Juniperus communis*. The herbaceous layer is typically sparse, with low diversity, and frequently includes the graminoids *Carex rossii, Carex geophila, Carex inops ssp. heliophila, Poa fendleriana*, and the forbs *Goodyera oblongifolia, Lathyrus lanszwertii var. leucanthus (= Lathyrus arizonicus), Mertensia arizonica, Thalictrum fendleri*, and *Viola canadensis*. *Pseudotsuga menziesii* and *Abies concolor* seedlings are typically present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2427 to 2683 m (7963-8802 feet) elevation. It occurs mostly on mid or high-level sideslopes, and also occasionally on the high-level plateau. Slopes from the 12 sampled sites in the park range from 2 to 40 degrees, with an average slope of 13 degrees. This association occurs across all aspects. Soils are primarily well-drained or rapidly drained silt loams or sandy loams. Stands have a large percentage of litter (60-89%) and a relatively high cover of downed wood (average of 8%) on the soil surface. There is very little history of fire, and the majority of stands host a moderate to heavy fuel load.

Global Environment: This white fir forest occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada. Stands are found on a variety of generally cool and dry sites with gentle to steep slopes (3-50%). Landforms include valleys and plateaus, low and midslopes of hills, mesas, ravines, and canyonsides, and exposed ridge and mountain summits at elevations ranging from 2230 to 2930 m (7300-9600 feet) (Moir and Ludwig 1979, Graybosch and Buchanan 1983, Mauk and Henderson 1984, Youngblood and Mauk 1985, Johnston 1987, Roberts et al. 1992, Muldavin et al. 1996, Stuever and Hayden 1997b). Aspect is variable, but stands often occur on cooler northerly aspects, especially at lower elevations. Soils are rapidly drained, sandy loams to silty clay loams derived from limestone, sandstones, shales, and rhyolitic volcanics (Bandelier tuff). The ground surface has low to moderate exposure of bare soil, low to high cover of litter, low to moderate cover of small rocks, sparse to low cover of large rocks, and sparse to moderate cover of downed wood. Litter depths range from 0-2.1 cm.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: *Abies concolor* (up to 20% cover) and *Pinus ponderosa* (up to 12% cover) dominate the canopy of this dry, mixed-conifer type, while *Populus tremuloides* and *Pseudotsuga menziesii* occur occasionally. *Abies concolor* also dominates the subcanopy with an average of 6% cover, while *Pseudotsuga menziesii* and *Pinus ponderosa* occur occasionally at low cover (1-2%). The shrub stratum is essentially nonexistent in this association. *Mahonia repens* is the most frequent and dominant dwarf-shrub, but only occurs at 1-2% cover. *Poa fendleriana* and *Carex rossii* are the most frequent graminoid components of a sparse herbaceous layer, and usually occur at about 1% cover. At least 45 forb species were found in the 12 stands sampled; however, both forb diversity and cover are extremely low within individual stands. *Populus tremuloides* and *Abies concolor* seedlings are frequent at low cover (usually 1-3%). This association hosts the lowest species richness of all high-elevation, forested community types in Grand Canyon National Park. Plots hosted between 11 and 29 species, with an average of 20 species per 400-square-meter plot.

Global Vegetation: This forest is characterized by a moderate to closed tree canopy (25-72% cover) that is generally dominated or codominated by *Abies concolor* or is at least present in the tree canopy and dominates understory regeneration. *Pseudotsuga menziesii* is often present to codominant in the canopy. Other trees may be present in the canopy or subcanopy with low to moderate cover, such as *Pinus ponderosa, Pinus flexilis, Populus tremuloides*, and *Picea engelmannii* (accidental). The understory is characterized by the sparse to occasionally moderately dense, low-diversity understory with 1-10% cover of the diagnostic dwarf-shrub *Mahonia repens*. If the shrub layer is moderately dense, then it is dominated by *Mahonia repens*. Other shrubs present in stands may include a few scattered *Symphoricarpos oreophilus, Amelanchier alnifolia, Arctostaphylos patula, Holodiscus dumosus, Paxistima myrsinites, Rosa woodsii*, or *Juniperus communis* (Moir and Ludwig 1979, Alexander et al. 1984a, Mauk and Henderson 1984, Youngblood and Mauk 1985, DeVelice et al. 1986, Muldavin et al. 1996, Stuever and Hayden 1997b). The herbaceous layer is typically sparse, with low diversity, but is occasionally moderately dense. It is

frequently composed of a mixture of graminoids, including *Carex rossii, Carex geophila, Carex inops ssp. heliophila, Poa fendleriana*, *Bromus anomalus*, and *Elymus elymoides*, and the forbs *Geranium viscosissimum, Goodyera oblongifolia, Lathyrus lanszwertii var. leucanthus (= Lathyrus arizonicus), Mertensia arizonica, Senecio wootonii, Thalictrum fendleri*, and *Viola canadensis*. *Pseudotsuga menziesii* and *Abies concolor* seedlings are typically present.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shurb	*Mahonia repens*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Abies concolor, Pseudotsuga menziesii*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Mahonia repens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abies concolor*, *Carex rossii*, *Mahonia repens*, *Pinus ponderosa*, *Poa fendleriana*, *Populus tremuloides*, *Pseudotsuga menziesii*
Global: *Abies concolor*, *Carex inops* ssp. *heliophila*, *Carex rossii*, *Mahonia repens*, *Poa fendleriana*, *Pseudotsuga menziesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Other: *Arnica cordifolia* (G5), *Corallorhiza maculata* (G5), *Goodyera oblongifolia* (G5?), *Orthilia secunda* (G5), *Pyrola picta* (G4G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This association includes some white fir / sparse understory habitat types that have *Mahonia repens* present (Alexander et al. 1984a, DeVelice et al. 1986). *Pseudotsuga menziesii / Mahonia repens* Forest (CEGL000442) is similar except it lacks *Abies concolor* and can occur outside the range of *Abies concolor* extending north into Idaho and Oregon (Pfister 1977, Steele et al. 1981, 1983, Cole 1982).
Global Similar Associations:

- *Abies concolor / Juniperus communis* Forest (CEGL000249) also has sparse shrub and herbaceous layers. *Mahonia repens* is sometimes present; however, *Juniperus communis* occurs in essentially all stands at about 3% cover. This association is also slightly more mesic.
- *Abies concolor / Symphoricarpos oreophilus* Forest (CEGL000263) is also dominated by *Abies concolor* and *Pinus ponderosa* in the canopy, but has a distinctive shrub layer of *Symphoricarpos oreophilus*.
- *Pseudotsuga menziesii / Mahonia repens* Forest (CEGL000442)

Global Related Concepts:

- *Abies concolor - Pseudotsuga menziesii / Mahonia repens* Plant Association (Johnston 1987) =
- *Abies concolor - Pseudotsuga menziesii* Habitat Type, *Berberis repens* Phase (Moir and Ludwig 1979) >
- *Abies concolor / Berberis repens* Habitat Type (Youngblood and Mauk 1985) =
- *Abies concolor / Berberis repens* Habitat Type (Muldavin et al. 1996) =
- *Abies concolor / Berberis repens* Habitat Type (Mauk and Henderson 1984) =
- *Abies concolor / Mahonia repens* Forest (Muldavin et al. 2006) =
- *Abies concolor / Mahonia repens* Plant Association (Larson and Moir 1987) =
- *Abies concolor / Mahonia repens* Plant Association (Stuever and Hayden 1997b) =
- *Abies concolor / Mahonia repens* Plant Community (Roberts et al. 1992) =
- *Abies concolor/Mahonia repens* (Bourgeron and Engelking 1994) =

- *Abies concolor* / Sparse Habitat Type (Fitzhugh et al. 1987) >
- *Abies concolor* / Sparse Habitat Type (DeVelice et al. 1986) =
- *Abies concolor* / Sparse Undergrowth Habitat Type (Alexander et al. 1984a) =
- DRISCOLL FORMATION CODE:I.A.9.c. (Driscoll et al. 1984) >
- Mixed Conifer Type, *Abies concolor* Phase (Graybosch and Buchanan 1983) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association was sampled in scattered locations across the North Rim with no apparent distribution pattern. Plots exist from Point Sublime, Cape Royal, Swamp Ridge, and Little Dragon.
Global Range: This white fir forest association occurs in mountains and higher plateaus in the Colorado Plateau and southern Rocky Mountains and ranges from central Utah and southern Colorado south into New Mexico and Arizona, and possibly extends into eastern Nevada.
Nations: US
States/Provinces: AZ:S3, CO:S4, NM:S5, NV, UT:S5, WY
TNC Ecoregions: 4:C, 6:?, 11:C, 18:C, 19:C, 20:C, 21:P
USFS Ecoregions (1994/95): 313A:CC, M261G:CC, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Bandelier, Bryce Canyon, Cedar Breaks, Grand Canyon, Great Basin); USFS (Coronado, Dixie, Fishlake, Lincoln, Manti-La Sal, Uinta, Wasatch-Cache)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (12 plots): GRCA.02092, GRCA.02097, GRCA.02165, GRCA.02192, GRCA.02201, GRCA.02205, GRCA.03075, GRCA.03076, GRCA.03113, GRCA.03162, GRCA.03184, GRCA.03185.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: K.A. Schulz
References: Alexander et al. 1984a, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Graybosch and Buchanan 1983, Heinze et al. 1962, Johnston 1984, Johnston 1987, Larson and Moir 1987, Mauk and Henderson 1984, Moir and Ludwig 1979, Muldavin et al. 1996, Muldavin et al. 2006, Muldavin et al. 2011b, Pfister 1972, Reid and Hall 2010, Roberts et al. 1992, Schulz and Hall 2011, Steele et al. 1981, Steele et al. 1983, Stuever and Hayden 1997b, Tendick et al. 2011a, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

***Picea pungens* / *Festuca arizonica* Woodland**

Blue Spruce / Arizona Fescue Woodland
Identifier: CEGL000895

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Picea pungens* / *Festuca arizonica* Woodland

ELEMENT CONCEPT

Global Summary: This blue spruce woodland association is currently described from Grand Canyon National Park in Arizona. It is also reported from Colorado, New Mexico and Wyoming. More survey and classification work are needed to fully characterize this type. It occurs at approximately 2575 m (8450 feet) elevation in somewhat mesic environments. This vegetation type occurs in linear swathes along valley bottoms and cold-air drainages, while various other mixed-conifer associations occur on the adjacent sideslopes. Slopes are flat to low, and aspects are potentially variable. Soils are well-drained, fine-textured silt loams. *Populus tremuloides* dominates the canopy; however, the presence of *Picea pungens* both as an emergent and in the subcanopy is indicative of this association. Shrubs are essentially absent. *Festuca arizonica* dominates the understory, while *Carex* spp. can also be present. *Lupinus argenteus, Antennaria parvifolia*, and to some extent *Artemisia carruthii, Cirsium* sp., *Cryptantha setosissima*, and *Antennaria rosulata* are dominant components of the understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This blue spruce woodland occurs on the North Rim at approximately 2575 m (8450 feet) elevation in somewhat mesic environments. It occurs in valley bottoms along cold-air drainages. Slopes are flat to low (roughly 4 degrees), and aspects are potentially variable (the single classification plot for this association occurs on a south-facing slope). Soils are well-drained, fine-textured silt loams. Stands have a high cover of herbaceous litter (typically 67%) and moderate cover of bare soil (20%). Stands typically lack the thick layer of conifer litter that is typical of many other forested types on the North Rim. This vegetation type occurs in linear swathes along valley bottoms and cold-air drainages, while various other mixed-conifer associations occur on the adjacent sideslopes.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 16% in this association. *Populus tremuloides* (13%) dominates the canopy; however, the presence of *Picea pungens* both as an emergent (3%) and in the subcanopy (2%) is indicative of this association. Shrubs are essentially absent. *Festuca arizonica* (10%) dominates the understory, while *Carex* spp. can also be present (at up to 7% cover). *Lupinus argenteus* (3%), *Antennaria parvifolia* (2%), and to some extent *Artemisia carruthii* (1%), *Cirsium* sp. (1%), *Cryptantha setosissima* (1%), and *Antennaria rosulata* (1%) are dominant components of the understory. Tree seedlings are essentially absent. This association hosts the highest species richness of all forested community types on the North Rim, with 40 species per 400-square-meter plot. This statistic is based upon a single classification plot; however, the pattern seems realistic as this community type occurs at the junction of mixed-conifer communities upslope and meadow communities in the valley bottom. It can be expected to host species from both of the adjacent communities.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus tremuloides*
Tree subcanopy	Needle-leaved tree	*Picea pungens*
Herb (field)	Forb	*Antennaria parvifolia, Antennaria rosulata, Artemisia carruthii, Cryptantha setosissima, Lupinus argenteus*
Herb (field)	Graminoid	*Festuca arizonica, Muhlenbergia montana, Poa fendleriana, Poa pratensis*
Emergent tree	Needle-leaved tree	*Picea pungens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Antennaria rosulata*, *Festuca arizonica*, *Lupinus argenteus*, *Picea pungens*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Poa pratensis* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Picea pungens* / *Carex siccata* Forest (CEGL000387) occurs on the North Rim in similar habitats. It has less *Populus tremuloides* cover in the canopy, and *Carex siccata* (as opposed to *Festuca arizonica*) is the dominant component of the understory.
Global Similar Associations:

- *Picea pungens* / *Carex siccata* Forest (CEGL000387) has less *Populus tremuloides* cover in the canopy, and *Carex siccata* (as opposed to *Festuca arizonica*) is the dominant component of the understory.

Global Related Concepts:

- *Picea pungens* / *Festuca arizonica* Woodland (DeVelice et al. 1986) =
- *Picea pungens*/*Festuca arizonica* (Bourgeron and Engelking 1994) =

- DRISCOLL FORMATION CODE:II.A.2.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim in mesic valley bottoms and cold-air drainages. It is documented by a single classification plot in the vicinity of Kanabownits Canyon, approximately 1 mile southwest of Fawn Spring.
Global Range: This association is currently described from Grand Canyon National Park in Arizona. It is also reported from Colorado, New Mexico and Wyoming. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ:S1, CO:S3, NM:S5, WY
TNC Ecoregions: 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M313A:CC, M331G:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02146.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Komarkova 1986, Larson and Moir 1987, Reid and Hall 2010, WNDD unpubl. data, Western Ecology Working Group n.d.

***Pseudotsuga menziesii / Quercus gambelii* Forest**

Douglas-fir / Gambel Oak Forest
Identifier: CEGL000452

USNVC CLASSIFICATION

Division	Rocky Mountain Cool Temperate Forest (1.B.2.Nb)
Macrogroup	Southern Rocky Mountain Lower Montane Forest (M022)
Group	Southern Rocky Mountain White Fir - Douglas-fir Dry Forest (G226)
Association	*Pseudotsuga menziesii* / *Quercus gambelii* Forest

ELEMENT CONCEPT

Global Summary: This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into New Mexico, Arizona and Utah. Elevation ranges from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, lower and middle slopes, steep upper slopes and gentle to rolling tops of mesas and ridges. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes (southern aspects at higher elevations). Soils vary but are often shallow and rocky, ranging from sand to clay, often derived from sandstone. The vegetation is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with *Quercus gambelii* well-represented in the understory. Scattered large *Pinus ponderosa*, *Pinus strobiformis*, *Pinus flexilis*, *Pinus edulis*, or *Juniperus* spp. (especially on drier sites) may be present in the tree canopy or subcanopy. *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently well over 25%. At higher elevations, *Quercus gambelii* are more treelike and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis*, *Juniperus osteosperma*, or *Juniperus deppeana* are often present. The presence of *Chrysothamnus depressus* in some stands reflects the presence of fairly well-developed soils. The herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but it can be moderately dense and diverse. Many other species are associated, such as *Amelanchier* spp., *Holodiscus dumosus, Fendlera rupicola, Fraxinus anomala, Mahonia repens, Paxistima myrsinites, Quercus X pauciloba, Robinia neomexicana, Rosa woodsii, Carex* spp., *Festuca arizonica, Koeleria macrantha, Muhlenbergia virescens, Poa fendleriana, Lathyrus lanszwertii var. leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

ENVIRONMENTAL DESCRIPTION

Global Environment: This forest association occurs on mountains and plateaus at elevations ranging from 1229 to 2870 m (4030-9400 feet). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and gentle to rolling tops of mesas and ridges. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes, canyon sideslopes and mesa escarpments (southern aspects at higher elevations). Soils vary but are often shallow and rocky, ranging from sand to clay, often derived from sandstone. The surface is generally largely covered with a thin layer of litter. Parent materials are variable and include recent alluvium, fractured limestone, sandstone, metamorphic/granitic rocks, basalt, andesite, volcanic tuff, eroded Claron Formation (Pink Member), and even slickrock. Occasionally, talus to large blocks of rock and bedrock dominate the surface of sites on colluvial slopes / landslide deposits.

VEGETATION DESCRIPTION

Global Vegetation: This forest is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, with *Quercus gambelii* well-represented in the understory. Scattered large *Pinus ponderosa, Pinus strobiformis, Pinus flexilis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites) may be present in the tree canopy or subcanopy. *Abies concolor* is typically not present. *Quercus gambelii* typically dominates both the subcanopy (tree form, if present) and the open to moderately dense tall-shrub layer that often consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently well over 25%. At higher elevations, *Quercus gambelii* are more treelike, and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. The presence of *Chrysothamnus depressus* in some stands reflects the presence of fairly well-developed soils. Other common shrub species, depending on geographic location, may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Brickellia longifolia, Cercocarpus montanus, Fendlera rupicola, Fraxinus anomala, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Purshia tridentata, Quercus X pauciloba, Rhus trilobata, Ribes cereum, Robinia neomexicana, Rosa woodsii, Shepherdia rotundifolia*, and *Yucca* spp. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs but ranges to moderately dense and diverse. Species vary greatly by site characteristics and location. Associated graminoids may include *Achnatherum hymenoides, Bromus* spp., *Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens, Piptatherum micranthum*, and *Poa fendleriana*. Common forbs include *Achillea millefolium var. occidentalis, Cryptantha* sp., *Galium coloradoense, Gilia stenothyrsa, Lathyrus lanszwertii var. leucanthus, Lepidium montanum, Machaeranthera grindelioides, Maianthemum stellatum, Packera multilobata, Packera neomexicana, Physaria acutifolia, Thalictrum fendleri, Solidago* spp., and *Vicia americana*. The shrub layer generally has equal or greater cover than graminoids. Post-burn stands may have relatively low cover of *Quercus gambelii* temporarily, as these shrubs resprout and grow. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus ponderosa, Pseudotsuga menziesii*
Tall shrub/sapling	Broad-leaved deciduous tree	*Quercus gambelii*

CHARACTERISTIC SPECIES

Global: *Pseudotsuga menziesii*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Gilia stenothyrsa* (G3), *Shepherdia rotundifolia* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This is a broadly defined association characterized by dominance or codominance of two widespread species, *Pseudotsuga menziesii* and *Quercus gambelii*. Within the literature on habitat type, there are four phases mentioned: *Festuca arizonica* phase, *Holodiscus dumosus* phase, *Muhlenbergia virescens* phase (all defined by having at least 5% cover of both *Quercus gambelii* and the nominal species), and *Quercus gambelii* (typic) phase by a undeveloped herbaceous layer (Alexander et al. 1984b, DeVelice et al. 1986, Alexander et al. 1987, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are three similar *Pseudotsuga menziesii* associations in the USNVC that use these phase species as nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships among associations and possibly subdivide this broadly defined association into types based on herbaceous layer and habitat.
Global Similar Associations:
- *Abies concolor - (Pseudotsuga menziesii)* / *Quercus gambelii* / *Carex rossii* Forest (CEGL005351)
- *Abies concolor - (Pseudotsuga menziesii)* / *Quercus gambelii* / *Thalictrum fendleri* Forest (CEGL005352)
- *Abies concolor* / *Quercus gambelii* Forest (CEGL000261)
- *Pinus ponderosa* / *Quercus gambelii* Woodland (CEGL000870)
- *Pseudotsuga menziesii* / *Festuca arizonica* Forest (CEGL000433)
- *Pseudotsuga menziesii* / *Holodiscus discolor* / *Carex geyeri* Forest (CEGL000437)
- *Pseudotsuga menziesii* / *Muhlenbergia montana* Forest (CEGL000443)
- *Pseudotsuga menziesii* / *Muhlenbergia virescens* Forest (CEGL000444)

Global Related Concepts:
- *Pseudotsuga menziesii* / *Quercus gambelii* Association (Bourgeron et al. 1995a) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest (Hansen et al. 2003) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest Association (Bourgeron et al. 1993b) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest Association (Kittel et al. 1999b) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Forest Association (Kittel et al. 1994) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (Alexander et al. 1984b) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (Fitzhugh et al. 1987) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (Alexander et al. 1987) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (DeVelice et al. 1986) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (Youngblood and Mauk 1985) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Habitat Type (Muldavin et al. 1996) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Plant Association (Larson and Moir 1987) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Plant Association (Johnston 1987) =
- *Pseudotsuga menziesii* / *Quercus gambelii* Plant Association (Stuever and Hayden 1997b) =
- *Pseudotsuga menziesii* / *Symphoricarpos oreophilus* Habitat Type (Komarkova et al. 1988b) ><
- *Pseudotsuga menziesii*/*Quercus gambelii* (Bourgeron and Engelking 1994) =
- *Pseudotsuga menziesii*/*Quercus gambelii* (Kittel et al. 1999b) =
- Barn Canyon Conifer (Blackhawk Coal Company 1981) =
- Douglas Fir-Pine Series (Diamond 1993) >

ELEMENT DISTRIBUTION

Global Range: This *Pseudotsuga menziesii* forest association occurs in the southern Rocky Mountains and southwestern U.S. and is found on foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah.
Nations: US
States/Provinces: AZ, CO:S4, NM:S5, TX:S1, UT:S3?, WY
TNC Ecoregions: 10:C, 18:C, 19:C, 20:C, 21:C, 22:P, 24:P
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313E:CC, 321A:CC, 331J:CC, 341B:CC, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Bandelier, Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Curecanti, El Malpais, Grand Canyon, Mesa Verde, Natural Bridges, Navajo, Walnut Canyon, Zion); USFS (Apache-Sitgreaves, Arapaho-Roosevelt, Cibola, Gila, Gunnison, Uncompahgre, White River NF)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz, mod. J. Drake
References: Alexander et al. 1984b, Alexander et al. 1987, Bader 1932, Blackhawk Coal Company 1981, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, Bourgeron et al. 1995a, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2010, DeVelice et al. 1986, Diamond 1993, Fitzhugh et al. 1987, Freeman and Dick-Peddie 1970, Hansen et al. 2003, Hansen et al. 2004a, Hess and Wasser 1982, Johnston 1987, Keammerer 1974b, Kittel et al. 1994, Kittel et al. 1999b, Komarkova et al. 1988a, Komarkova et al. 1988b, Larson and Moir 1987, Muldavin et al. 1996, Muldavin et al. 2011a, Muldavin et al. 2011b, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010a, Stuever and Hayden 1997b, TNHS unpubl. data, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Tiedemann and Terwilliger 1978, Von Loh et al. 2007, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood and Mauk 1985

1.B.2.Nc. Western North American Cool Temperate Woodland & Scrub

M026. Intermountain Singleleaf Pinyon - Western Juniper Woodland
G247. Great Basin Pinyon - Juniper Woodland

Pinus monophylla - Juniperus osteosperma / Artemisia tridentata Woodland

Singleleaf Pinyon - Utah Juniper / Big Sagebrush Woodland
Identifier: CEGL000832

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association occurs in the Great Basin. Elevations range from 1220-2300 m (4000-7550 feet). Stands occur on mesas, hills and rocky ridges on gentle to steep slopes on all aspects. The soils are shallow to moderately deep, calcareous, lithic loams or clays. The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. *Juniperus osteosperma* is often more abundant at lower elevation. The short-shrub layer is typically sparse (10-15% cover) and is dominated by *Artemisia tridentata*. *Chrysothamnus viscidiflorus* or *Purshia tridentata* are frequent associates. Other associated shrubs may include low cover of *Amelanchier* spp., *Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, and species of *Gutierrezia, Opuntia, Tetradymia*, and *Yucca*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Frequent graminoids are *Elymus elymoides* and *Poa secunda*. Although forb cover is generally sparse, it may be very diverse. Frequent forbs include species of *Astragalus, Balsamorhiza, Machaeranthera, Eriogonum*, and *Phlox*. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on plateau lands in Grand Canyon-Parashant National Monument at 1800 to 1950m (5925-6375 feet) elevation. It typically occurs on gently sloping (1-5 degree) high-level plateaus, low-level valley bottoms, and gentle sideslopes. Occasionally, this association occurs on steeper sideslopes of up to 30 degrees. It occurs across all aspects, but perhaps slightly favors north-facing slopes. Soils are mainly well-drained but may vary from somewhat poorly-drained on shallow slopes, to rapidly-drained on steeper ones. They are generally silty clay loams derived from limestone or basalt parent materials. Ground cover is dominated by gravel (33%), litter (29%), bare soil (25%), and surface rocks (5%). This association is common in Grand Canyon-Parashant National Monument and exists as part of a vast network of similar woodland vegetation types.
Global Environment: This woodland association occurs in the Great Basin. Elevations range from 1220-2300 m (4000-7550 feet). Stands occur on mesas, hills and rocky ridges on gentle to steep slope on all aspects. The soils

are shallow to moderately deep, calcareous, lithic loams or clays. Litter from trees may cover up to half the ground surface (30-55%). Cover of rock (about 10%), pavement (10-25%), and bare ground (10-20%) are generally less.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports an open tree canopy 20% cover or less, which consists of *Juniperus osteosperma* (8%) and *Pinus monophylla* (3%). In half of the stands sampled, a notable subcanopy of *Juniperus osteosperma* (6%) and *Pinus monophylla* (1%) was observed. The tall-shrub stratum is relatively undefined; however, scattered *Purshia stansburiana* (1-3%) occasionally occur. The short-shrub layer is well-developed and is characterized by *Artemisia tridentata* (10%). Dwarf-shrubs are generally sparser but may occur at up to 10% cover and include species such as *Gutierrezia sarothrae* (7%) and *Opuntia* sp. (trace). The graminoid layer has variable cover (0-15%) but typically exists at around 5%. The most common species include *Poa fendleriana* (1%), *Elymus elymoides* (3%), *Bouteloua gracilis* (3%), and *Bromus tectorum* (1%). Total forb cover averages 2% with *Eriogonum umbellatum, Frasera albomarginata, Cordylanthus parviflorus* and *Penstemon linarioides* occurring most frequently. Mosses were observed in the majority of stands at trace amounts. This vegetation type supports average species diversity among Grand Canyon plant communities, with 18 species per 400-square-meter plot.

Global Vegetation: The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. *Juniperus osteosperma* is often more abundant at lower elevation. The short-shrub layer is typically sparse (10-15% cover) and is dominated by *Artemisia tridentata*. *Chrysothamnus viscidiflorus* or *Purshia tridentata* are frequent associates. Other associated shrubs may include low cover of *Amelanchier* spp., *Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, and species of *Gutierrezia, Opuntia, Tetradymia* and *Yucca*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Frequent graminoids are *Elymus elymoides* and *Poa secunda*. Other associated graminoids may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Achnatherum thurberianum (= Stipa thurberiana), Koeleria macrantha, Pleuraphis jamesii*, or *Pseudoroegneria spicata*. Although forb cover is generally sparse, it may be very diverse. Common forbs include *Astragalus* spp., *Balsamorhiza sagittata, Cryptantha cinerea var. jamesii (= Cryptantha jamesii), Lomatium* spp., *Machaeranthera canescens, Eriogonum* spp., *Gayophytum ramosissimum*, and *Phlox* spp. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Forb	*Eriogonum umbellatum*
Herb (field)	Graminoid	*Bouteloua gracilis, Elymus elymoides*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Bouteloua gracilis*, *Cordylanthus parviflorus*, *Elymus elymoides*, *Eriogonum umbellatum*, *Frasera albomarginata*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Penstemon linarioides*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*
Global: *Artemisia tridentata*, *Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (19-Sep-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) also supports an open canopy of pinyon and juniper and a shrub layer dominated by *Artemisia tridentata*; however, *Pinus edulis*, and not *Pinus monophylla*, codominates the canopy layer. This association typically occurs in the central and eastern Grand Canyon, while *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* (CEGL000832) is restricted to the western portion of the Grand Canyon.
Global Related Concepts:

- *Pinus - Juniperus - Artemisia* Association (Ostler et al. 2000) **>**
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata / Bromus tectorum* Community (Blackburn et al. 1969b) **=**
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Community (Blackburn et al. 1969c) **=**
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Community (Blackburn et al. 1968a) **=**
- *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* Woodland (Keeler-Wolf and Thomas 2000) **=**
- *Pinus monophylla-Juniperus osteosperma/Artemisia tridentata* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau.
Global Range: This Great Basin association is known from Nevada and Utah.
Nations: US
States/Provinces: AZ, NV:S5, UT
TNC Ecoregions: 6:C, 11:C, 17:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:??, 341D:CC, 341F:CC, 342B:CC, M341A:C?, M341C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Great Basin, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (17 plots): GRCA.04065, GRCA.04197, GRCA.04107, GRCA.04075, GRCA.04080, GRCA.04089, GRCA.04088, GRCA.04076, GRCA.04109, GRCA.04141, GRCA.04132, GRCA.04103, GRCA.04058, GRCA.04077, GRCA.04179, GRCA.04225, GRCA.04169.
Local Description Authors: S. Fugate
Global Description Authors: K.A. Schulz

References: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1969b, Blackburn et al. 1969c, Bourgeron and Engelking 1994, Bradley et al. 1992, Bunting 1987, Cogan et al. 2004, Driscoll et al. 1984, Everett 1987, Johnson and Payne 1968, Keeler-Wolf and Thomas 2000, Koniak 1985, Ostler et al. 2000, Peterson 2008, Reid and Hall 2010, Schulz and Hall 2011, Western Ecology Working Group n.d., Wright et al. 1979

Pinus monophylla - Juniperus osteosperma / Sparse Understory Woodland

Singleleaf Pinyon - Utah Juniper / Sparse Understory Woodland
Identifier: CEGL000829

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland

ELEMENT CONCEPT

Global Summary: This widespread woodland association is known from the Great Basin and northern Mojave Desert. Elevations normally range from 1370-2135 m (4500-7000 feet). Stands occur on flat to moderately sloping sites on all aspects. The soils are variable, but typically shallow and lithic. Litter from trees often covers about half the ground surface. Cover of rock, pavement or bare ground may also be significant depending on the site. The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) dominated by *Pinus monophylla* without a significant understory. *Juniperus osteosperma* may be present to codominant. Shrub cover, if present, is sparse (<10% cover). *Artemisia tridentata, Purshia tridentata*, and *Chrysothamnus viscidiflorus* are most consistent. Other shrubs include *Amelanchier* spp., *Eriogonum microthecum, Cercocarpus montanus, Gutierrezia sarothrae, Purshia tridentata, Quercus gambelii, Quercus turbinella*, and species of *Opuntia*. Herbaceous cover is typically sparse and dominated by perennial graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument from 1800 to 1975 m (5900-6450 feet) elevation. It occurs on high-level plateaus and sideslopes, typically on gentle slopes (1-4 degrees). Soils are moderately- to well-drained silty clays that occasionally contain loam. When unobscured, the underlying geology is typically limestone or basalt. Ground cover is dominated by gravel (32%), bare soil (26%), litter (21%), and rocks (16%).
Global Environment: This widespread woodland association is known from the Great Basin and northern Mojave Desert. Elevations normally range from 1370-2135 m (4500-7000 feet). Stands occur on flat to moderately sloping sites on all aspects. The soils are variable, but typically shallow and lithic. Litter from trees often covers about half the ground surface. Cover of rock, pavement or bare ground may also be significant depending on the site.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages 15-20% but can be as high as 35% in this woodland association. *Pinus monophylla* (5%) and *Juniperus osteosperma* (15%) codominate this vegetation type; and while the bulk of their cover lies in the tree canopy layer, they can also occur in the subcanopy. This association is also characterized by having a fairly sparse understory, with shrub, graminoid, and forb layers all averaging around 1-3% cover. Tall shrubs are very rarely present and show low cover when they do occur. *Artemisia tridentata* (up to 1%) is frequently present as a short shrub, but rarely has significant cover. *Gutierrezia sarothrae* (up to 1%) and *Yucca baccata* (1-2%) sometimes occur. The cacti *Opuntia whipplei (= Cylindropuntia whipplei)* (up to 1%) and *Opuntia* sp. (up to 1%) occur occasionally and are the most frequent dwarf-shrubs. *Poa fendleriana* (1%) and *Elymus elymoides* (up 1%) regularly occur in the poorly-developed graminoid layer. *Eriogonum umbellatum* (1%) and *Penstemon linarioides* (1%) are among the most frequent forbs. Mosses (up 1%) and lichens (1%) also frequently occur in small amounts. Based upon the 16 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.
Global Vegetation: The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) dominated by *Pinus monophylla* without a significant understory. *Juniperus osteosperma* may be present to codominant. Shrub cover, if present, is sparse (<10% cover). *Artemisia tridentata, Purshia tridentata*, and

Chrysothamnus viscidiflorus are most consistent. Other shrubs include *Amelanchier* spp., *Eriogonum microthecum, Cercocarpus montanus, Gutierrezia sarothrae, Purshia tridentata, Quercus gambelii, Quercus turbinella*, and species of *Opuntia*. Herbaceous cover is typically sparse and dominated by graminoids with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Leymus cinereus (= Elymus cinereus), Elymus elymoides, Hesperostipa comata, Achnatherum thurberianum (= Stipa thurberiana), Poa fendleriana*, or *Poa secunda*. Although forb cover is generally sparse, it may be diverse. Common forbs include *Comandra umbellata ssp. pallida (= Comandra pallida), Cryptantha cinerea var. jamesii (= Cryptantha jamesii)*, and species of *Astragalus, Eriogonum*, and *Phlox*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Elymus elymoides*, *Eriogonum umbellatum*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Opuntia whipplei*, *Penstemon linarioides*, *Pinus monophylla*, *Poa fendleriana*, *Yucca baccata*
Global: *Juniperus osteosperma*, *Pinus monophylla*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941) supports very similar overall species composition and occurs in the same geographic area; however, *Quercus turbinella* dominates the shrub strata and often occurs at relatively high covers.
Global Comments: This pinyon-juniper type may have several shrub species but all occur in small amounts usually totaling less than 10% cover.
Global Similar Associations:
- *Pinus monophylla - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL005397)
- *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941) supports very similar overall species composition, but *Quercus turbinella* dominates the shrub strata and often occurs at relatively high covers.
- *Pinus monophylla* Woodland (CEGL000825)

Global Related Concepts:
- *Juniperus osteosperma / Pinus monophylla* Community (Blackburn et al. 1969d) =
- *Pinus monophylla - Juniperus osteosperma* Association (Peterson 1984) =
- *Pinus monophylla / Juniperus osteosperma* Community (Blackburn et al. 1968a) >
- *Pinus monophylla / Juniperus osteosperma* Dominated Community (Blackburn et al. 1968c) =
- *Pinus monophylla-Juniperus osteosperma* (Bourgeron and Engelking 1994) =

- *Pinus monophylla* Association (Peterson 1984) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- Pinyon - Juniper Woodland Community (Armstrong 1969) >
- Singleleaf pinyon-Utah juniper Series (Sawyer and Keeler-Wolf 1995) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument on the Shivwits Plateau. It was sampled from Horse Valley west to Burnt Canyon Point and from Mount Dellenbaugh south to Twin Point.
Global Range: This woodland association occurs in the Great Basin and northern Mojave Desert.
Nations: US
States/Provinces: AZ, CA:S4, NV:S5, UT
TNC Ecoregions: 6:C, 11:C, 18:P, 19:P
USFS Ecoregions (1994/95): 313A:CC, 342B:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Great Basin, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (16 plots): GRCA.04084, GRCA.04131, GRCA.04140, GRCA.04142, GRCA.04144, GRCA.04161, GRCA.04175, GRCA.04178, GRCA.04183, GRCA.04189, GRCA.04193, GRCA.04195, GRCA.04201, GRCA.04208, GRCA.04210, GRCA.04222.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: Armstrong 1969, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969d, Bourgeron and Engelking 1994, Bradley et al. 1992, Cogan et al. 2004, Driscoll et al. 1984, Heinze et al. 1962, Peterson 1984, Peterson 2008, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Schulz and Hall 2011, Western Ecology Working Group n.d., Wright et al. 1979

***Juniperus osteosperma - (Pinus monophylla) / Arctostaphylos pungens* Woodland**

Utah Juniper - (Singleleaf Pinyon) / Pointleaf Manzanita Woodland
Identifier: CEGL005299

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Juniperus osteosperma - (Pinus monophylla) / Arctostaphylos pungens* Woodland

ELEMENT CONCEPT

Global Summary: This pinyon-juniper woodland association is currently described from Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs at 1800 to 2100 m (5900-6850 feet) elevation and typically on gentle to moderately steep (1-12 degrees), mid and upper sideslopes and plateaus that are often east-facing. It favors moderately- to rapidly-drained silty clay loams, which are derived from basalt and limestone parent materials. This association supports a characteristically dense short-shrub layer beneath an open tree canopy predominantly comprised of *Juniperus osteosperma* with some scattered *Pinus monophylla*. Occasionally, *Juniperus osteosperma* will occur in the tree subcanopy as well. The tall-shrub stratum is typically ill-defined and may include low covers of *Purshia stansburiana* and *Garrya flavescens*. The majority of the cover and diversity in this association occurs in the short-shrub layer which is overwhelmingly dominated by *Arctostaphylos pungens*. Other notable short-shrub species include *Quercus turbinella, Ceanothus greggii*, Yucca baccata, and *Artemisia tridentata ssp. vaseyana*. Dominant graminoids in the sparse herbaceous understory include *Poa fendleriana* and *Bromus tectorum*. A variety of forb species, such as *Arabis* sp., *Eriogonum umbellatum, Sphaeralcea ambigua, Comandra umbellata, Penstemon linarioides*, and *Hymenopappus filifolius*, may all occur at low individual covers. This vegetation type exists within a larger expanse of continuous *Juniperus osteosperma* and *Pinus monophylla* woodland vegetation.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument at 1800 to 2100 m (5900-6850 feet) elevation. It typically occurs on gentle to moderately steep (1-12 degrees), mid and upper sideslopes and plateaus that are often east-facing. It favors moderately- to rapidly-drained silty clay loams, which are derived from basalt and limestone parent materials. Ground cover consists primarily of litter (52%), gravel (25%), rocks (11%), and bare soil (7%). This vegetation type exists within a larger expanse of continuous *Juniperus osteosperma* and *Pinus monophylla* woodland vegetation.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association supports a characteristically dense short-shrub layer (40%) beneath an open tree canopy (10%). The tree canopy is predominantly comprised of *Juniperus osteosperma* (9%) with some scattered *Pinus monophylla* (2%). Occasionally, *Juniperus osteosperma* will occur in the tree subcanopy as well, with up to 10% cover. The tall-shrub stratum is typically ill-defined and may include low covers of *Purshia stansburiana* and *Garrya flavescens*. The majority of the cover and diversity in this association occurs in the short-shrub layer which is overwhelmingly dominated by *Arctostaphylos pungens* (33%). Other notable short-shrub species include *Quercus turbinella* (4%), *Ceanothus greggii* (2%), *Yucca baccata* (2%), and *Artemisia tridentata ssp. vaseyana* (2%). The herbaceous understory averages 4% total cover. Dominant graminoids include *Poa fendleriana* (2%) and *Bromus tectorum* (1%). A variety of forb species, such as *Arabis* sp., *Eriogonum umbellatum, Sphaeralcea ambigua, Comandra umbellata, Penstemon linarioides*, and *Hymenopappus filifolius*, may all occur at low individual covers. Based on the 5 plots sampled in Grand Canyon, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos pungens*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Arctostaphylos pungens*, *Artemisia tridentata* ssp. *vaseyana*, *Ceanothus greggii*, *Juniperus osteosperma*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*, *Quercus turbinella*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs in Grand Canyon-Parashant National Monument; it was sampled from the Shivwits Plateau, particularly around Twin Point.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.04092, GRCA.04138, GRCA.04192, GRCA.04219, GRCA.04221.
Local Description Authors: S. Fugate
Global Description Authors: S. Fugate
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Juniperus osteosperma - (Pinus monophylla) / Ceanothus greggii Woodland

Utah Juniper - (Singleleaf Pinyon) / Mojave Desert Whitethorn Woodland
Identifier: CEGL005300

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Juniperus osteosperma - (Pinus monophylla) / Ceanothus greggii* Woodland

ELEMENT CONCEPT

Global Summary: This pinyon-juniper woodland association is currently described from Grand Canyon-Parashant National Monument Arizona. More survey and classification work are needed to fully characterize this type. It occurs at 1800 to 2050 m (5890-6700 feet) elevation on gently sloping (1-9 degrees) sideslopes and high-level plateaus. It seems to often favor north-facing aspects, but can also occur on east- and south-facing slopes as well. Soils tend to be moderately to well-drained clay silt loams that are typically derived from basalt or limestone parent materials. The tree canopy is comprised primarily of *Juniperus osteosperma* with some occasional *Pinus monophylla*. Many stands support a sparse subcanopy consisting mostly of *Juniperus osteosperma*. *Ceanothus greggii* is the characteristic shrub species in this association, and *Artemisia tridentata* also occurs in most stands at low cover. Various other shrub species, such as *Opuntia whipplei, Quercus gambelii*, Purshia stansburiana, and *Gutierrezia sarothrae*, frequently occur. *Bouteloua gracilis, Poa fendleriana*, Elymus elymoides, and *Bouteloua curtipendula* are the dominant grasses in a sparse herbaceous understory. *Penstemon linarioides, Camissonia* sp., *Eriogonum umbellatum*, and *Hymenoxys richardsonii* are common forb species. This association can occur over large areas, often as part of an extensive network of various *Juniperus osteosperma - Pinus monophylla* vegetation types.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on plateau lands of Grand Canyon-Parashant National Monument. It occurs at 1800 to 2050 m (5890-6700 feet) elevation on gently sloping (1-9 degrees) sideslopes and high-level plateaus. It seems to often favor north-facing aspects, but can also occur on east- and south-facing slopes as well. Soils tend to be moderately to well-drained clay silt loams that are typically derived from basalt or limestone parent materials. Ground cover is dominated by gravel (30%), surface rocks (30%), litter (27%), and bare soil (7%). This association can occur over large areas, often as part of an extensive network of various *Juniperus osteosperma - Pinus monophylla* vegetation types.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports 15-20% canopy cover; however, the canopy can vary in either direction depending upon site conditions. The tree canopy is comprised primarily of *Juniperus osteosperma* (12%) with some occasional *Pinus monophylla* (2%). Many stands support a sparse subcanopy consisting mostly of *Juniperus osteosperma* (3%). Overall shrub cover varies widely; some stands have as little as 5% shrub cover, while dense stands support up to 40% shrub cover. *Ceanothus greggii* (5%, but sometimes much higher) is the characteristic shrub species in this association, and *Artemisia tridentata* (1%) also occurs in most stands. Various other shrub species, such as *Opuntia whipplei (= Cylindropuntia whipplei)* (1%), *Quercus gambelii* (1%), *Purshia stansburiana* (1%), and *Gutierrezia sarothrae* (1%), frequently occur. *Bouteloua gracilis* (3%), *Poa fendleriana* (1%), *Elymus elymoides* (1%), and *Bouteloua curtipendula* (2%) are the dominant grasses in a herbaceous understory that averages 5% total cover. *Penstemon linarioides, Camissonia* sp., *Eriogonum umbellatum*, and *Hymenoxys richardsonii* are common forb species (2%). Based upon the 9 stands sampled, this association hosts slightly below-average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter

plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Ceanothus greggii*
Herb (field)	Forb	*Penstemon linarioides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Bouteloua gracilis*, *Ceanothus greggii*, *Eriogonum umbellatum*, *Juniperus osteosperma*, *Penstemon linarioides*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Penstemon linarioides* (state-vulnerable, G5); **Invasive/Exotic**: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is found at Grand Canyon-Parashant National Monument, where it was sampled on the Shivwits Plateau.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (9 plots): GRCA.04072, GRCA.04091, GRCA.04133, GRCA.04134, GRCA.04143, GRCA.04148, GRCA.04150, GRCA.04172, GRCA.04202.
Local Description Authors: S. Fugate
Global Description Authors: S. Fugate
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Pinus monophylla - Juniperus osteosperma / Bouteloua gracilis* Woodland**

Singleleaf Pinyon - Utah Juniper / Blue Grama Woodland
Identifier: CEGL005396

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma / Bouteloua gracilis* Woodland

ELEMENT CONCEPT

Global Summary: This pinyon-juniper woodland association is currently described from Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs at 1875 to 1925 m (6150-6300 feet) elevation on gently sloping (1-7 degrees) high-level plateaus and sideslopes, and occurs across all aspects. Soils are moderately- to well-drained silty clays derived from basalt parent material. This association typically supports an open tree canopy consisting of *Juniperus osteosperma* and *Pinus monophylla*. In half of the stands, there is a notable subcanopy comprised also of *Pinus monophylla* and *Juniperus osteosperma*. Beneath the tree canopy is an extremely sparse short-shrub layer of *Ceanothus greggii* and *Artemisia tridentata*. Dwarf-shrubs such as *Gutierrezia sarothrae* and *Opuntia* sp. often occur at trace covers. *Bouteloua gracilis* dominates a well-developed graminoid component, while *Poa fendleriana, Elymus elymoides*, and *Aristida purpurea* are frequent at lower covers. Common forbs include *Penstemon linarioides, Eriogonum umbellatum*, and *Hymenoxys richardsonii*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument at 1875 to 1925 m (6150-6300 feet) elevation. It typically occurs on gently sloping (1-7 degrees) high-level plateaus and sideslopes, and occurs across all aspects. Soils are moderately- to well-drained silty clays derived from basalt parent material. Ground cover is primarily dominated by surface rocks (53%), litter (16%), gravel (14%), and bare soil (13%), with small amounts of wood and moss as well.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports an open tree canopy (8-10%) consisting of *Juniperus osteosperma* (7%) and *Pinus monophylla* (2%). In half of the stands, there is a notable subcanopy (3%) comprised also of *Pinus monophylla* and *Juniperus osteosperma*. Beneath the tree canopy is an extremely sparse short-shrub layer (1%) of *Ceanothus greggii* and *Artemisia tridentata*. Dwarf-shrubs such as *Gutierrezia sarothrae* and *Opuntia* sp. often occur at trace covers. *Bouteloua gracilis* (6%) dominates a well-developed graminoid component, while *Poa fendleriana, Elymus elymoides*, and *Aristida purpurea* are frequent at less than 1% cover each. Common forbs (3%) include *Penstemon linarioides, Eriogonum umbellatum*, and *Hymenoxys richardsonii*. This association supports average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Elymus elymoides*, *Eriogonum umbellatum*, *Hymenoxys richardsonii*, *Juniperus osteosperma*, *Penstemon linarioides*, *Pinus monophylla*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Erodium cicutarium* (exotic, Medium/Low), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jul-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) also has a pinyon-juniper canopy and an understory dominated by *Bouteloua gracilis*; however, *Pinus edulis*, and not *Pinus monophylla*, codominates the canopy layer.

Global Similar Associations:

- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) also has a pinyon-juniper

canopy and an understory dominated by *Bouteloua gracilis*, but *Pinus edulis* rather than *Pinus monophylla* codominates the canopy layer.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs in Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (9 plots): GRCA.04187, GRCA.04211, GRCA.04145, GRCA.04129, GRCA.04147, GRCA.04146, GRCA.04200, GRCA.04149, GRCA.04154.
Local Description Authors: S. Fugate
Global Description Authors: S. Fugate
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland**

Singleleaf Pinyon - Utah Juniper / Blackbrush Woodland
Identifier: CEGL002971

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland

ELEMENT CONCEPT

Global Summary: This association has only been described from Zion National Park and Grand Canyon National Park. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument at 1750 to 2050 m (5750-6750 feet) elevation. It typically occurs on gentle to steep (5-45 degrees) mid and upper sideslopes, on north- and northeast-facing aspects. Soils are moderately well-drained to rapidly-drained sandy clay loams derived from basalt and limestone parent materials. Ground cover is dominated by litter (55%), with some gravel (17%), surface rocks (10%), and bare soil (5%). This vegetation type generally occurs within a larger network of other pinyon-juniper woodland associations.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This woodland association typically supports an open tree canopy of 10-15% cover which is codominated by *Juniperus osteosperma* (6%) and *Pinus monophylla* (5%). *Quercus gambelii* (8%) is the sole component of a well-defined and characteristic tall-shrub stratum. *Artemisia tridentata* (1-2%) is characteristic of the somewhat sparse (3%) short-shrub layer; however, other scattered species such as *Purshia stansburiana* (2%) and *Amelanchier utahensis* (1%) also occur. The dwarf-shrub stratum is essentially absent and supports less than 1% cover. A graminoid understory varies from almost absent to very well-developed (up to 25%). *Poa fendleriana* is typically the most prevalent grass species, while *Elymus elymoides* also occurs in some stands. Forbs (3%) such as *Arenaria macradenia, Collomia linearis, Comandra umbellata, Cordylanthus parviflorus, Eriogonum umbellatum, Ipomopsis aggregata, Frasera albomarginata*, and *Penstemon palmeri* are common. Based upon the 3 stands sampled, this association hosts somewhat below-average species diversity among plant communities in Grand

Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Artemisia tridentata*, *Elymus elymoides*, *Juniperus osteosperma*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION

Status: Provisional
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: This association differs from other pinyon-juniper woodland types by the codominance of *Pinus monophylla* (and not *Pinus edulis*) in the canopy layer and the presence of both *Quercus gambelii* and *Artemisia tridentata* in the shrub understory.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled on the Shivwits Plateau.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.01631, GRCA.04114, GRCA.04135.
Local Description Authors: S. Fugate
Global Description Authors:
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

***Pinus monophylla - Juniperus osteosperma / Purshia stansburiana* Woodland**

Singleleaf Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland
Identifier: CEGL005397

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma / Purshia stansburiana* Woodland

ELEMENT CONCEPT

Global Summary: This pinyon-juniper woodland association is currently described from Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs at 1775 to 1850 m (5860-6050 feet) elevation on gently to moderately sloping (1-14 degrees) high-level plateaus, low-level valley bottoms, and mid to upper sideslopes. It often favors south-facing aspects. Soils tend to be well- or rapidly-drained silty clay loams derived from limestone parent materials. This woodland association supports sparse to dense tree canopy of *Juniperus osteosperma* and *Pinus monophylla Purshia stansburiana* dominates and characterizes the shrub strata. Various short shrubs such as *Gutierrezia sarothrae, Ephedra viridis, Artemisia tridentata*, and *Yucca baccata* occur occasionally at relatively low individual covers. *Opuntia whipplei* and *Opuntia* sp. are frequent components of the very sparse dwarf-shrub stratum. The herbaceous understory is poorly developed; frequent graminoids include *Bromus tectorum, Bouteloua gracilis, Poa fendleriana*, and *Elymus elymoides*, while notable forbs include *Eriogonum umbellatum, Cordylanthus parviflorus, Frasera albomarginata*, and *Comandra umbellata*. This vegetation type occurs within a large matrix of pinyon-juniper vegetation types.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument at 1775 to 1850 m (5860-6050 feet) elevation. It typically occurs on gently to moderately sloping (1-14 degrees) high-level plateaus, low-level valley bottoms, and mid to upper sideslopes. It often favors south-facing aspects. Soils tend to be well- or rapidly-drained silty clay loams derived from limestone parent materials. Ground cover is dominated by gravel (50%), litter (27%), bare soil (10%), and surface rocks (5%). This vegetation type occurs within a large matrix of pinyon-juniper vegetation types.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This woodland association typically supports 20-25% tree cover; however, the canopy can be as dense as 50% in some stands, or less than 20% in sparser stands. *Juniperus osteosperma* (13%) and *Pinus monophylla* (8%) codominant the canopy and also occur in the somewhat sparse subcanopy (3%). *Purshia stansburiana* (6-8%) dominates and characterizes the shrub strata in this association. On some stands, it can be quite dense (up to 25%), and in other stands, it occurs at very low covers. Even in these cases, however, *Purshia stansburiana* acts as an indicator species for the association. Various short shrubs such as *Gutierrezia sarothrae, Ephedra viridis, Artemisia tridentata*, and *Yucca baccata* occur occasionally at relatively low individual covers. *Opuntia whipplei (= Cylindropuntia whipplei)* and *Opuntia* sp. are frequent components of the sparse dwarf-shrub stratum (1%). The herbaceous understory is poorly developed with only 2% graminoid cover and 2% forb cover on average. Frequent graminoids include *Bromus tectorum, Bouteloua gracilis, Poa fendleriana*, and *Elymus elymoides*, while notable forbs include *Eriogonum umbellatum, Cordylanthus parviflorus, Frasera albomarginata*, and *Comandra umbellata*. This vegetation type supports average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Purshia stansburiana*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Pinus monophylla*, *Purshia stansburiana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Poa pratensis* (exotic, Medium), *Verbascum thapsus* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jul-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: Some stands of *Pinus monophylla - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL005397) support low shrub and herbaceous cover and may represent *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland (CEGL000829); however, *Purshia stansburiana* acts as an indicator species, even at low covers. *Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL000782) also supports a pinyon-juniper canopy and a strong *Purshia stansburiana* component in the shrub layers; however, *Pinus edulis*, and not *Pinus monophylla*, codominates the canopy. This vegetation type also occurs in the central and eastern portions of the Grand Canyon, while *Pinus monophylla - Juniperus osteosperma* / *Purshia stansburiana* Woodland is restricted to the far western extent of Grand Canyon.

Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL000782) supports a pinyon-juniper canopy and a strong *Purshia stansburiana* component in the shrub layers, but *Pinus edulis* rather than *Pinus monophylla* codominates the canopy.
- *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland (CEGL000829)

Global Related Concepts:

- *Pinus monophylla - Juniperus osteosperma* / *Purshia stansburiana* Woodland (Keeler-Wolf and Thomas 2000) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument. It was sampled from the Shivwits Plateau, particularly on Twin Point and Burnt Canyon Point.

Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (20 plots): GRCA.04215, GRCA.04220, GRCA.04218, GRCA.04074, GRCA.04059, GRCA.04073, GRCA.04174, GRCA.04060, GRCA.04100, GRCA.04217, GRCA.04081, GRCA.04082, GRCA.04066, GRCA.04093, GRCA.04096, GRCA.04095, GRCA.04085, GRCA.04086, GRCA.04105, GRCA.04063, GRCA.04078.

Local Description Authors: S. Fugate

Global Description Authors: S. Fugate

References: Keeler-Wolf and Thomas 2000, Reid and Hall 2010, Western Ecology Working Group n.d.

***Pinus monophylla - Juniperus osteosperma* / *Quercus gambelii* Woodland**

Singleleaf Pinyon - Utah Juniper / Alderleaf Mountain Mahogany - Gambel Oak Woodland

Identifier: CEGL002968

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma* / *Quercus gambelii* Woodland

ELEMENT CONCEPT

Global Summary: This association has only been described from Zion National Park. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument at 1750 to 2050 m (5750-6750 feet) elevation. It typically occurs on gentle to steep (5-45 degrees) mid and upper sideslopes, on north- and northeast-facing aspects. Soils are moderately well-drained to rapidly-drained sandy clay loams derived from basalt and limestone parent materials. Ground cover is dominated by litter (55%), with some gravel (17%), surface rocks (10%), and bare soil (5%). This vegetation type generally occurs within a larger network of other pinyon-juniper woodland associations.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This woodland association typically supports an open tree canopy of 10-15% cover which is codominated by *Juniperus osteosperma* (6%) and *Pinus monophylla* (5%). *Quercus gambelii* (8%) is the sole component of a well-defined and characteristic tall-shrub stratum. *Artemisia tridentata* (1-2%) is characteristic of the somewhat sparse (3%) short-shrub layer; however, other scattered species such as *Purshia stansburiana* (2%) and *Amelanchier utahensis* (1%) also occur. The dwarf-shrub stratum is essentially absent and supports less than 1% cover. A graminoid understory varies from almost absent to very well-developed (up to 25%). *Poa fendleriana* is typically the most prevalent grass species, while *Elymus elymoides* also occurs in some stands. Forbs (3%) such as *Arenaria macradenia, Collomia linearis, Comandra umbellata, Cordylanthus parviflorus, Eriogonum umbellatum, Ipomopsis aggregata, Frasera albomarginata*, and *Penstemon palmeri* are common. Based upon the 3 stands sampled, this association hosts somewhat below-average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Artemisia tridentata*, *Elymus elymoides*, *Juniperus osteosperma*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: This association differs from other pinyon-juniper woodland types by the codominance of *Pinus monophylla* (and not *Pinus edulis*) in the canopy layer and the presence of both *Quercus gambelii* and *Artemisia tridentata* in the shrub understory.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled on the Shivwits Plateau.
Global Range: This association has currently only been described from Zion National Park in southwestern Utah.
Nations: US
States/Provinces: UT
USFS Ecoregions (1994/95): 313A:CC, M341C:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.01631, GRCA.04114, GRCA.04135.
Local Description Authors: S. Fugate
Global Description Authors:
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

Pinus monophylla - Juniperus osteosperma / Quercus turbinella Woodland

Singleleaf Pinyon - Utah Juniper / Turbinella Live Oak Woodland
Identifier: CEGL002941

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Great Basin Pinyon - Juniper Woodland (G247)
Association	*Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland

ELEMENT CONCEPT

Global Summary: This association has only been described from Zion National Park. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in Grand Canyon-Parashant National Monument from 1800 to 2100 m (5875-6900 feet) elevation. It chiefly occurs on high-level plateaus and sideslopes, but also sometimes occurs in drainage channels. Slopes are generally gentle (1-9 degrees) but can sometimes be steeper (13-17 degrees). Soils are moderately- to rapidly-drained silty or sandy clays that occasionally contain loam. When unobscured, the underlying geology is typically limestone or basalt. Stands have a high cover of litter (33%) and gravel (43%) with lesser amounts of rock (13%) and bare soil (5%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages 20-25% but can be as high as 50% in this woodland association. *Pinus monophylla* (11%) and *Juniperus osteosperma* (13%) codominate this vegetation type and occur in both the tree canopy and subcanopy layers. *Quercus turbinella* (5-20%) is the characteristic shrub species and occurs primarily as a short shrub, but also occasionally as a tall shrub. *Ceanothus greggii* (3%), *Purshia stansburiana* (1%), and *Yucca baccata* (up to 1%) are also regularly present in both the short- and dwarf-shrub layers. A sparse dwarf-shrub layer is typically present, with *Phoradendron juniperinum* (up to 1%) and *Opuntia* sp. (up to 1%) occurring most frequently. *Poa fendleriana* (1%), *Bromus tectorum* (1%), and *Bromus rubens* (up to 1%) are frequent in a fairly lacking graminoid layer. *Eriogonum umbellatum* (up to 1%), *Comandra umbellata* (up to 1%), and *Penstemon linarioides* (up to 1%) are among the most frequent species in a relatively weak forb layer (1%). Mosses and lichens also frequently occur in trace amounts. Based upon the 16 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma, Pinus monophylla*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus tectorum*, *Ceanothus greggii*, *Comandra umbellata*, *Eriogonum umbellatum*, *Juniperus osteosperma*, *Penstemon linarioides*, *Phoradendron juniperinum*, *Pinus monophylla*, *Poa fendleriana*, *Purshia stansburiana*, *Quercus turbinella*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: In *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL004007), *Pinus edulis*, and not *Pinus monophylla*, codominates the canopy of this similar woodland community. It occurs in the eastern portions of the Grand Canyon, while *Pinus monophylla* vegetation types are restricted to the western portions of the greater Grand Canyon bioregion.
Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL004007) is codominated by *Pinus edulis* rather than *Pinus monophylla*.
- *Pinus monophylla - Juniperus osteosperma* / Sparse Understory Woodland (CEGL000829)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument on the Shivwits Plateau. It was sampled from Horse Valley west to Burnt Canyon Point, and from Mount Dellenbaugh south to Twin Point.
Global Range: This association has currently only been described from Zion National Park in southwestern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (16 plots): GRCA.04057, GRCA.04061, GRCA.04071, GRCA.04098, GRCA.04101, GRCA.04104, GRCA.04111, GRCA.04116, GRCA.04117, GRCA.04119, GRCA.04137, GRCA.04176, GRCA.04177, GRCA.04182, GRCA.04206, GRCA.04216.
Local Description Authors: R. Meszaros
Global Description Authors: Western Ecology Group
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

G249. Intermountain Basins Curl-leaf Mountain-mahogany Scrub & Woodland

Cercocarpus ledifolius / *Quercus gambelii* Woodland

Curl-leaf Mountain-mahogany / Gambel Oak Woodland
Identifier: CEGL005359

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Intermountain Basins Curl-leaf Mountain-mahogany Scrub & Woodland (G249)
Association	*Cercocarpus ledifolius* / *Quercus gambelii* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is currently described from Bryce Canyon National Park in Utah. It is also reported from Grand Canyon National Park in Arizona. Additional global information will be added as it becomes available. This woodland occurs on a mesatop. The sites are gentle (3-degree slope), occur between 2434 and 2435 m in elevation, and are oriented to the east or west. The ground surface has low exposure of bare soil, high cover of litter, low cover of small rocks, and sparse cover of downed wood. Litter depths range from 0.1-2.6 cm. Soils are rapidly drained silty clay loams or loams derived from new alluvium. Total vegetation cover is dense (70-84% cover) and is characterized by the canopy tree *Cercocarpus ledifolius* that ranges in height from 2-5 m and the tall shrub *Quercus gambelii*. The remaining canopy layer provides sparse cover and includes *Juniperus osteosperma*. The herbaceous layer is moderately diverse floristically and provides sparse to moderate cover. The medium-tall bunch grasses *Leymus salinus* and *Pseudoroegneria spicata (= Elymus spicatus)* provide low to moderate cover. Forbs include *Lappula occidentalis, Packera multilobata (= Senecio multilobatus)*, and *Chaetopappa ericoides*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This curl-leaf mountain-mahogany woodland association occurs on the North Rim. It occurs at approximately 2425 m (7950 feet) elevation on the high-level plateau, directly on the edge of the rim. It typically occurs on flat to gently sloping (3 degrees), south-facing slopes. It seems to favor rapidly-drained, limestone-derived, sandy loam soils. Ground cover is ubiquitously dominated by deciduous litter (70%); gravel (12%), moss (3%) and downed wood (4%) are also present. This community is restricted to rimrock environments on the North Rim, particularly on the eastern portion of the North Rim area.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 35-40% in this association. A well-developed tall-shrub layer of *Cercocarpus ledifolius* (25-30%) and *Quercus gambelii* (5-10%) characterizes this association. *Ribes leptanthum* (2%) and *Ribes cereum* (1%) occur sporadically as short shrubs, and *Opuntia erinacea* (2%) is a common ground-hugging dwarf-shrub. This community supports a well-developed graminoid understory (10%) dominated by *Poa fendleriana* (4%) and *Bouteloua gracilis* (2%). Other notable graminoids include *Carex geophila, Elymus elymoides*, and *Hesperostipa comata*, all of which occur at about 1% cover. A variety of scattered forb species, including *Petradoria pumila, Packera multilobata, Pedicularis centranthera, Erigeron divergens*, and *Schoenocrambe linearifolia*, comprise a well-developed forb understory (8%). *Pinus edulis* (3%) seedlings are common. Based upon the single stand sampled, this association hosts slightly above-average species diversity among Grand Canyon plant communities, with 24 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

GGrand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus ledifolius*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ribes leptanthum*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved evergreen tree	*Cercocarpus ledifolius*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Cercocarpus ledifolius*, *Packera multilobata*, *Pedicularis centranthera*, *Petradoria pumila*, *Poa fendleriana*, *Quercus gambelii*, *Ribes cereum*, *Ribes leptanthum*, *Schoenocrambe linearifolia*

Global: *Cercocarpus ledifolius*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (7-Mar-2008).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Abies concolor* / *Cercocarpus ledifolius* Woodland (CEGL000885) also hosts a significant component of *Cercocarpus ledifolius*; however, it also supports a well-developed tree canopy of *Abies concolor*. Both this association and *Cercocarpus ledifolius* / *Quercus gambelii* Woodland (CEGL005359) occur in similar rimrock habitats on the North Rim.

Global Similar Associations:

- *Abies concolor* / *Cercocarpus ledifolius* Woodland (CEGL000885) also contains a significant component of *Cercocarpus ledifolius*, but with a well-developed tree canopy of *Abies concolor*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known only from the North Rim, where it was sampled from Cape Final. It is fairly abundant on the rim of Cape Final, but seems to be quite uncommon elsewhere in the park.

Global Range: This woodland association is currently only known from Bryce Canyon National Park, Utah, and Grand Canyon National Park, Arizona. Additional range information will be added as it becomes available.

Nations: US

States/Provinces: AZ, UT

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): M341C:CC

Federal Lands: NPS (Bryce Canyon, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02088.

Local Description Authors: K. Christie

Global Description Authors: M. Smith and J. Von Loh

References: Reid and Hall 2010, Tendick et al. 2011b, Western Ecology Working Group n.d.

G246. Intermountain Juniper Savanna

Juniperus osteosperma / Elymus elymoides Woodland [Park Special]

Utah Juniper / Squirreltail Woodland

Identifier: CEPS009533

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Intermountain Juniper Savanna (G246)
Association	*Juniperus osteosperma / Elymus elymoides* Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Utah juniper woodland association occurs on the high-level plateau in Grand Canyon-Parashant National Monument at approximately 1825 (6000 feet) elevation. It occurs on flat or gentle slopes (1-2 degrees), often with south-facing aspects. Soils tend to be moderately well-drained silty clays derived from basalt parent material. Ground cover is comprised primarily of gravel (53%), bare soil (25%), litter (10%), and rocks (10%). This association often occurs in areas composed of a matrix of variable *Juniperus osteosperma* woodland vegetation types.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports a moderately dense tree canopy composed almost entirely of *Juniperus osteosperma* (20-25%), but a few scattered *Pinus monophylla* (1%) may occur. There are no tall shrubs and a very insignificant short-shrub cover of *Purshia stansburiana*. The dwarf-shrub (1%) layer is poorly-developed as well, but may include various species such as *Eriogonum wrightii, Opuntia phaeacantha, Echinocereus triglochidiatus, Opuntia engelmannii*, and *Artemisia tridentata ssp. vaseyana*. The herbaceous understory in this vegetation type is well-developed with 10-12% graminoid cover and 2% forb cover. *Elymus elymoides* (11%) is the dominant and characteristic grass and is accompanied by low amounts of *Bromus tectorum* and *Poa fendleriana*. Notable forbs include *Eriogonum umbellatum, Lappula occidentalis, Sphaeralcea ambigua, Erodium cicutarium, Portulaca oleracea*, and *Psoralidium tenuiflorum*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Forb	*Lappula occidentalis*
Herb (field)	Graminoid	*Elymus elymoides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Elymus elymoides*, *Juniperus osteosperma*, *Lappula occidentalis*, *Pinus monophylla*, *Sphaeralcea ambigua*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.04205, GRCA.04207.
Local Description Authors: S. Fugate
Global Description Authors:
References: Western Ecology Working Group n.d.

Juniperus osteosperma / Pleuraphis jamesii Woodland

Utah Juniper / James' Galleta Woodland
Identifier: CEGL002362

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Intermountain Singleleaf Pinyon - Western Juniper Woodland (M026)
Group	Intermountain Juniper Savanna (G246)
Association	*Juniperus osteosperma* / *Pleuraphis jamesii* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association occurs on valley floors, ridges, and benches in northwestern Colorado and eastern Utah. Sites have gentle to moderate slopes (2-16%), occur between 1341 and 1860 m elevation, and may be oriented to any aspect. The unvegetated surface has high cover of litter and low exposure of bare soil. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, talus, eolian sands or alluvium. Stands occur in relatively small patches, often in a mosaic with other pinyon-juniper / grass understory woodland types. Total vegetation cover rarely exceeds 60%. The tree canopy consists of *Juniperus osteosperma* with between 5 and 40% cover. *Pinus edulis* is generally absent. Scattered shrubs, such as *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Opuntia polyacantha*, may be present, but there is no developed shrub layer. The herbaceous stratum is sparse to moderately dense and is dominated by graminoids. *Pleuraphis jamesii* is dominant to codominant and is generally accompanied by other grasses such as *Achnatherum hymenoides, Bouteloua gracilis*, or *Hesperostipa comata*. Forbs are sparse in cover and inconsistent in composition among sites. Biological soil crusts may be well-developed in areas that are protected from grazing.

ENVIRONMENTAL DESCRIPTION

Global Environment: This woodland association occurs on valley floors, ridges, and benches in northwestern Colorado and eastern Utah. Sites have gentle slopes (3-5%), occur between 1579 and 1860 m elevation, and may be oriented to any aspect. The unvegetated surface has high cover of litter and low exposure of bare soil. Soils are well-drained sands, sandy clays, or clay loams derived from shales, sandstones, or a mix of the two.

VEGETATION DESCRIPTION

Global Vegetation: This woodland association occurs in relatively small patches, often in a mosaic with other pinyon-juniper woodland types. Total vegetation cover rarely exceeds 60%. The tree canopy consists of *Juniperus osteosperma* with between 20 and 40% cover. *Pinus edulis* is absent or occurs only as scattered individuals. Scattered shrubs, such as *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae*, and *Opuntia polyacantha*, may be present, but there is no developed shrub layer. The herbaceous stratum is sparse to moderately dense and is dominated by graminoids. *Pleuraphis jamesii* is dominant to codominant and is generally accompanied by other grasses such as *Achnatherum hymenoides, Bouteloua gracilis*, or *Hesperostipa comata*. Forbs are sparse in cover and inconsistent in composition among sites.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Global: *Juniperus osteosperma*, *Pleuraphis jamesii*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Mar-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:

- *Juniperus osteosperma* / *Bouteloua gracilis* Woodland (CEGL002361)

- *Juniperus osteosperma / Hesperostipa comata* Woodland (CEGL002815)
- *Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii* Woodland (CEGL002379)

ELEMENT DISTRIBUTION

Global Range: This association has been documented in northwestern Colorado and eastern Utah. It is likely to be widespread throughout the Colorado Plateau, including Arizona and New Mexico.
Nations: US
States/Provinces: AZ, CO, NM?, UT
TNC Ecoregions: 9:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles
References: Clark et al. 2009, Coles et al. 2008a, Reid and Hall 2010, Romme et al. 1993, Western Ecology Working Group n.d.

M027. Rocky Mountain Two-needle Pinyon - Juniper Woodland

G251. Colorado Plateau Pinyon - Juniper Scrub

Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland

Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland
Identifier: CEGL000779

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Scrub (G251)
Association	*Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association occurs on dry sandstone ridgetops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations of 1484 to 2470 m (4870-8100 feet) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common, and slopes can be variable in steepness. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in the cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Bare soil is common. The vegetation is characterized by a short (2-10 m), open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (5-25% cover). *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, though higher covers are possible. The shrubs *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii*, or *Yucca* spp. are often present in many stands. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses such as species of *Cryptantha*, *Penstemon*, and *Opuntia*, *Achnatherum hymenoides (= Oryzopsis hymenoides)*, *Bouteloua gracilis, Elymus elymoides, Pleuraphis jamesii*, and *Poa fendleriana*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association predominantly occurs in the Inner Canyon on slickrock terraces of the Esplanade Formation, but also occurs in the Inner Canyon on sideslopes of canyons. It occurs from 1350 to 1975 m (4450-6450 feet) elevation on shallow to steep (1-35 degrees) sideslopes and terraces. On steeper terrain, this association seems to prefer western aspects, while on gradual terrain, it occurs across all aspects. Soils are rapidly-drained sandy loams derived from sandstone. Bedrock (33%), gravel (24%), surface rocks (11%), bare soil (11%), litter (10%), and a relatively high cover of cryptogamic soil crust (5%) are all common components of the ground cover. This vegetation type appears to have a wide elevational range in the

park and seems to exist in two distinct environments.

Global Environment: This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, colluvial slopes, slickrock hills, benches and knolls at moderate elevations (1484 -2470 m) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common, and slopes can vary from gentle to steep. Exposed bedrock and large rock may cover over 50% of the stand, with vegetation growing in soil that has collected in joints and cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Soils are rapidly drained sandy loams, sands, or silt loams derived from colluvium derived from a variety of parent materials, including Carmel Formation, Cedar Mesa sandstone, Chinle Formation, Dakota Formation, Kayenta Formation, Morrison Formation, Navajo Formation, or Wingate Formation. Bare soil is common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This sparse woodland association typically supports 5-7% canopy cover, which is comprised of *Pinus edulis* (4%) and *Juniperus osteosperma* (2%). *Cercocarpus intricatus* (3%) characterizes the shrub strata, although it is not always the most dominant shrub species on each site. *Quercus turbinella* (5-6%) commonly codominates the shrub layers and can occur as either a tall or short shrub. The short-shrub layer (10-12%) is typically quite diverse in this association and includes various chaparral species such as *Glossopetalon spinescens* (2%) and *Ephedra viridis* (1%), and occasionally *Cercocarpus montanus* (2%), *Bernardia myricifolia* (2%), and *Rhus trilobata* (2%). *Gutierrezia sarothrae* (1%), *Agave utahensis* (2%), and *Opuntia polyacantha* (1%) are common components of the fairly sparse dwarf-shrub layer. *Achnatherum speciosum* (2%) is a common graminoid component; however, various other grasses can occur at low covers. Species such as *Heterotheca villosa, Phlox austromontana*, and *Leptodactylon pungens (= Linanthus pungens)* are common in the relatively sparse (2%) forb understory.

Global Vegetation: The association is characterized by an open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (5-25% cover). The tree canopy may be between 2 and 10 m tall; *Pinus edulis* and *Juniperus osteosperma* vary in cover between 1 and 15%, with some stands having up to 25% cover of *Pinus edulis*. Some stands may have an occasional emergent *Pinus ponderosa, Pseudotsuga menziesii*, or *Juniperus scopulorum* tree. Additionally, some sparse (<10% total cover), tree-dominated stands from extremely dry, rocky sites in the Colorado Plateau are included in this woodland association as a best fit. The shrub layer represents the mesic end of the pinyon-juniper / mixed shrub understory communities found on slickrock exposures. *Amelanchier utahensis, Arctostaphylos patula, Gutierrezia sarothrae, Mahonia fremontii, Quercus gambelii* (low cover), or *Yucca* spp. are often present in many stands. A variety of other shrubs and dwarf-shrubs may be present depending on location, including *Artemisia bigelovii, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlerella utahensis, Fraxinus anomala, Glossopetalon spinescens var. meionandrum, Holodiscus dumosus, Philadelphus microphyllus, Purshia stansburiana, Quercus turbinella*, or *Shepherdia rotundifolia*. *Coleogyne ramosissima* is typically absent. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses, such as species of *Cryptantha, Penstemon*, and *Opuntia, Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Elymus elymoides, Pleuraphis jamesii*, and *Poa fendleriana*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	*Agave utahensis*
Herb (field)	Graminoid	*Achnatherum speciosum*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus intricatus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Cercocarpus intricatus*, *Ephedra viridis*, *Glossopetalon spinescens*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Opuntia polyacantha*, *Pinus edulis*, *Quercus turbinella*
Global: *Cercocarpus intricatus*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)
Global: Vulnerable: *Hymenoxys lapidicola* (G1), *Shepherdia rotundifolia* (G3G4); **Other**: *Glossopetalon spinescens* var. *meionandrum* (G5T3), *Yucca elata* var. *utahensis* (endemic variety, G5T3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (30-Dec-2000). The plant association is limited to a small geographic area and is documented from a narrow elevational band on sandstone substrates in extreme northwestern Colorado and possibly adjacent Utah. There are 11 documented stands in Colorado with size ranging from 4-450 acres. Although most occurrences are considered in good to excellent condition, those in excellent condition tend to be small. Grazing and woodcutting are the primary threats where stands are accessible.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL004007) also supports a woodland canopy of pinyon and juniper and abundant *Quercus turbinella* in the shrub layers. However, *Cercocarpus intricatus* rarely occurs in this community, and when it does occur, it is at lower covers than in *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000779).
Global Comments: Compare this association with *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733) which is very similar, but lacks *Pinus edulis*. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Cercocarpus intricatus* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:

- *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733)
- *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL004007) supports a woodland canopy of pinyon and juniper and abundant *Quercus turbinella* in the shrub layers, but *Cercocarpus intricatus* rarely occurs.

Global Related Concepts:

- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker 1983c) =
- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker 1984a) =
- *Juniperus osteosperma - Pinus edulis / Cercocarpus ledifolius var. intricatus* Plant Association (Baker and Kennedy 1985) =
- *Pinus edulis/Cercocarpus ledifolius* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known the Inner Canyon, where it was sampled from west of Hubbell Butte, on canyon slopes south of Toroweap Point, and from Surprise Valley.
Global Range: This plant association is found on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming.
Nations: US
States/Provinces: AZ, CO:S3, UT, WY

TNC Ecoregions: 9:C, 10:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 341C:CC, M331E:CC, M341C:CC
Federal Lands: NPS (Arches, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Natural Bridges, Navajo, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01582, GRCA.02594, GRCA.04645, GRCA.04646.
Local Description Authors: S. Fugate
Global Description Authors: A.E. Black, mod. K.A. Schulz, J. Drake, J. Coles
References: Baker 1983b, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Driscoll et al. 1984, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010a, Thomas et al. 2010, Von Loh et al. 2007, WNDD unpubl. data, Western Ecology Working Group n.d., Zimmerman 1978

Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland

Two-needle Pinyon - Utah Juniper / Blackbrush Woodland
Identifier: CEGL000781

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Scrub (G251)
Association	*Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association has been described from valley bottoms, terraces, benches, slopes, mesa rims, elevated plains and rolling terrain sometimes interrupted by bedrock. It occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Arizona and probably also Nevada. Sites are on flat to moderate slopes (0-20%) between 1070 and 1890 m (3500-6200 feet) elevation on all aspects. Bare soil covers most of the unvegetated surface, although cryptogam cover can be as high as 45%. Soils are typically shallow, rocky sandy loams derived from sandstone, eolian sands, alluvium or limestone. A few stands occur on deep or clay-textured soils derived from shale. Stands of this association can vary greatly in appearance, ranging from sparsely vegetated (<10% total cover) to relatively dense (80% cover). Sparsely vegetated stands also tend to have dwarfed trees not exceeding 2 m in height. Typically, stands have an open (5-25% cover) tree canopy 3-6 m tall that contains both *Pinus edulis* and *Juniperus osteosperma*, although one or the other tree may dominate. The shrub layer has 5 to 55% cover and is dominated by *Coleogyne ramosissima*. In Arizona, *Mortonia sempervirens* may be codominant. Other common shrub species may include *Agave utahensis, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens var. aridum (= Glossopetalon nevadense), Glossopetalon spinescens , Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Quercus turbinella, Yucca baccata, Yucca harrimaniae*, and *Yucca elata var. utahensis (= Yucca utahensis)*. The sparse herbaceous layer is composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Poa fendleriana, Bouteloua curtipendula*, and *Aristida* species. *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* may be present to abundant in disturbed sites. Forbs are typically variable and scattered, contributing little cover. *Lappula occidentalis, Lepidium montanum, Chaenactis stevioides, Psilostrophe sparsiflora*, and *Streptanthella longirostris* are among the many species that have been recorded. Scattered cacti are often present, including *Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha, Echinocereus triglochidiatus*, and *Echinocereus engelmannii*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in the Inner Canyon at approximately 1600 to 1625 m (5300-5350 feet) elevation, and in the Western Grand Canyon at 1350 to 1500 m (4425-4900 feet). In both locations, it exists on gently sloping (0-8 degrees) sideslopes, terraces, and plateaus. It can occur across various aspects, typically in well- to rapidly-drained sandy soils. The ground cover is dominated by bare soil (45%), litter (20%), and gravel (17%), with more gravel present on sites in the Western Grand Canyon. This

vegetation type represents vast transition zones between more predominant pinyon-juniper woodlands above and blackbrush shrublands below.

Global Environment: This woodland association has been described from valley bottoms, terraces, benches, slopes, mesa rims, elevated plains and rolling terrain sometimes interrupted by bedrock. It likely occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Nevada. Sites are on flat to moderate slopes (0-20%) between 1070 and 1890 m (3500-6200 feet) elevation on all aspects. Bare soil covers most of the unvegetated surface, although cryptogam cover can be as high as 45%. Soils are typically shallow, rocky sandy loams derived from sandstone, eolian sands, alluvium or limestone. A few stands occur on deep or clay-textured soils derived from shale. Parent materials are variable and include eolian deposits derived from Cedar Mesa, Dakota or Navajo sandstones and the Morrison Formation (Salt Wash Member), Kayenta Formation, and Moenkopi Formation.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characterized by an open woodland canopy of *Pinus edulis* (7%) with occasional and scattered *Juniperus osteosperma* (1%). *Coleogyne ramosissima* (9%) dominates the short-shrub layer, which is well-represented and averages about 15% cover. Other typical shrub species include *Yucca baccata* (2%), as well as scattered *Ceanothus greggii, Ephedra fasciculata, Mahonia fremontii*, and *Glossopetalon spinescens* at low covers. In one plot sampled in the Western Grand Canyon, *Mortonia utahensis* (4%) was nearly codominant in the short-shrub stratum. The dwarf-shrub stratum averages 3% cover and consists mostly of *Gutierrezia microcephala* (2%), *Thamnosma montana* (1%), and *Opuntia polyacantha* (1%). The herbaceous understory is quite sparse and is comprised mainly of graminoids, including *Bromus rubens* (1%) and *Vulpia octoflora* (trace cover). *Poa fendleriana* was seen atypically on one site at 6% cover. Forbs occur in trace amounts as well and often include *Cordylanthus parviflorus* and *Lepidium* sp.

Global Vegetation: Stands of this association can vary greatly in appearance, ranging from sparsely vegetated (<10% total cover) to relatively dense (80% cover). Sparsely vegetated stands also tend to have dwarfed trees not exceeding 2 m in height. Typically, stands have an open (5-25% cover) tree canopy 3-6 m tall that contains both *Pinus edulis* and *Juniperus osteosperma*, although one or the other tree may dominate. The shrub layer has 5 to 55% cover and is dominated by *Coleogyne ramosissima*. In some parts of the range, *Mortonia sempervirens* may be codominant. Other shrub species present may include *Agave utahensis, Cercocarpus montanus, Ephedra viridis, Glossopetalon spinescens var. aridum (= Glossopetalon nevadense), Glossopetalon spinescens, Gutierrezia sarothrae, Opuntia polyacantha, Purshia stansburiana, Quercus turbinella, Yucca baccata, Yucca harrimaniae*, and *Yucca elata var. utahensis (= Yucca utahensis)*. The sparse herbaceous layer is composed of graminoids such as *Achnatherum hymenoides, Achnatherum speciosum (= Stipa speciosa), Elymus elymoides, Poa fendleriana, Bouteloua curtipendula*, and *Aristida* species. *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* may be present to abundant in disturbed sites. Forbs are typically variable and scattered, contributing little cover. *Lappula occidentalis, Lepidium montanum, Chaenactis stevioides, Psilostrophe sparsiflora*, and *Streptanthella longirostris* are among the many species that have been recorded. Scattered cacti are often present, including *Opuntia erinacea, Opuntia phaeacantha, Opuntia polyacantha, Echinocereus triglochidiatus*, and *Echinocereus engelmannii*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus edulis*
Short shrub/sapling	Thorn shrub	*Coleogyne ramosissima*
Herb (field)	Dwarf-shurb	*Gutierrezia microcephala*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Mortonia sempervirens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Coleogyne ramosissima*, *Gutierrezia microcephala*, *Juniperus osteosperma*, *Opuntia polyacantha*, *Pinus edulis*, *Thamnosma montana*, *Yucca baccata*
Global: *Coleogyne ramosissima*, *Ephedra viridis*, *Juniperus osteosperma*, *Mortonia sempervirens*, *Pinus edulis*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High); **Other**: *Quercus havardii* var. *tuckeri* (G4T3?Q)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (19-Sep-2000). This late-seral woodland association occurs extensively across the Colorado Plateau in southwestern Colorado and southern Utah into Arizona and probably also Nevada. Introduced annual grasses such as *Bromus rubens* may threaten this woodland because the dry annual grasses provide fine fuels that allow fire to spread. *Coleogyne ramosissima* is very sensitive to fire. A hot fire will completely remove this shrub from a site for decades. More survey work is needed to assess the entire range of this type.

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: In the Inner Canyon, this vegetation type can be differentiated from other pinyon-juniper woodlands by the overwhelming presence of *Coleogyne ramosissima* beneath the woodland canopy. It appears to exist in the transition zones between more predominant *Pinus edulis - Juniperus osteosperma* woodlands above and more homogenous *Coleogyne ramosissima* shrublands below. These transitional areas can be extensive and well-established in some areas and, therefore, are thought to be a well-defined association rather than an ecotonal area. In the Western Grand Canyon, this vegetation type can be differentiated from other similar types by the overwhelming presence of *Coleogyne ramosissima*.
Global Similar Associations:
- *Coleogyne ramosissima* Shrubland (CEGL001332)
- *Pinus edulis - Juniperus osteosperma / Purshia tridentata* Woodland (CEGL000789)

Global Related Concepts:
- *Coleogyne ramosissima - Pinus edulis - Juniperus osteosperma - Ephedra viridis* Association (122.4147) (Warren et al. 1982) **=**
- *Pinus edulis / Coleogyne ramosissima* Plant Association (Stuever and Hayden 1997a) **=**
- *Pinus edulis / Coleogyne ramosissima* Plant Association (Larson and Moir 1987) **=**
- *Pinus edulis/Coleogyne ramosissima* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from the Esplanade Formation near Mount Huethawali; and from the Western Grand Canyon, where it was sampled from the vicinity of 220-Mile Canyon.
Global Range: This woodland association occurs extensively across the Colorado Plateau from southwestern Colorado through southern Utah into Arizona. It is likely to occur in California and Nevada. More survey work is needed to assess the range.
Nations: US
States/Provinces: AZ:S3, CO:S2, NV?, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (4 plots): GRCA.01115, GRCA.01635, GRCA.01642, GRCA.02035.

Local Description Authors: S. Fugate
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, FEIS 1996, Larson and Moir 1987, Reid and Hall 2010, Romme et al. 1993, Stuever and Hayden 1997a, Warren et al. 1982, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland

Two-needle Pinyon - Utah Juniper / Turbinella Live Oak Woodland
Identifier: CEGL004007

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Scrub (G251)
Association	*Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in northern Arizona in the southern Colorado Plateau. It occurs on canyon slopes, rims and mesatops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands. The vegetation is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have tree cover between 5-10% cover. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha var. polyacantha*, and *Opuntia whipplei*. Herbaceous cover is variable, ranging from sparse to moderately dense, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Exotic annual grass *Bromus tectorum* is present in some stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in the Inner Canyon, the Western Grand Canyon, and in Grand Canyon-Parashant National Monument. It occurs from approximately 1300 to 1950 m (4200-6200 feet) elevation on sideslopes, terraces, and ledges, and often occurs on the Esplanade Sandstone Formation. It can occur across all aspects (although it appears to favor either north-facing or south-facing slopes), at a variety of topographic positions, and on a wide variety of slopes (2-40 degrees). Soils are rapidly-drained sandy loams derived from mostly sandstone or limestone parent materials. Gravel (34%), rocks (25%), litter (17%), bedrock (7%), and bare soil (7%) are common components of the ground cover. This vegetation type can be expansive where it occurs.
Global Environment: This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona. It occurs on canyon slopes, rims, and mesatops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: The floristic composition and vegetation density in this association show a relatively high degree of variability. The tree canopy can support anywhere from 5 to 35% cover but is typically about 15%. *Pinus edulis* (6%) and *Juniperus osteosperma* (11%) dominate the woodland canopy, although the relative cover between these two dominants varies from stand to stand. A huge variety of up to 40 different shrub species can occur in this association, and total shrub cover typically averages 15%. *Quercus turbinella* is the most frequently occurring shrub species and characterizes the understory. It primarily exists as a short shrub with anywhere between 5 and 35% cover. Other common short shrub species include *Ceanothus greggii* (2%), *Ephedra viridis* (4%), and *Glossopetalon spinescens* (4%). Common dwarf-shrubs include *Agave utahensis* (1%), *Yucca baccata* (1%), *Gutierrezia*

sarothrae (1%), *Thamnosma montana* (1%), and *Opuntia* spp. (1%). In general, the understory in this association is somewhat sparse (4%) compared to the shrub strata, although over 20 different grass species and over 70 different forbs may be present. *Achnatherum speciosum* (1%) and *Poa fendleriana* (1%) are the most common and dominant graminoids. *Cryptantha* spp. and *Artemisia ludoviciana* are among the most common forbs, typically with less than 1% cover each. A large variety of other forbs, such as *Sphaeralcea grossulariifolia, Phlox austromontana, Draba cuneifolia*, and *Psilostrophe sparsiflora*, occur in trace amounts. Although there is significant variation in this community, it can be characterized by its open to dense woodland canopy, its remarkable shrub diversity, and the dominance of *Quercus turbinella* in the shrub strata.

Global Vegetation: This woodland is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have tree cover between 5 and 10%. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Amelanchier utahensis, Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha var. polyacantha, Opuntia whipplei*, and *Purshia stansburiana*. Additional shrubs contribute low cover and include *Ericameria nauseosa, Gutierrezia sarothrae, Opuntia erinacea, Rhus trilobata var. trilobata (= Rhus aromatica var. trilobata), Shepherdia rotundifolia, Sclerocactus whipplei*, and *Yucca angustissima var. kanabensis (= Yucca kanabensis)*. Herbaceous cover is variable, ranging from sparse to moderate, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Other common species include grasses *Achnatherum hymenoides, Aristida purpurea, Bouteloua barbata, Bouteloua curtipendula, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana*, and forbs such as *Brickellia microphylla var. scabra, Gutierrezia microcephala, Heterotheca villosa, Lesquerella fendleri*, and *Stephanomeria minor var. minor*. Exotic annual grass *Bromus tectorum* is present in some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Achnatherum speciosum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Ceanothus greggii*, *Ephedra viridis*, *Glossopetalon spinescens*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Pinus edulis*, *Poa fendleriana*, *Quercus turbinella*, *Thamnosma montana*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (19-Jul-2006).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This association differs from other *Pinus edulis - Juniperus osteosperma* communities by the open arrangement of the tree canopy and the well-developed shrub layer dominated by *Quercus turbinella*. This vegetation type is most typically seen on rocky and gravelly sideslopes, as opposed to rims and plateaus.
Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000779)
- *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, the Western Grand Canyon, and from Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled from Kwagunt Creek, near Freya Castle, near Juno Temple, Bright Angel Canyon, Drummond Plateau, near Cove Canyon, and in the vicinity of Toroweap Valley. It was sampled on in the Western Grand Canyon from 220-Mile Canyon and Tincanebits Canyon. In Grand Canyon-Parashant National Monument, it was sampled from near Mount Dellenbaugh.
Global Range: This woodland is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC
Federal Lands: NPS (Canyon de Chelly, Grand Canyon, Grand Canyon-Parashant, Pipe Spring)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (16 plots): GRCA.01538, GRCA.01574, GRCA.01578, GRCA.01640, GRCA.02034, GRCA.02587, GRCA.02588, GRCA.02598, GRCA.02601, GRCA.02606, GRCA.02617, GRCA.02643, GRCA.03586, GRCA.03590, GRCA.04184, GRCA.04209.
Local Description Authors: S. Fugate
Global Description Authors: K.A. Schulz, mod. G. Kittel
References: Coles et al. 2008b, Reid and Hall 2010, Thomas et al. 2010, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland

Two-needle Pinyon - Utah Juniper / Mixed Shrubs Talus Woodland
Identifier: CEGL002328

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Scrub (G251)
Association	*Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland

ELEMENT CONCEPT

Global Summary: This Colorado Plateau open woodland association is found in western Colorado and eastern Utah generally on lower slopes where talus and rockfalls accumulate. Sites can be between 1330 and 2290 m (4365-7500 feet) elevation. Slopes can be gentle to steep and of any aspect. The unvegetated ground surface is mostly bedrock and large and small rocks. Soils are rapidly drained. The parent material is talus rockfall. This woodland association can have sparse to moderate vegetation cover (4-61%) but is most often relatively sparse (<15% cover). The sparse to open tree canopy is 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* are the dominant canopy trees; either species can range from extremely low to moderate cover. The composition of the shrub stratum can be diverse, but cover is sparse to low. Common species are *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Eriogonum corymbosum, Fendlera rupicola, Gutierrezia sarothrae, Opuntia* spp., and *Rhus trilobata*. The herbaceous layer also provides sparse to low cover. Common graminoid species are *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Pleuraphis jamesii*, and *Poa fendleriana*. Common forbs are *Chamaesyce fendleri, Descurainia pinnata, Heterotheca villosa, Lepidium montanum*, and *Streptanthus cordatus*. Cryptogams are rare or absent on these active slopes.

ENVIRONMENTAL DESCRIPTION

Global Environment: This association is found on midslopes of ridges on dry colluvial slopes and in ravines and canyons on talus and rockfalls in the Colorado Plateau. Sites are found between 1330 and 2290 m elevation. Slopes can be gentle to steep (up to 78%) and of any aspect. The unvegetated ground surface is mostly bedrock and large and small rocks. Bare soil and litter are also found. Soils are variable and are generally rapidly drained clay loam,

loam, sandy loam, loamy sand and, less commonly, silty clay soils. The parent material is talus rockfall and older landslide deposits from the Tidwell Member of the Morrison Formation, Chinle Formation, Kayenta and Wingate sandstones, Moenkopi Formation and Cutler Group (including Cedar Mesa sandstone).

VEGETATION DESCRIPTION

Global Vegetation: This woodland association can have very sparse to moderate total vegetation cover (4-61%) but is most often relatively sparse (<15%). The sparse to open tree canopy is 2-10 m tall. *Pinus edulis* and *Juniperus osteosperma* are the dominant canopy trees. Either species can have extremely low cover. *Juniperus osteosperma* has been observed with up to 45% cover, and *Pinus edulis* with up to 15% cover. A few *Fraxinus anomala* may be found in some stands. The composition of the shrub stratum can be diverse, but cover is sparse to low. Common species are *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. vaseyana, Brickellia microphylla, Cercocarpus montanus, Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra viridis, Ephedra torreyana, Eriogonum corymbosum, Fendlera rupicola, Gutierrezia sarothrae, Opuntia* spp., and *Rhus trilobata*. The herbaceous layer also provides sparse to low cover, usually less than 5%. Common graminoid species are *Achnatherum hymenoides, Aristida purpurea, Bromus tectorum, Elymus elymoides, Pleuraphis jamesii*, and *Poa fendleriana*. Common forbs are *Chamaesyce fendleri, Descurainia pinnata, Heterotheca villosa, Lepidium montanum*, and *Streptanthus cordatus*. Cryptogams are rare or absent on these active slopes.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii, Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Opuntia fragilis*
Herb (field)	Graminoid	*Achnatherum hymenoides, Elymus elymoides, Poa fendleriana*

CHARACTERISTIC SPECIES

Global: *Artemisia bigelovii*, *Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High); **Other**: *Cercocarpus montanus* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:

- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)

ELEMENT DISTRIBUTION

Global Range: This association is found on the eastern edge of the Colorado Plateau and western slope of the southern Rocky Mountains in western Colorado.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Colorado, Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Drake, mod. K.A. Schulz
References: Coles et al. 2009a, Coles et al. 2010, Reid and Hall 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

G250. Colorado Plateau Pinyon - Juniper Woodland

Juniperus osteosperma / Artemisia tridentata Woodland

Utah Juniper / Basin Big Sagebrush Woodland
Identifier: CEGL000730

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Juniperus osteosperma / Artemisia tridentata* Woodland

ELEMENT CONCEPT

Global Summary: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1220 to 2260 m (4000-7400 feet). This community generally occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable. The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata ssp. wyomingensis* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 20%, and canopy height is usually 2-10 m. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia* spp., may be present but generally with low cover. The sparse to moderately dense herbaceous layer is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Utah juniper woodland association occurs on plateaus, mesas, and sideslopes of the Western Grand Canyon and Grand Canyon-Parashant National Monument, and also on sideslopes in the Inner Canyon. It typically occurs at 1800 to 1900 m (5925-6225 feet) elevation, but can also be found in the Inner Canyon at 1400-1425 m (4600 to 4650 feet). It can occur on gentle to steep slopes (1 to 25 degree), often on northern aspects. Soils are variously clay-based. Ground cover is dominated by gravel (45%) and litter (25%), but may also include a notable amount of bare soil (15%) and surface rocks (8%). This vegetation type can be extensive where it exists, and typically occurs in areas where *Juniperus osteosperma* woodlands abut *Artemisia tridentata* shrublands.
Global Environment: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1220 to 2260 m (4000-7400 feet). This community occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvial or eolian deposits derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characterized by an open tree canopy comprised al-

most entirely of *Juniperus osteosperma* (5-10%). Occasionally, a tree subcanopy is present, which consists of *Juniperus osteosperma* (3-7%) and *Pinus monophylla* (1%). When present, the tall-shrub stratum is sparse, and consists entirely of *Purshia stansburiana* (2%). A short-shrub layer (12%) dominated by *Artemisia tridentata ssp. vaseyana* (8-10%) characterizes this association. Occasionally other short shrub species such as *Purshia stansburiana* (2%), *Rhus trilobata* (1%), and *Gutierrezia sarothrae* (1%) occur at low covers. Dwarf-shrubs are very uncommon in this association and when present comprise very little cover. Graminoids (5%) including *Bouteloua gracilis* (5%), *Poa fendleriana* (1%), and *Elymus elymoides* (1%) make up the majority of cover in the relatively well-developed understory. Scattered forb species such as *Eriogonum umbellatum, Comandra umbellata*, and *Frasera albomarginata* can occur at very low covers. Based on the 6 stands sampled, this association supports average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

Global Vegetation: The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata ssp. wyomingensis* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 20%, and the height of the tree canopy is 2-10 m. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia* spp., may be present but generally with low cover. The herbaceous layer tends to have sparse to low cover but can range to moderately dense cover in some stands. It is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Purshia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Forb	*Eriogonum umbellatum*
Herb (field)	Graminoid	*Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata ssp. wyomingensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Comandra umbellata*, *Elymus elymoides*, *Eriogonum umbellatum*, *Frasera albomarginata*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Pinus monophylla*, *Poa fendleriana*, *Purshia tridentata*, *Rhus trilobata*

Global: *Artemisia tridentata* ssp. *wyomingensis*, *Juniperus osteosperma*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Lactuca serriola* (exotic, Low/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (1-Feb-1996).

CLASSIFICATION

Status: Standard

Classification Confidence: 2 - Moderate

Grand Canyon National Park Comments: *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) also supports an open canopy of *Juniperus osteosperma* and a shrub layer dominated by *Artemisia tridentata*; however, *Pinus edulis* is codominant in the canopy layer.
Global Comments: On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia tridentata ssp. wyomingensis* shrublands with scattered pinyon and juniper trees, but they are considered a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:
- *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) also supports an open canopy of *Juniperus osteosperma* and a shrub layer dominated by *Artemisia tridentata*, but *Pinus edulis* is codominant in the canopy.

Global Related Concepts:
- *Juniperus osteosperma* / *Artemisia tridentata* / *Agropyron spicata* Community (Blackburn et al. 1971) =
- *Juniperus osteosperma* / *Artemisia tridentata* / *Poa secunda* Community (Blackburn et al. 1969a) =
- *Juniperus osteosperma* / *Artemisia tridentata* / *Stipa comata* Community (Blackburn et al. 1971) =
- *Juniperus osteosperma* / *Artemisia tridentata* Community (Blackburn et al. 1968a) =
- *Juniperus osteosperma* / *Artemisia tridentata* Community (Blackburn et al. 1968c) =
- *Juniperus osteosperma* / *Artemisia tridentata* Community Type (DeVelice and Lesica 1993) =
- *Juniperus osteosperma* / *Artemisia tridentata* Plant Association (Johnston 1987) =
- *Juniperus osteosperma* / *Artemisia tridentata* Plant Association (Larson and Moir 1987) =
- *Juniperus osteosperma* / *Artemisia tridentata* Plant Association (Stuever and Hayden 1997a) =
- *Juniperus osteosperma* / *Chrysothamnus viscidiflorus* / *Bromus tectorum* Community (Blackburn et al. 1969e) =
- *Juniperus osteosperma/Artemisia tridentata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled in Toroweap Valley; from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau; and from the Inner Canyon where, it was sampled in upper Unkar Creek.
Global Range: This sparse woodland association occurs throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin region and extends east to the Bighorn Mountains and hills of central Wyoming.
Nations: US
States/Provinces: AZ:S4, CA:S2?, CO:SU, ID:S1?, MT:S3, NM:S5, NV, UT:S5, WY
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 341D:CC, 342A:CC, 342B:CC, 342D:CC, 342F:CC, 342G:CC, M331B:CC, M331E:CC, M331G:CC, M332E:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Colorado, Dinosaur, Grand Canyon, Grand Canyon-Parashant, Hovenweep, Navajo, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (6 plots): GRCA.03582, GRCA.04062, GRCA.04099, GRCA.04126, GRCA.04128, GRCA.04570.
Local Description Authors: S. Fugate
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles
References: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969a, Blackburn et al. 1969e, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bradley 1964, Brotherson and Evenson 1983, Bunting 1987, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Dastrup 1963, DeVelice and Lesica 1993, Donart et al. 1978b, Driscoll et al. 1984, Everett 1987, Francis 1986, Isaacson 1967, Jameson et al. 1962, Johnson and Payne 1968, Johnston 1987, Jones 1992b, Larson and Moir 1987, MTNHP 2002b, Milton and Purdy 1983, Moir and Carleton 1987, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010a, Stuever and Hayden 1997a, USFS 1983a, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, West et al. 1998, Western Ecology Working Group n.d., Wright et al. 1979

Juniperus osteosperma / Poa fendleriana Woodland [Park Special]

Utah Juniper / Muttongrass Woodland
Identifier: CEPS009687

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Juniperus osteosperma / Poa fendleriana* Woodland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Juniperus osteosperma / Pseudoroegneria spicata Woodland

Utah Juniper / Bluebunch Wheatgrass Woodland
Identifier: CEGL000738

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Juniperus osteosperma / Pseudoroegneria spicata* Woodland

ELEMENT CONCEPT

Global Summary: This juniper woodland association occurs on moderate to steep talus slopes, foothills, benches, plateaus, and canyons in Idaho, Montana, north-central and western Wyoming, Colorado, Utah and Nevada. Elevation ranges from 1520 to 2140 m (4985-7020 feet), and sites are typically oriented to the south or west. Soils are generally clay loam, sandy loam or sandy clay and are generally shallow and often gravelly or rocky. They are derived from limestone, sandstone or shale. The open tree canopy is dominated by *Juniperus osteosperma*; in Wyoming, *Cercocarpus ledifolius* or *Juniperus scopulorum* are sometimes also present. If *Pinus edulis* is present, it is as seedlings or scattered individuals with minimal cover. Tree canopy cover ranges between 10 and 40%. There is no developed shrub layer, but scattered individuals of *Artemisia nova, Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha* may be present, as may *Juniperus osteosperma* seedlings. *Pseudoroegneria spicata* dominates the herbaceous understory with 2 to 30% cover. Other herbaceous species commonly present with lesser cover include graminoids *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana, Poa secunda*, and *Bromus tectorum*. Forbs are generally sparse; species likely to be present include *Arenaria hookeri, Leptodactylon pungens, Phlox hoodii, Sphaeralcea coccinea*, and *Stenotus acaulis*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This association occurs on moderate to steep talus slopes, foothills, benches, plateaus, and

canyons in throughout much of the Intermountain western U.S. Elevation ranges from 1520 to 2140 m (4985-7020 feet), and sites are typically oriented to the south or west. Gravel and rocks cover 50% of the soil surface in most stands, but in some stands, cryptobiotic crusts may cover much of the soil surface. Soils are generally clay loam or sandy clay, are generally shallow and often gravelly or rocky, and are derived from limestone, sandstone or shale.

VEGETATION DESCRIPTION

Global Vegetation: This woodland association is dominated by *Juniperus osteosperma*; in Wyoming, *Cercocarpus ledifolius* or *Juniperus scopulorum* are sometimes also present in the canopy. If *Pinus edulis* is present, it is as seedlings or scattered individuals with minimal cover. Tree canopy cover ranges between 10 and 40%. There is no developed shrub layer, but scattered individuals of *Artemisia nova, Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha* may be present, as may *Juniperus osteosperma* seedlings. *Pseudoroegneria spicata* dominates the herbaceous understory with 2 to 30% cover. Other herbaceous species commonly present with lesser cover include graminoids *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana, Poa secunda*, and *Bromus tectorum*. Forbs are generally sparse; species likely to be present include *Arenaria hookeri, Leptodactylon pungens, Phlox hoodii, Sphaeralcea coccinea*, and *Stenotus acaulis*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Graminoid	*Pseudoroegneria spicata*

CHARACTERISTIC SPECIES

Global: *Juniperus osteosperma*, *Poa fendleriana*, *Pseudoroegneria spicata*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: Johnston (1987) describes a similar community from the Piceance Basin of northwestern Colorado in which the canopy is codominated by *Pinus edulis*.
Global Similar Associations:

- *Juniperus occidentalis* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation (CEGL001728)
- *Juniperus scopulorum* / *Pseudoroegneria spicata* Woodland (CEGL000748)
- *Pinus edulis - Juniperus osteosperma* / *Pseudoroegneria spicata* - Cushion Plant Woodland (CEGL002819)
- *Pinus edulis - Juniperus* spp. / *Pseudoroegneria spicata* Woodland (CEGL000788)

Global Related Concepts:

- *Juniperus osteosperma* / *Agropyron spicatum* Community (Baker 1984a) =
- *Juniperus osteosperma* / *Agropyron spicatum* Community (Baker and Kennedy 1985) =
- *Juniperus osteosperma* / *Agropyron spicatum* Community (Marriott and Jones 1989) =
- *Juniperus osteosperma* / *Agropyron spicatum* Community (Jones 1992b) =
- *Juniperus osteosperma* / *Roegneria spicata var. inerme* Plant Association (Johnston 1987) <
- *Juniperus osteosperma/Pseudoroegneria spicata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: This association has been documented from throughout much of the Intermountain western U.S.,

including Idaho, Montana, north-central and western Wyoming, Colorado, Utah and Nevada.
Nations: US
States/Provinces: AZ, CO, ID:S1, MT:S2, NV:S4, UT, WY:S3
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 11:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341:C, 342A:CC, 342B:CC, 342F:CC, 342G:CC, M331A:CC, M331B:CC, M331E:CC, M332E:CC, M341:C
Federal Lands: NPS (Dinosaur, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles, mod. K.A. Schulz
References: Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Coles et al. 2008a, Despain 1973a, Driscoll et al. 1984, Johnston 1987, Jones 1989b, Jones 1992b, Knight et al. 1987, Lesica and DeVelice 1992, MTNHP 2002b, Marriott and Jones 1989, Reid and Hall 2010, Tausch and Tueller 1977, WNDD unpubl. data, Western Ecology Working Group n.d., Wight 1965, Wight and Fisser 1968

Juniperus osteosperma / Sparse Understory Woodland

Utah Juniper / Sparse Understory Woodland
Identifier: CEGL000732

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Juniperus osteosperma* / Sparse Understory Woodland

ELEMENT CONCEPT

Global Summary: This widespread woodland association occurs in the Great Basin, Colorado Plateau and western Rocky Mountain regions where it occupies sites in which junipers have become established but that are too dry to support a developed understory of shrubs, forbs and grasses. Lack of soil moisture-holding capacity, southern or western aspects, old-growth conditions, or high cover by rocks or bedrock may all contribute to the development of these stands. Elevations range between 1400 and 2200 m, and stands occur on may types of soils, geology, slope, aspect and landform. Total vegetation cover ranges from 10 to 70% and consists almost entirely of the *Juniperus osteosperma* canopy. Shrub cover and herbaceous cover each total less than 5%, and usually total 1% or less. Because of the sparseness of the understory vegetation, there are few species that can be expected throughout the range of this association. Common species include *Ephedra viridis, Gutierrezia sarothrae*, and *Elymus elymoides*. Cryptobiotic crust cover may be high.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Utah juniper woodland association occurs on high-level plateaus and mid-level sideslopes in Grand Canyon-Parashant National Monument. It typically occurs at 1825 to 1900 m (5975-6250 feet) elevation, on gently sloping (1-3 degrees) gradients, across various aspects. Soils tend to be silty clay loams. Ground cover consists mainly of gravel (37%), bare soil (22%), and litter (27%), with smaller amounts of large rocks (6%) and wood (1%). This vegetation type can occur across large areas in these environments.
Global Environment: This widespread woodland association occurs on slopes, ridges, benches and mesas at elevations ranging between 1400 and 2200 m (4600-7220 feet). Slopes range from gentle to moderately steep, with a few examples on very steep slopes. Sites may be oriented to any aspect. In Colorado Plateau and Great Basin stands, substrates and soils tend to have poor water-holding capacity (hydrothermically altered volcanic tuff, clay or coarse sands) and are on warm south or west exposures. In some Colorado Plateau stands, the substrate is so rocky as to afford few places for shrubs or herbaceous species to grow, or the woodland is in an old-growth condition and juniper trees are using all of the available light and moisture. The unvegetated ground surface may have high cover of cryptobiotic crusts on sandy sites; shale sites usually have high cover of bare ground, and other sites may have high cover by rock, bedrock and gravel.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports a moderately dense tree canopy composed chiefly of *Juniperus osteosperma* (12-23%), with trace amounts of *Pinus monophylla* (1%) which can be found more often in the subcanopy. Tall shrubs are absent, and short shrubs rarely exceed 1% cover; however, very scattered *Artemisia tridentata ssp. vaseyana*, *Purshia stansburiana*, and *Opuntia whipplei (= Cylindropuntia whipplei)* do occur in some stands. The dwarf-shrub stratum exists with low cover and consists mostly of *Gutierrezia sarothrae* (1%) and *Opuntia* sp (trace). The herbaceous understory is also sparse and poorly-developed and occurs at no more than 2% cover. *Poa fendleriana* (1%) is the most frequent grass species, while *Bromus tectorum*, *Bouteloua gracilis*, and *Elymus elymoides* can all occur at trace covers. Notable forbs include *Eriogonum umbellatum* and *Penstemon linarioides*. This association often occurs as part of an extensive network of various *Juniperus osteosperma* community types.

Global Vegetation: This common woodland association is characterized by a canopy of *Juniperus osteosperma* with between 10 and 70% cover, sometimes less in very open stands. In many stands the total vegetation cover does not exceed 20%. *Pinus edulis* is generally absent from the canopy. Trees may be barely 2 m high on shale sites, or in old-growth stands the trees may approach 5 m in height. Scattered shrubs are usually present, but do not exceed 5% cover, and usually the total is 1% or less. Common species include *Ephedra viridis, Cercocarpus montanus, Artemisia tridentata ssp. wyomingensis, Gutierrezia sarothrae*, and *Opuntia* spp. Forbs and grasses also total less than 5% (usually 1% or less) and may include *Pleuraphis jamesii, Achnatherum hymenoides, Petradoria pumila*, or *Elymus elymoides*. Cryptobiotic crusts may cover as much as 25% of the unvegetated area in stands with sandy substrates.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Forb	*Eriogonum umbellatum*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata* ssp. *vaseyana*, *Bouteloua gracilis*, *Bromus tectorum*, *Elymus elymoides*, *Eriogonum umbellatum*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Opuntia whipplei*, *Penstemon linarioides*, *Pinus monophylla*, *Poa fendleriana*

Global: *Ephedra viridis*, *Juniperus osteosperma*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Opuntia whipplei* (state-critically imperiled, G4?), *Penstemon linarioides* (state-vulnerable, G5); **Invasive/Exotic**: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNRQ (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 1 - Strong

Grand Canyon National Park Comments: This vegetation type can be distinguished from similar *Juniperus osteosperma* woodlands based on its extremely lacking understory.

Global Comments: Milton and Purdy (1983) describe a pinyon-juniper / sparse understory woodland type at two sites in the Great Basin of Nevada and western Utah. The soils at these sites are derived from hydrothermically al-

tered rocks. Juniper (*Juniperus osteosperma*) is the dominant tree; however, the scattered pinyon pine in these sites is *Pinus monophylla*, not *Pinus edulis* as occurs in the Colorado Plateau.

Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148)

Global Related Concepts:

- *Juniperus osteosperma*/Barren (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau.

Global Range: This association occurs widely in the Great Basin of Nevada and western Utah, as well as the Colorado Plateau and western Rocky Mountains of eastern Utah and western Colorado, and extends north to the Uinta Mountains.

Nations: US

States/Provinces: AZ, CO, NV, UT, WY

TNC Ecoregions: 6:P, 9:C, 11:C, 19:C

USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC

Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Grand Canyon, Grand Canyon-Parashant, Hovenweep)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (4 plots): GRCA.04064, GRCA.04120, GRCA.04130, GRCA.04188.

Local Description Authors: S. Fugate

Global Description Authors: J. Coles

References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Driscoll et al. 1984, Milton and Purdy 1983, Reid and Hall 2010, Romme et al. 1993, Von Loh et al. 2008, WNDD unpubl. data, Western Ecology Working Group n.d.

***Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland**

Two-needle Pinyon - (Utah Juniper) / Blue Grama Woodland

Identifier: CEGL000778

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is known from mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extending north into southern Utah and probably western Colorado. Elevations normally range from 1700-2400 m (5575-7875 feet). Sites are variable but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesatops, on gentle to moderate (10-40%) rocky slopes of foothills, and at the base of cinder cones. The substrates are variable and range from deep, fine- or coarse-textured soils derived from cinder to finer-textured soils derived from sandstone, shale and limestone. The vegetation is characterized by an open to moderately dense tree canopy (10-65% cover) codominated by *Pinus edulis* and *Juniperus osteosperma* trees that are between 1 and 5 m tall. *Pinus edulis* may be present with relatively small cover in some stands. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus*, such as *Juniperus scopulorum*, may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present in low cover, such as *Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum microthecum, Rhus trilobata*, or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by

the warm-season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), Hesperostipa neomexicana (= Stipa neomexicana)*, and *Pleuraphis jamesii (= Hilaria jamesii)*. *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low but may be moderately diverse.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on the high-level plateau of the South Rim at 1975 to 2275 m (6425-7450 feet) elevation. It typically occurs on flat to gentle slopes (mostly 1-4 degrees, but occasionally steeper), often on south- or east-facing aspects. Soils are composed of well-drained, limestone-derived silt loams and sandy loams. Gravel (25%), bare soil (12%), and litter (44%) are common components of the ground cover. This vegetation type can occur at the transition zone between pinyon-juniper and ponderosa pine woodlands.

Global Environment: This woodland association is known from mountains and mesas in the southern Colorado Plateau, Mogollon Rim and extending north into southern Utah and probably western Colorado. Elevations normally range from 1700-2400 m (5575-7875 feet). Sites are variable but generally are relatively dry and rocky. Stands occur on flat to moderate slopes along drainages and on mesatops, on gentle to moderate (10-40%) rocky slopes of foothills, and at the base of cinder cones. The substrates are variable and range from to deep, coarse-textured soils derived from cinder, to sandy loams derived from sandstone or fine-textured soils derived from limestone or shale.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 15-20% in this woodland association, but can be much higher in some stands. *Juniperus osteosperma* and *Pinus edulis* codominate the tree canopy, yet *Juniperus osteosperma* (13-20%) is usually more prevalent than *Pinus edulis* (6-8%). Scattered *Pinus ponderosa* (3%) may occur in the canopy layer when this association occurs near the transition between pinyon-juniper and ponderosa pine vegetation types. Both tall and short shrubs are essentially non-existent. Dwarf-shrubs are also uncommon, but species, including *Artemisia bigelovii* (2%), *Opuntia whipplei* (1%), *Yucca baccata* (1%), *Echinocereus fendleri* (1%), and *Opuntia polyacantha* (1%), infrequently occur. Graminoids are the dominant understory component of this community, typically comprising 10% cover. On some sites, graminoid cover can reach almost 20%. *Bouteloua gracilis* (7%) overwhelmingly dominates the stratum, but *Poa fendleriana* (1-3%) is also commonly present. Forb diversity can be quite high in this association, and at least 40 different species can occur; however, overall forb cover is quite low (3%). *Eriogonum racemosum, Petradoria pumila, Erigeron divergens*, and *Hymenopappus filifolius* commonly occur at trace covers. Based upon the 5 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 25 species per 400-square-meter plot. One classification plot hosted 38 different species.

Global Vegetation: This plant association is characterized by a sparse to moderately dense tree canopy (5-65% cover) codominated by *Pinus edulis* and *Juniperus osteosperma* trees that are between 1 and 5 m tall. *Juniperus deppeana* may replace *Juniperus osteosperma* in southern stands. Other species of *Juniperus*, such as *Juniperus scopulorum*, may be present in higher elevation stands. Shrub cover is sparse (<10% cover). If *Quercus gambelii* is present, it has less than 5% cover. Other associated shrubs may be present, such as scattered *Artemisia tridentata, Brickellia californica, Cercocarpus montanus, Chrysothamnus viscidiflorus, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fallugia paradoxa, Gutierrezia sarothrae, Opuntia* spp., *Purshia stansburiana, Rhus trilobata, Ribes cereum*, or *Yucca* spp. The herbaceous layer is typically moderately dense and is dominated by the warm-season, perennial short grass *Bouteloua gracilis*. Associated graminoids include *Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Elymus elymoides, Koeleria macrantha, Hesperostipa comata (= Stipa comata), Hesperostipa neomexicana (= Stipa neomexicana)*, and *Pleuraphis jamesii (= Hilaria jamesii)*. *Muhlenbergia montana* is absent or scarce (<1% cover). Forb cover is typically low but may be moderately diverse. Species such as *Artemisia dracunculus, Eriogonum* spp., *Hymenoxys richardsonii*, and *Oxytropis lambertii* are common.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*

Herb (field)	Forb	*Petradoria pumila*
Herb (field)	Graminoid	*Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus deppeana, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
Herb (field)	Graminoid	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Juniperus osteosperma*, *Pinus edulis*
Global: *Bouteloua gracilis*, *Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Ceratocephala testiculata* (exotic), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Eriogonum tumulosum* (G3Q), *Phacelia rafaelensis* (G3); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and poorly developed shrub strata. It does not have a well-developed graminoid component, however, and *Bouteloua gracilis* only occurs at up to 1% cover. *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland (CEGL000787) also supports an open canopy of *Pinus edulis* and *Juniperus* spp., poorly developed shrub strata, and a well-developed graminoid understory. However *Poa fendleriana* (7%) is the dominant graminoid component, as opposed to *Bouteloua gracilis* (0-1%). *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) can also support *Artemisia bigelovii* in some stands; however, its graminoid component is much more dominant than the shrub component, and *Artemisia bigelovii* only typically occurs at 2% cover, compared to 4-8%.
Global Comments: The two *Pinus edulis / Bouteloua gracilis* plant associations are treated as phases in Stuever and Hayden (1997a). In the USNVC we are including stands with southern Great Plains, Chihuahua Desert floristic affinities in *Pinus edulis - (Juniperus monosperma, Juniperus deppeana) / Bouteloua gracilis* Woodland (CEGL002151), and stands with the Colorado Plateau and Great Basin floristic affinities in *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778). Both of these associations may include stands codominated by *Juniperus deppeana* in their southern extent. Stuever and Hayden (1997a) also described a *Juniperus deppeana* phase (recognized by its dominance in the stand) and hillslope phase, which occurs on slopes >15% and may have low cover of grasses (<5% cover). More survey is needed to fully understand the distribution and ecological relationships between these 3 species of *Juniperus* and *Pinus edulis*.
Global Similar Associations:

- *Pinus edulis - (Juniperus monosperma, Juniperus deppeana) / Bouteloua gracilis* Woodland (CEGL002151)
- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118)
- *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and poorly developed shrub strata but does not have a well-developed graminoid component.
- *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland (CEGL000787) also supports an open canopy of *Pinus edulis* and *Juniperus* spp., poorly developed shrub strata, and a well-developed graminoid understory dominated by *Poa fendleriana* rather than *Bouteloua gracilis*.
- *Pinus monophylla - Juniperus osteosperma / Bouteloua gracilis* Woodland (CEGL005396)

Global Related Concepts:

- *Pinus edulis/Bouteloua gracilis* (Bourgeron and Engelking 1994) **=**
- *Pinus edulis/Bouteloua gracilis* Plant Association (Larson and Moir 1987) **?**
- *Pinus edulis/Bouteloua gracilis* Plant Association (Stuever and Hayden 1997a) **?**
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim; it was sampled from Desert View and to the east, southwest of Grand Canyon Village, and west of Hermits Rest near the Waldron trailhead.
Global Range: This woodland association is known from mountains and mesas in the southern Colorado Plateau and Mogollon Rim of northern Arizona and extends into southern Utah and probably into western Colorado and possibly into western New Mexico.
Nations: US
States/Provinces: AZ:S4, CO?, NM?, UT, WY
TNC Ecoregions: 19:C, 20:C, 21:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC, M313A:CC, M313B:CC, M331G:CC
Federal Lands: NPS (Canyon de Chelly, Canyonlands, Capitol Reef, Grand Canyon, Petrified Forest, Sunset Crater Volcano, Walnut Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.02059, GRCA.02060, GRCA.02229, GRCA.03208, GRCA.03217.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, Clark et al. 2009, Dick-Peddie 1993, Driscoll et al. 1984, Dwyer and Pieper 1967, Hansen et al. 2004a, Hansen et al. 2004c, Jameson 1962, Kennedy 1983a, Ladyman and Muldavin 1996, Larson and Moir 1987, Little 1987, Moir and Carleton 1987, Muldavin et al. 1998a, Powell 1988a, Reid and Hall 2010, Romme et al. 1993, Stuever and Hayden 1997a, Thomas et al. 2009a, Thomas et al. 2010, USFS 1982, WNDD unpubl. data, Western Ecology Working Group n.d., Wright et al. 1973, Wright et al. 1979

***Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland**

Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland
Identifier: CEGL002329

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland

ELEMENT CONCEPT

Global Summary: This association is characteristic of rocky slopes in the Colorado Plateau and extends into the southern Rocky Mountains in western Colorado and northeastern Arizona. Elevations and aspects are variable. Stands occurring at lower elevations (1406-2006 m) on the Colorado Plateau and northwestern Colorado tend to occur on northerly aspects, whereas stands occurring in west-central and southwestern Colorado occur at higher elevations (2481-2510 m) and have southerly aspects. Stands throughout the range may be on gentle to steep slopes (7-160%). Soils are rapidly drained, but texture and parent materials vary from clay to sandy loam and from marine shale to sandstone and granite. The unvegetated ground surface is composed primarily of exposed bedrock, rocks, gravel and bare ground. This woodland association has an open to relatively closed tree canopy and sparse to dense total vegetation cover. *Juniperus osteosperma* and *Pinus edulis* comprise the tree canopy, but individually do not exceed 25% cover. There is a tall-shrub stratum with up to 25% cover dominated by *Amelanchier utahensis*. Other shrubs that may be present with low cover include *Artemisia tridentata, Cercocarpus montanus, Fraxinus anomala, Ephedra viridis, Fendlera rupicola, Quercus gambelii, Rhus trilobata*, and *Symphoricarpos oreophilus*. Dwarf-shrubs may include *Yucca harrimaniae, Gutierrezia sarothrae*, and *Chrysothamnus viscidiflorus*. The herbaceous layer has sparse to low cover and contains graminoids, such as *Achnatherum hymenoides, Carex geyeri, Leymus salinus*, and *Poa fendleriana*, and forbs, such as *Antennaria parvifolia, Erigeron peregrinus, Eriogonum ovalifolium, Heterotheca*

villosa, Lathyrus lanszwertii, Lepidium montanum, Phlox austromontana, and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This association is characteristic of rocky slopes in the Colorado Plateau and extends into the southern Rocky Mountains in western Colorado and northeastern Arizona. Elevations and aspects are variable. Stands occurring at lower elevations (1406-2006 m) on the Colorado Plateau and northwestern Colorado tend to occur on northerly aspects, whereas stands occurring in west-central and southwestern Colorado occur at higher elevations (2481-2510 m) and have southerly aspects. Stands throughout the range may be on gentle to steep slopes (7-160%). Soils are rapidly drained, but texture and parent materials vary from clay to sandy loam and from marine shale to sandstone and granite. The unvegetated ground is composed primarily of exposed bedrock, rocks, gravel and bare ground.

VEGETATION DESCRIPTION

Global Vegetation: This woodland association has an open to relatively closed tree canopy and sparse to dense total vegetation cover. The dominant tree species, *Juniperus osteosperma* and *Pinus edulis*, are typically between 2 and 10 m tall and individually do not exceed 25% cover. There is a tall-shrub stratum with up to 25% cover dominated by *Amelanchier utahensis*. Other shrubs that may be present with low cover (<5% cover) include *Artemisia tridentata, Coleogyne ramosissima, Cercocarpus montanus, Eriogonum microthecum, Fraxinus anomala, Ephedra viridis, Fendlera rupicola, Quercus gambelii, Purshia mexicana, Rhus trilobata*, and *Symphoricarpos oreophilus*. Dwarf-shrubs may include *Yucca harrimaniae, Gutierrezia sarothrae*, and *Chrysothamnus viscidiflorus*. The herbaceous layer has sparse to low cover and contains graminoids, such as *Aristida purpurea, Achnatherum hymenoides, Carex geyeri, Leymus salinus, Pleuraphis jamesii*, and *Poa fendleriana*, and forbs, such as *Antennaria parvifolia, Artemisia ludoviciana, Astragalus moencoppensis, Collinsia parviflora, Cryptantha flava, Erigeron peregrinus, Erigeron utahensis, Eriogonum ovalifolium, Heterotheca villosa, Hymenopappus filifolius, Lathyrus lanszwertii, Lepidium montanum, Phlox austromontana*, and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*

CHARACTERISTIC SPECIES

Global: *Amelanchier utahensis*, *Juniperus osteosperma*, *Pinus edulis*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: *Amelanchier utahensis* is a common constituent of plant communities on rocky slopes in the Colorado Plateau. There is some overlap with *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland (CEGL002334), and as more information becomes available, woodlands with *Amelanchier utahensis* as a significant component should be re-analyzed.
Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis)* Wooded Shrubland (CEGL002334)

ELEMENT DISTRIBUTION

Global Range: This association is found in the Colorado Plateau in northeastern Arizona and southeastern Utah and extends east into the southern Rocky Mountains of western Colorado.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Mesa Verde, Navajo)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Drake and J. Coles, mod. K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2010, Romme et al. 1993, Salas et al. 2010a, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Arctostaphylos pungens Woodland

Two-needle Pinyon - Utah Juniper / Pointleaf Manzanita Woodland
Identifier: CEGL000775

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Arctostaphylos pungens* Woodland

ELEMENT CONCEPT

Global Summary: These open woodlands have been described from canyon sides, terraces, benches and elevated plains in central and north-central Arizona and may extend into southwestern New Mexico. Elevations range from 1520-2440 m. Sites are flat to steep slopes often with southern aspects. Substrates are rocky soil derived from sandstone or limestone. Stands have a total vegetation cover of 20-60%. They are patchy with an open (>5% cover) conifer tree canopy 3-8 m tall that is codominated by *Pinus edulis* and *Juniperus osteosperma*. The short-shrub layer has over 25% cover and is often a dense and diverse thicket dominated by the evergreen sclerophyllous shrubs *Arctostaphylos pungens* and *Quercus turbinella*. Other shrub species often include *Garrya flavescens, Ephedra viridis, Yucca baccata, Artemisia tridentata, Amelanchier* spp., *Cercocarpus montanus, Cercocarpus intricatus, Mahonia fremontii, Purshia stansburiana, Yucca baccata, Rhus trilobata*, and *Glossopetalon spinescens*. The herbaceous layer is typically sparse if present and is composed of scattered forbs and graminoids. The dominance of *Arctostaphylos pungens* often with *Quercus turbinella* in the dense, short-shrub layer, and the sparse herbaceous cover separates this association from other *Pinus edulis - Juniperus osteosperma* woodlands. Small treeless thickets are included in this association.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in the Inner Canyon on arid sideslopes at 1600 to 2350 m (5150-7700 feet) elevation. It mostly occurs on south- and west-facing aspects, typically on steep slopes (30-35 degrees); although it sometimes occurs on gentler slopes as well. It favors rocky areas, with shallow loamy soils derived from various geologic parent materials. Rocks (15%), gravel (13%), bare soil (8%), and a large amount of litter (50-55%) dominate the ground cover. This community mostly occurs on canyon slopes where pinyon-juniper communities come into contact with chaparral or mountain-brush shrublands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover is quite variable in this woodland association; on some sites the canopy layer can have as much as 25% cover, while the canopy can be quite sparse (5%) in other stands. *Pinus edulis* (11%) dominates this layer, while *Juniperus osteosperma* occurs in most stands (3%) as well. Total shrub cover averages about 20-25% in this association. *Arctostaphylos pungens* (12%) characteristically dominates the

shrub strata and can sometimes be quite dense (up to 25% cover). Other shrub species, such as *Quercus gambelii*, *Quercus turbinella*, *Amelanchier utahensis*, *Cercocarpus montanus*, and *Garrya flavescens*, occur sporadically in some stands, usually at less than 5% cover each. Both graminoids (2%) and forbs (2%) are present in the understory. *Poa fendleriana* occurs consistently at about 1% cover, while *Packera multilobata* and *Phlox austromontana* are common forbs (both at trace cover). Based upon the 5 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos pungens*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Arctostaphylos pungens*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (19-Sep-2000). This seral woodland association occurs extensively in Grand Canyon National Park north of the Colorado river from the Shivwits Plateau to Nankoweap Valley, and is reported from the Globe District on Tonto National Forest. Fire is important in the maintenance of this vegetation because *Arctostaphylos pungens* seeds need heat scarification from fires fire to germinate. Fire suppression may hinder regeneration of and cause the *Arctostaphylos pungens* in the shrub layer to decline. Stands from Grand Canyon National Park are protected, but the status of stands on the Globe District of the Tonto National Forest is unknown. More survey work is needed to assess range, but it is thought to occur extensively along the Mogollon Rim in the ecotone between chaparral and pinyon - juniper woodlands, and may extend into southwestern New Mexico.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Arctostaphylos pungens* Shrubland (CEGL000958) also supports *Arctostaphylos pungens* as the dominant component of the shrub layer, but lacks a *Pinus edulis* canopy. It tends to grow on even drier slopes, often further down into the canyon.
Global Comments: This association, as well as the other associations in *Pinus edulis - (Juniperus* spp.) Woodland Alliance (A.516), need to be renamed to reflect codominance of *Pinus edulis* and *Juniperus osteosperma* or other *Juniperus* spp. in the tree canopy.
Global Similar Associations:

- *Arctostaphylos pungens* Shrubland (CEGL000958) also supports *Arctostaphylos pungens* as the dominant component of the shrub layer, but lacks a *Pinus edulis* canopy and tends to grow on even drier slopes.

Global Related Concepts:

- *Pinus edulis/Arctostaphylos pungens* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs in the Inner Canyon, where it was sampled from near Siegfried Pyre, upper Kwagunt Valley, Muav Canyon/White Creek, upper Gawain Abyss, and from the slopes to the south of Widforss Point.
Global Range: Stands have been described from the Globe Ranger District, Tonto National Forest, and from the Grand Canyon National Park, north of the Colorado River. However, this vegetation is a widespread type along the Mogollon Rim and may extend into mountains in southwestern New Mexico.

Nations: US
States/Provinces: AZ:S3, UT?
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon); USFS (Tonto)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (5 plots): GRCA.01583, GRCA.01588, GRCA.01611, GRCA.02200, GRCA.03072.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Larson and Moir 1987, Moir and Carleton 1987, Reid and Hall 2010, Stuever and Hayden 1997a, Warren et al. 1982, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Artemisia bigelovii Woodland

Two-needle Pinyon - Utah Juniper / Bigelow's Sagebrush Woodland
Identifier: CEGL002118

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland

ELEMENT CONCEPT

Global Summary: This association is found in western Colorado and eastern Utah, usually on mesa tops and canyon rims. Sites can have gentle to steep slopes and with varying local aspects but have been most commonly observed on sites whose general aspect is north or east. This association has been found at sites between 1476 and 2104 m (4840-6900 feet) elevation and mostly on sandstone. Soils are shallow, well-drained to rapidly drained loamy sands, sandy loams, or silt loams. The unvegetated ground surface is typically composed of litter, bedrock, and bare soil. This woodland association generally has sparse to moderate total vegetation cover. There is an open tree canopy 2-5 m tall dominated by *Pinus edulis* and *Juniperus osteosperma* with 2-20% cover each. The shrub layer is also open and, besides the abundance of *Artemisia bigelovii*, is usually mixed in composition. *Artemisia bigelovii* is the most abundant shrub with 2-10% cover. Other typical shrubs are *Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Fraxinus anomala* (which can be present in the tree canopy, as well), and *Gutierrezia sarothrae*. The herbaceous layer typically has less than 5% cover and contains graminoid species such as *Achnatherum hymenoides, Elymus elymoides*, and *Pleuraphis jamesii* and forbs such as *Arenaria fendleri, Erodium cicutarium, Heterotheca villosa*, and *Tetraneuris acaulis*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon woodland association occurs on the South Rim in rimrock habitats, often near canyon rims, on mesatops, or on craggy escarpments. It mostly occurs at 1900 to 2150 m (6275-7075 feet) across all aspects, on essentially flat (1-5 degrees) slopes of the high-level plateau. Occasionally, this association occurs on steeper slopes as well. It inhabits shallow, rocky, limestone-derived soils that are composed of rapidly-drained sandy loams. Chipped limestone gravel (35%), rocks (10%), bare soil (10%), and litter (30%) dominate the ground cover. A single plot was sampled from a similar habitat on the North Rim.
Global Environment: This association is most commonly found on mesa tops and canyon rims but has been found on valley midslopes with rocky or ledgy substrates. Slopes can vary in steepness (sampled plots are between 1 and 35 degrees) and local aspect but have been most commonly observed on sites whose general aspect is north or east. This association has been found at sites between 1476 and 2104 m elevation and mostly on sandstone substrates. Soils are shallow, well-drained to rapidly drained loamy sands, sandy loams, or silt loams. The unvegetated ground surface is typically composed of litter, bedrock, and bare soil. Large and small rocks can be present but are rarely abundant; fractures in the underlying bedrock control the density and distribution of woody vegetation. Parent materials include Dakota, Cedar Mesa, Kayenta Formation and Wingate Formation sandstones.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages 15-20% but can range up to 30% in this woodland association. *Pinus edulis* (10-20%) tends to be more abundant than *Juniperus osteosperma* (6-12%) in the canopy layer. Tall shrubs are essentially absent; however, both of the dominant tree species can adopt shrublike physiognomies as a result of the harsh, and often windy, rim habitat. Scattered *Purshia stansburiana* (1%) individuals also occasionally occur. Short shrubs are uncommon in this association, while *Ephedra viridis* sometimes occurs at 1-2% cover. The dwarf-shrub stratum is particularly well-represented here. The characteristic *Artemisia bigelovii* (4-8%) dominates the layer, while *Gutierrezia sarothrae* (3%) and *Opuntia polyacantha* (1%) occur frequently. While rather uncommon, *Yucca baccata* may be present on some sites at up to 10% cover. On some sites, *Artemisia bigelovii* and *Gutierrezia sarothrae* can manifest as short shrubs (those greater than 0.5 m); however, they are typically rather stunted. *Poa fendleriana* (2%) and *Bouteloua gracilis* (2%) dominate a graminoid layer which averages about 4% cover. The forb understory is quite lacking in this association and typically comprises less than 2% total cover. *Pinus edulis* and *Juniperus osteosperma* seedlings are common at about 1% cover each. Based upon the 8 stands sampled, this association hosts slightly below-average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

Global Vegetation: This woodland association generally has sparse to moderate total vegetation cover. There is an open tree canopy 2-5 m tall dominated by *Pinus edulis* and *Juniperus osteosperma*. These tree species can vary in abundance from 2-20% cover each. The shrub layer has sparse to low cover and, besides the abundance of *Artemisia bigelovii*, is variable in composition. *Artemisia bigelovii* is the most abundant shrub with 2-10% cover. Other typical components of the shrub stratum include *Chrysothamnus viscidiflorus, Echinocereus triglochidiatus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Fendlera rupicola, Fraxinus anomala* (which can be present in the tree canopy, as well), *Gutierrezia sarothrae*, and *Yucca baccata*. Occasional *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Cercocarpus intricatus, Grayia spinosa, Purshia stansburiana, Rhus trilobata*, and *Tetradymia spinosa* may be present in some stands. The herbaceous layer is sparse, typically less than 5% cover, and contains graminoid species such as *Achnatherum hymenoides, Elymus elymoides*, and *Pleuraphis jamesii*. Forbs include *Arenaria fendleri, Erodium cicutarium, Heterotheca villosa, Machaeranthera grindelioides, Streptanthus cordatus*, and *Tetraneuris acaulis*. Stands of this community sampled at higher elevation have northern aspects and more dense vegetation cover.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Herb (field)	Dwarf-shrub	*Artemisia bigelovii, Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua gracilis, Poa fendleriana*
Herb (field)	Other herbaceous	*Juniperus osteosperma, Pinus edulis*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	Dwarf-shrub	*Artemisia bigelovii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia bigelovii*, *Juniperus osteosperma*, *Pinus edulis*
Global: *Artemisia bigelovii*, *Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High)
Global: Invasive/Exotic: *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Dec-2004).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) also supports an open canopy of *Pinus edulis* and *Juniperus* spp.; however, *Artemisia tridentata*, and not *Artemisia bigelovii*, is the dominant shrub component. This community type is not restricted to rimrock habitats.
Global Comments: On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia bigelovii* dwarf-shrublands with scattered pinyon and juniper trees, but they are considered a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:

- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778)
- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782)
- *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) also supports an open canopy of *Pinus edulis* and *Juniperus* spp., but *Artemisia tridentata* rather than *Artemisia bigelovii* is the dominant shrub.
- *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland (CEGL000780)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs primarily on the South Rim in rimrock habitats. It occurs close to the rim on rocky limestone substrates. It was sampled from Cedar Mountain, Straight Canyon, Palisades of the Desert, from a small unnamed canyon southeast of Hermit's Rest, southeast of Desert View towards the park boundary, and from Pinal Point. A single site was sampled from the North Rim, on the Powell Plateau near Beale Point.
Global Range: This Colorado Plateau woodland association is found in western Colorado and southeastern Utah.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Colorado, Grand Canyon, Hovenweep)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (8 plots): GRCA.02051, GRCA.02055, GRCA.02057, GRCA.02112, GRCA.02227, GRCA.02240, GRCA.03216, GRCA.03221.
Local Description Authors: K. Christie
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

***Pinus edulis - Juniperus osteosperma / Cercocarpus ledifolius* Woodland**

Two-needle Pinyon - Utah Juniper / Curl-leaf Mountain-mahogany Woodland
Identifier: CEGL002940

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Cercocarpus ledifolius* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association occurs on ridges, mountains and plateaus in the Colorado Plateau of eastern and southern Utah and western Colorado. Sites are moderately steep to steep. Stands in the northern part of the range tend to be on slopes with southerly aspects; in the southern part of the range, northerly aspects are more common. Elevations range from 2400 to 2770 m (7900-9100 feet) in Utah and from 2200 to 2260 m (7200-7400 feet)

in Colorado. The unvegetated surface is primarily covered by large rocks, bare soil and bedrock exposures. Downed wood is common. Parent materials are sandstone or quartzite bedrock or colluvium. Soils are rapidly drained and range in texture from clay loam to loamy sand. Total vegetation cover ranges from 13 to 80%. The vegetation is characterized by an open canopy of *Pinus edulis*, *Juniperus scopulorum*, and *Juniperus osteosperma* trees, with *Cercocarpus ledifolius* trees or shrubs that range in cover from 5 to 30%. The associated short- and dwarf-shrub layer typically provides sparse to low cover and includes *Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Ericameria nauseosa, Quercus gambelii*, and *Gutierrezia sarothrae*. The herbaceous layer is somewhat diverse in terms of species composition but provides less than 10% total cover. Common graminoids include *Achnatherum hymenoides, Elymus elymoides, Poa fendleriana*, and *Carex* spp. Forbs present may include *Balsamorhiza sagittata, Chenopodium album, Descurainia californica*, and *Petradoria pumila*. Seedling *Pinus edulis* and *Juniperus* spp. are often present.

ENVIRONMENTAL DESCRIPTION

Global Environment: This woodland association occurs on ridges, mountains and plateaus in eastern and southern Utah and western Colorado. Sites are moderately steep to steep. Stands in the northern part of the range tend to be on slopes with southerly aspects and at higher elevations (2400-2770 m); in the southern part of the range, northerly aspects and lower elevations (2200-2260 m) are more common. The unvegetated surface is primarily covered by large rocks, bare soil and bedrock exposures. Parent materials are sandstone or quartzite bedrock or colluvium, and the soils are rapidly drained clay loams and loamy sands.

VEGETATION DESCRIPTION

Global Vegetation: This woodland association is patchy and somewhat rare within the Colorado Plateau. Total vegetation cover ranges from sparse to dense (13-80%). It is characterized by an open canopy, typically 5-10 m tall, of *Pinus edulis, Juniperus scopulorum*, and *Juniperus osteosperma* trees that provide up to 40% canopy closure, and *Cercocarpus ledifolius* shrubs that range in cover from 5 to 30%. *Cercocarpus ledifolius* may also occur in the tree canopy with its large trunks, wide-spreading branches and heights reaching 4 m. The associated short- and dwarf-shrub layer is low in terms of species composition, typically provides sparse to low cover and includes *Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Ericameria nauseosa, Quercus gambelii*, and *Gutierrezia sarothrae*. The herbaceous layer is somewhat diverse in terms of species composition but provides less than 10% total cover. Common graminoids include *Achnatherum hymenoides, Elymus elymoides, Poa fendleriana*, and *Carex* spp. Forbs present may include *Balsamorhiza sagittata, Chenopodium album, Descurainia californica*, and *Petradoria pumila*. Seedling *Pinus edulis* and *Juniperus* spp. are often present.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus ledifolius*

CHARACTERISTIC SPECIES

Global: *Amelanchier utahensis*, *Cercocarpus ledifolius*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*, *Poa fendleriana*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This association may be ecotonal, as it tends to occur at the upper end of the range of pinyon-juniper woodlands. However, it covers extensive areas where it does occur and may be considered a legitimate ecological type.

ELEMENT DISTRIBUTION

Global Range: This association has been described from high ridges in the Colorado Plateau in eastern and southern Utah and western Colorado.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331E:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Capitol Reef, Cedar Breaks, Dinosaur, Grand Canyon, Zion)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2011a, Tendick et al. 2011b, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / Mortonia utahensis Woodland [Park Special]

Two-needle Pinyon - Utah Juniper / Utah Mortonia Woodland
Identifier: CEPS009539

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Mortonia utahensis* Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in the Western Grand Canyon exclusively on the Sanup Plateau. It occurs from approximately 1350 to 1475 m (4450-4850 feet) elevation on gently sloping (0-8 degrees) sideslopes, step-in-slopes, and high-level plateaus. This association occurs on well-drained sandy soils derived from sandstone parent materials. It appears to occur across various aspects. The ground cover is dominated by bare soil (40%), litter (15%), gravel (13%), rocks (12%), and a notable component of cryptogamic soil crust (13%). This association is unique to Grand Canyon and has a limited distribution within the park, but nonetheless is commonly observed in these western, inner canyon environments.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characterized by a sparse arrangement of the vegetation within each stratum. The tree canopy is quite open and comprised of *Pinus edulis* (4%) and *Juniperus osteosperma* (3%). The short-shrub layer has an average cover of 10% and is composed of a unique assemblage of shrubs. *Mortonia utahensis* (5%) is the most commonly occurring shrub and is frequently accompanied by *Quercus turbinella* (2%), *Yucca baccata* (1%), *Ephedra fasciculata* (1%), and *Bernardia myricifolia* (2%). Other less frequently occurring short shrubs include *Ceanothus greggii, Rhus trilobata, Ericameria nauseosa*, and *Parthenium incanum*. Notable dwarf-shrubs include *Gutierrezia microcephala* (1%), *Thymophylla acerosa* (1%), and *Agave utahensis* (1%). The understory is poorly developed but commonly hosts *Aristida purpurea* (1%), *Hesperostipa comata* (trace cover), and *Tridens muticus* (trace cover). *Bouteloua eriopoda* occurs less frequently, but sometimes at up to 3% cover. Forb cover is quite lacking (1%), but species such as *Cordylanthus parviflorus, Lesquerella* sp., *Melampodium leucanthum*, and *Psilostrophe sparsiflora* occasionally occur. This association displays a moderate to high level of species diversity, while maintaining a sparse structural arrangement within each stratum.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Quercus turbinella*

Short shrub/sapling	Broad-leaved evergreen shrub	*Mortonia utahensis*
Herb (field)	Graminoid	*Aristida purpurea*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aristida purpurea*, *Bernardia myricifolia*, *Ephedra fasciculata*, *Gutierrezia microcephala*, *Juniperus osteosperma*, *Mortonia utahensis*, *Pinus edulis*, *Quercus turbinella*, *Thymophylla acerosa*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: This association is unique to Grand Canyon National Park and apparently is not seen anywhere else. It is differentiated from other *Pinus edulis - Juniperus osteosperma* woodlands based on the overwhelming presence of *Mortonia utahensis* relative to other shrubs. This association could be confused with another vegetation type where *Coleogyne ramosissima* is codominant or dominant in the shrub stratum.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled exclusively from the Sanup Plateau.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01633, GRCA.01641, GRCA.01643, GRCA.01648.
Local Description Authors: S. Fugate
Global Description Authors:
References: Western Ecology Working Group n.d.

***Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland**

Two-needle Pinyon - Utah Juniper / Stansbury's Cliffrose Woodland
Identifier: CEGL000782

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is known from the Colorado Plateau of southern Utah and Colorado south to central Arizona. It occurs on dry sites on canyon rims, ridges and slopes. Elevations range from 1400 to 2165 m. Stands typically occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow and rocky, ranging from sand to clay loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale. The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover)

codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (<5% cover) with scattered perennial forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on the South Rim at 1975 to 2225 m (6450-7275 feet) elevation, on the North Rim at 2300 to 2400 m (7575-7900 feet), and in the Western Grand Canyon at 1800 to 1900 m (5900-6250 feet). It typically occurs on gentle to flat slopes (up to 4 degrees) of the high-level plateau, but also infrequently on much steeper sideslopes. It seems to prefer canyon rims, ridges, and other exposed habitats. This community likely occurs across a variety of aspects; however, all of the stands sampled were found on either south-facing or north-facing slopes. Soils are typically shallow, limestone-derived, rapidly-drained sandy or silt loams. Bare soil (16%) and litter (40%) are major components of the ground cover, while gravel cover varies considerably from stand to stand (up to 55% in some areas). This association mostly occurs within healthy pinyon-juniper woodlands, on sites that show no evidence of past fire.

Global Environment: This woodland occurs on the Colorado Plateau of southern Utah and Colorado south to central Arizona, on dry canyon rims, ridges, hills, benches, mesas and occasionally in intermittent drainages. Elevations range from 1400 to 2165 m (4600-7100 feet). Stands typically occur on gentle to moderately steep slopes on all aspects, but range from flat to steep slopes (0-30%). Soils are generally shallow and rocky, ranging in texture from sand in most stands to clay loam or sandy clay. Exposed sandstone or limestone bedrock and bare soil have high cover, and woody plants are generally rooted in cracks and joints in bedrock. A minority of stands may also occur on shale slopes covered by sandstone colluvium. Parent materials are variable and include sandstones and shale of the Moab Tongue of the Curtis Formation, Kayenta Formation, Moenkopi Formation, and eolian silt deposits.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover averages about 25% in this association, but can range up to 45% in denser stands. The woodland canopy is codominated by *Pinus edulis* (16-18%) and *Juniperus osteosperma* (8%). *Purshia stansburiana* (6%) is the characteristic tall shrub, and other species are quite infrequent in this stratum. Sometimes *Purshia stansburiana* exists at considerably lower cover (as little as 2%), but still acts as an indicator species for the association. Short-shrub cover typically averages about 5% or less. *Artemisia tridentata* frequently occurs at about 1% cover, while a suite of about a dozen other shrubs, including *Artemisia bigelovii, Chamaebatiaria millefolium*, and *Ephedra viridis*, occur inconsistently from site to site at low individual covers. Dwarf-shrubs (2%), including *Yucca baccata, Opuntia* spp., and *Escobaria vivipara*, also occur sporadically with low individual covers. *Gutierrezia sarothrae* occurs in the majority of stands at about 4-8% cover. Graminoids are not typically well-represented here; however, *Poa fendleriana* (up to 2%) and *Bouteloua gracilis* (up to 5%) both occasionally occur. The forb stratum (1%) is particularly sparse, and composition varies from site to site. Based upon the 10 stands sampled, this association hosts somewhat below-average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter plot.

Global Vegetation: This woodland association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer, often with *Artemisia tridentata* in the northern part of its range. Total vegetation cover can vary from 12% to more than 65%, with tree canopy sometimes falling below 10% cover in very open stands. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present, including *Amelanchier utahensis, Arctostaphylos patula, Artemisia bigelovii, Artemisia nova, Artemisia tridentata, Chamaebatiaria millefolium, Ephedra viridis, Ericameria nauseosa, Eriogonum corymbosum, Eriogonum microthecum, Fraxinus anomala, Gutierrezia sarothrae, Quercus gambelii* (<5% cover), *Rhus trilobata, Shepherdia rotundifolia, Symphoricarpos longiflorus*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Poa fendleriana, Pleuraphis jamesii*, and *Schizachyrium scoparium*. Forbs may include *Artemisia ludoviciana, Artemisia frigida, Calliandra humilis, Descurainia pinnata, Eriogonum ovalifolium, Lappula occidentalis,*

Oenothera pallida, and *Penstemon linarioides*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Purshia stansburiana*
Herb (field)	Graminoid	*Bouteloua gracilis, Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Tall shrub/sapling	Broad-leaved evergreen tree	*Purshia stansburiana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Juniperus osteosperma*, *Pinus edulis*, *Purshia stansburiana*
Global: *Achnatherum hymenoides*, *Artemisia tridentata* ssp. *wyomingensis*, *Ephedra viridis*, *Juniperus osteosperma*, *Pinus edulis*, *Purshia stansburiana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Portulaca oleracea* (exotic)
Global: Vulnerable: *Shepherdia rotundifolia* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High), *Descurainia pinnata* (invasive native), *Erodium cicutarium* (invasive/exotic, Medium/Low); **Other**: *Glossopetalon spinescens* var. *meionandrum* (G5T3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118) occurs in somewhat similar rimrock environments and occasionally supports *Purshia stansburiana* in the tall-shrub stratum; however, *Artemisia bigelovii* is the overwhelmingly dominant shrub species. Likewise, *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782) can support *Artemisia bigelovii* (at 1-4% cover); however, it is less dominant than the *Purshia stansburiana* (which can occur at up to 13% cover). There is a variety of other *Pinus edulis - Juniperus osteosperma* vegetation types that also support well-developed shrub and poorly-developed herbaceous layers; however, *Purshia stansburiana* is not the dominant shrub species in any of these communities.
Global Comments: The global name of this association was changed on 2001-09-04 because of a taxonomic change of the nominal species. *Purshia mexicana var. stansburiana* (Torr.) Welsh is now recognized as *Purshia stansburiana* (Torr.) Henrickson (Kartesz 1999). *Purshia mexicana* (D. Don) Henrickson, a closely related species, occurs in Chihuahua, Durango and Zacateca, Mexico, and possibly extreme southern Arizona, and is not known to be present in this association (Cronquist et al. 1997).
This association appears to be part of a continuum of Colorado Plateau woodland communities growing on fractured sandstone. Stands where *Purshia stansburiana* is the dominant understory shrub are less common than those in which it is a component of a mixed shrub understory that includes *Cercocarpus montanus, Amelanchier utahensis*, and *Cercocarpus intricatus* in mesic stands, or *Coleogyne ramosissima* and *Yucca* spp. in xeric stands. An analysis of the woodland data from four parks (Colorado, Arches, Natural Bridges, Canyonlands) confirmed that *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782) is a valid association but not always easy to distinguish from more mixed-shrub woodlands in the field.

Global Similar Associations:
- *Pinus edulis - Juniperus osteosperma* / *Artemisia bigelovii* Woodland (CEGL002118) occurs in somewhat similar rimrock environments and occasionally supports *Purshia stansburiana* in the tall-shrub stratum, but *Artemisia bigelovii* is the dominant shrub species.
- *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland (CEGL000776) is similar to the *Artemisia tridentata* phase of this association except *Purshia stansburiana* is not codominant.
- *Pinus monophylla - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL005397)
- *Purshia stansburiana* Shrubland (CEGL002957)

Global Related Concepts:
- *Juniperus osteosperma - Pinus edulis* / *Cowania mexicana* Plant Association (Baker 1984a) =
- *Pinus edulis* / *Cowania mexicana* Plant Association (Larson and Moir 1987) =
- *Pinus edulis* / *Purshia stansburiana* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis*/*Cowania mexicana* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- Juniper-Pinyon Stand-Type (Northcutt 1978) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the South Rim, the North Rim, and in the Western Grand Canyon. On both the South Rim and the North Rim, it usually occurs in areas close to the actual canyon rim. On the North Rim, it was sampled from Cape Royal and from an unnamed point west of Walla Valley overlooking Gawain Abyss and Clint Creek; on the South Rim, it was sampled from Chemehuevi Point in the South Bass area, from Eremita Mesa near Mimbreno Point, and from Zuni Point; in the Western Grand Canyon, it was sampled from Tuckup Point, the Kanab Plateau just west of Paradise Canyon, and from the Kanab Plateau southeast of Hancock Knoll.
Global Range: This woodland association occurs in the Colorado Plateau region of central Arizona, western New Mexico, southwestern Colorado, and southern Utah.
Nations: US
States/Provinces: AZ:S3, CO:S3?, NM:S4?, UT:S3?, WY
TNC Ecoregions: 18:C, 19:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC, M313A:CC, M313B:CC, M341C:CC
Federal Lands: NPS (Arches, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Hovenweep, Natural Bridges, Walnut Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (10 plots): GRCA.02037, GRCA.02086, GRCA.02135, GRCA.02224, GRCA.02225, GRCA.03057, GRCA.03058, GRCA.03060, GRCA.03213, GRCA.03214.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2009a, Cronquist et al. 1997, Driscoll et al. 1984, Hansen et al. 2004a, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Reid and Hall 2010, Romme et al. 1993, Stuever and Hayden 1997a, Tendick et al. 2011b, Thomas et al. 2010, USFS 1982, USFS 1985c, Von Loh et al. 2008, WNDD unpubl. data, Western Ecology Working Group n.d.

Pinus edulis - Juniperus osteosperma / *Sparse Understory* Woodland

Two-needle Pinyon - Utah Juniper / Sparse Understory Woodland
Identifier: CEGL002148

USNVC CLASSIFICATION

Division Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)

Macrogroup Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group Colorado Plateau Pinyon - Juniper Woodland (G250)
Association *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland

ELEMENT CONCEPT

Global Summary: This variable woodland association is widespread in parts of western Colorado and eastern Utah. It is found most commonly on mid- to upper slopes, though other topographic positions are possible. It has been sampled at elevations between 1354 and 2389 m and on all aspects. At higher elevations, it tends toward southwestern aspects. Sites range from flat to moderately steep. The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, or limestones. The lack of an understory may be due to high rock cover, low soil moisture, or a closed evergreen canopy of pinyon and juniper. This widespread association occurs as relatively sparse to moderately vegetated stands with total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included as a best fit in this woodland association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands but always at no more than 5% cover. Several shrub species are commonly found in this association, but they occur as widely scattered individuals or an open shrub stratum. Scattered small *Pinus edulis* and *Juniperus osteosperma* are found along with shrubs such as *Amelanchier utahensis, Artemisia tridentata ssp. wyomingensis, Cercocarpus montanus, Ephedra viridis, Eriogonum microthecum, Shepherdia rotundifolia*, and *Opuntia* spp. The herbaceous layer is low in cover (<5%) and usually low in diversity. *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Poa fendleriana*, and *Pleuraphis jamesii* are common graminoids. Forbs are not abundant, but typical species include *Descurainia pinnata, Cryptantha* spp., and *Tetraneuris acaulis*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This woodland association is found most commonly on mid- to upper slopes, though other topographic positions are possible, such as valley floors, plateaus, colluvial slopes, hills, canyon rims, canyon sides, mesas, plains, and benches. It has been sampled at elevations between 1354 and 2389 m and on all aspects. At higher elevations, such as in Black Canyon of the Gunnison National Park it tends toward southwestern aspects. Sites range from flat to moderately steep (0-25 degrees). The ground has variable amounts of litter and often has moderate to high amounts of gravel, rocks, and exposed bedrock. Cryptogamic cover is usually low to moderate, but some sites have up to 55-65% cover. Soils vary in texture and can be loamy sand, silts, loams or silty clay but are always rapidly drained to moderately well-drained. Parent materials are also highly variable and can be sandstones, shales, limestones, among others.

VEGETATION DESCRIPTION

Global Vegetation: This widespread pinyon-juniper woodland association occurs as relatively sparse to moderately vegetated stands with total vegetation cover ranging from 10-75%. Sparsely vegetated stands (<10% total vegetation cover) composed of only trees are included as a best fit in this woodland association in extremely dry, rocky portions of the Colorado Plateau. The tree canopy is dominated by *Pinus edulis* and *Juniperus osteosperma*. Both typically range from 1-35% cover with some stands having canopy cover by one species up to 50%. The tree canopy is short, usually 2-10 m tall, and open to moderately closed. *Fraxinus anomala* has been observed in the canopy of some stands at Colorado National Monument but always at no more than 5% cover. Several shrub species are commonly found in this association, but they occur as widely scattered individuals or an open shrub stratum. Scattered small *Pinus edulis* and *Juniperus osteosperma* are found along with shrubs such as *Amelanchier utahensis, Artemisia bigelovii, Artemisia tridentata ssp. wyomingensis, Cercocarpus montanus, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra viridis, Eriogonum microthecum, Gutierrezia sarothrae, Shepherdia rotundifolia, Symphoricarpos longiflorus*, and *Opuntia* spp., usually *Opuntia fragilis* or *Opuntia polyacantha*. The herbaceous layer is low in cover (<5%) and usually low in diversity. *Achnatherum hymenoides, Bouteloua gracilis, Bromus tectorum, Poa fendleriana*, and *Pleuraphis jamesii* are common graminoids. Forbs are not abundant, but typical species include *Descurainia pinnata, Cryptantha* spp., and *Tetraneuris acaulis*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*

CHARACTERISTIC SPECIES

Global: *Achnatherum hymenoides*, *Ephedra viridis*, *Juniperus osteosperma*, *Opuntia fragilis*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Shepherdia rotundifolia* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (15-Dec-2004).
CLASSIFICATION
Status: Standard
Classification Confidence: 1 - Strong
Global Comments: Environmental and physiognomic variability within this association is high. There are few consistent understory species across all parks, but that is part of the concept of this type. The general sparseness of the understory is one of the main diagnostic features. Because of the wide range of circumstances that result in a sparse understory, a lot of variability in the floristic components of the understory is allowed. It is possible that this type will be split into several associations based on environmental factors, since floristic factors are not diagnostic. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%, and they are considered a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:

- *Juniperus osteosperma* / Sparse Understory Woodland (CEGL000732)
- *Pinus edulis - (Juniperus osteosperma)* / *Bouteloua gracilis* Woodland (CEGL000778)
- *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland (CEGL000787)

ELEMENT DISTRIBUTION

Global Range: This association is known to occur in western Colorado and eastern Utah.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Hubbell Trading Post, Mesa Verde, Natural Bridges)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Reid and Hall 2010, Romme et al. 1993, Salas and Bolen 2010b, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

Pinus edulis - Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland

Two-needle Pinyon - Juniper species / (Wyoming Big Sagebrush, Mountain Big Sagebrush) Woodland
Identifier: CEGL000776

USNVC CLASSIFICATION

Division Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)

Macrogroup Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group Colorado Plateau Pinyon - Juniper Woodland (G250)
Association *Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland

ELEMENT CONCEPT

Global Summary: This broadly defined woodland association is common in the Colorado Plateau but also occurs on dry foothills and mesas from north-central New Mexico and southern Colorado west to the eastern Mojave Desert, in extreme northwestern Colorado and adjacent Utah. Elevations range from 1465 to 2500 m (4800-8200 feet). Stands occur most often on flat to gentle slopes on all aspects. The soils are generally poorly developed, moderately deep to deep, well-drained to rapidly drained loams and sands. Ground cover is variable; bare soil is common, but bedrock, litter, and large or small rocks can also be abundant on some sites. Parent material includes sandstone and shale. The vegetation is characterized by a typically open tree canopy (10-30% cover but ranges up to 50% cover) that is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common from northwestern New Mexico west and north into Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* (either *ssp. vaseyana* or *ssp. wyomingensis* depending on location) strongly dominates the sparse to moderately dense short-shrub layer (10-35% cover). *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii* (typically <5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but generally sparse and dominated by graminoids (<5% cover) with scattered forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs throughout the greater Grand Canyon region on high-level plateaus and sideslopes, usually at 1625 to 2050 m (5300-6700 feet) elevation. On the plateau, this association favors gentle slopes (1-6 degrees), but when it occurs on sideslopes, it favors steeper gradients (12-35 degrees). It can occur across all aspects. Soils are rapidly-drained sandy or silty loams. Gravel (40%), bare soil (15%), rocks (10%), and litter (20%) are the major components of the ground cover. A single stand was sampled outside the typical elevational range and was found at 2250 m.
Global Environment: This broadly defined woodland association occurs on dry foothills and mesas across much of the Colorado Plateau and adjacent areas. Elevations range from 1459 to 2502 m. Stands occur most often on flat to gentle slopes but can be found on moderate to moderately steep slopes on all aspects. The soils are often deep, generally poorly developed, moderately well-drained to rapidly drained loams and sands, and skeletal. Ground cover is variable; bare soil is common, but bedrock, litter, and large or small rocks can also be abundant on some sites. Parent material includes sandstone and shale.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover typically averages 15-20% in this association but may reach 35% in dense stands. An open woodland canopy of codominant *Pinus edulis* (6%, up to 15% in denser stands) and *Juniperus osteosperma* (8%, up to 20% in denser stands) and a dominant shrub understory of *Artemisia tridentata* (8%, up to 15% in denser stands) characterize this vegetation type. Scattered *Ephedra viridis* (2%) and *Yucca baccata* (1%) are common associates in the short-shrub stratum. Dwarf-shrub cover averages about 3%, and *Gutierrezia sarothrae* (3%) is the most frequent component of this stratum, but does not occur in every stand. The understory in this association is quite lacking; graminoid and forbs average only 1% cover each and show little compositional consistency among sites. Based upon the 20 stands sampled, this association hosts below-average species diversity among Grand Canyon plant communities, with only 13 species per 400-square-meter plot.
Global Vegetation: This woodland is characterized by a typically open tree canopy (usually 10-30% cover but ranges up to 50% cover) that ranges from 2 to 10 m tall in most stands. The tree canopy is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common in stands reported from northwestern New Mexico, western Colorado, Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* strongly dominates the relatively sparse to moderately dense short-shrub layer (10-35% cover); either *ssp. vaseyana* or *ssp. wyomingensis* may be present, with *ssp. vaseyana* being more characteristic of higher elevations or more mesic conditions. *Purshia stansburiana* is typically absent or scarce.

Other shrubs present may include *Amelanchier utahensis*, *Arctostaphylos patula*, *Cercocarpus montanus*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Quercus gambelii* (typically <5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable but is generally sparse and dominated by graminoids (<5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides)*, *Bouteloua gracilis*, *Carex filifolia*, *Hesperostipa comata*, *Koeleria macrantha*, *Muhlenbergia torreyi*, *Pascopyrum smithii*, *Pleuraphis jamesii*, and *Poa fendleriana*. Forbs include species of *Cryptantha*, *Eriogonum*, *Penstemon*, and *Phlox*. Cryptogram cover tends to be low, but some stands may have moderate cover.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata ssp. vaseyana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Ephedra viridis*, *Juniperus osteosperma*, *Pinus edulis*, *Yucca baccata*
Global: *Artemisia tridentata* ssp. *vaseyana*, *Artemisia tridentata* ssp. *wyomingensis*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)
Global: Vulnerable: *Shepherdia rotundifolia* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a shrub layer dominated by *Artemisia*. It is characterized by the presence of *Artemisia bigelovii*, and not *Artemisia tridentata*, and typically occurs in rimrock environments.
Global Comments: On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Artemisia tridentata* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:
- *Juniperus osteosperma / Artemisia tridentata* Woodland (CEGL000730)
- *Pinus edulis - Juniperus osteosperma / Artemisia bigelovii* Woodland (CEGL002118) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a shrub layer dominated by *Artemisia bigelovii* rather than *Artemisia tridentata*.
- *Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland (CEGL000782)

Global Related Concepts:
- 122.4143 *Juniperus osteosperma - Pinus edulis - Artemisia tridentata* Vegetation Type (Warren et al. 1982) <
- 122.4144 *Juniperus osteosperma - Artemisia tridentata - Pinus edulis* Vegetation Type (Warren et al. 1982) <

- *Pinus edulis - Juniperus monosperma / Artemisia tridentata / Bouteloua gracilis* Vegetation Type (Dick-Peddie 1993) <
- *Pinus edulis - Juniperus monosperma / Artemisia tridentata* / Mesic Grass - Forb Vegetation Type (Dick-Peddie 1993) <
- *Pinus edulis - Juniperus osteosperma / Artemisia tridentata* Plant Association (Johnston 1987) =
- *Pinus edulis / Artemisia tridentata* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis / Artemisia tridentata* Plant Association (Larson and Moir 1987) =
- *Pinus edulis/Artemisia tridentata* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- High-elevation Pinyon-Juniper/Shallow Sand Loams (Tiedemann 1978) =
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- Tree type (Jameson et al. 1962) <
- Upland sand (pinyon - juniper) site (Mason et al. 1967) ><

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs throughout much of Grand Canyon National Park and environs in appropriate plateau habitats. It was sampled on the South Rim from Piute Point; on the North Rim from the Powell Plateau; on Forest Service lands adjacent to the North Rim from Indian Hollow, Monument Point, and Crazy Jug Point; and from the Western Grand Canyon near Burnt Canyon Point, west of Toroweap Valley, and from the Kanab Plateau including Tuckup Point, SB Point, near Kanab Point.
Global Range: This woodland association is common on the Colorado Plateau, occurring from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona and the eastern Mojave Desert, and in extreme northwestern Colorado and adjacent Utah.
Nations: US
States/Provinces: AZ:S4, CO:S3?, NM:S5, NV, UT, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 17:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 322A:??, 341B:CC, 341F:C?, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Aztec Ruins, Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Mesa Verde, Natural Bridges, Navajo, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (20 plots): GRCA.02070, GRCA.02071, GRCA.02072, GRCA.02074, GRCA.02077, GRCA.02078, GRCA.02081, GRCA.02113, GRCA.02599, GRCA.02642, GRCA.03048, GRCA.03051, GRCA.03054, GRCA.03064, GRCA.03065, GRCA.03066, GRCA.03205, GRCA.03617, GRCA.03655, GRCA.03656.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles
References: Bourgeron and Engelking 1994, Bunting 1987, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2010, Dick-Peddie 1993, Driscoll et al. 1984, Erdman 1970, Everett 1987, Heinze et al. 1962, Isaacson 1967, Jameson et al. 1962, Johnston 1987, Larson and Moir 1987, Mason et al. 1967, Moir and Carleton 1987, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2009, Salas et al. 2010a, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Tiedemann 1978, USFS 1983a, USFS 1985a, USFS 1985e, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979

***Pinus edulis - Juniperus spp. / Cercocarpus montanus* - Mixed Shrubs Woodland**

Two-needle Pinyon - Juniper species / Alderleaf Mountain-mahogany - Mixed Shrubs Woodland
Identifier: CEGL000780

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)

Association *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland

ELEMENT CONCEPT

Global Summary: This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in western Colorado and adjacent Utah. It can be found on any slope position, though lower slopes are less common. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil with little litter. Sandstone or shale are the most common parent materials. This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. with a shrub layer dominated by *Cercocarpus montanus*. The tree canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus* spp. codominate in most stands, but sometimes one may be more prevalent than the other. The species of *Juniperus* varies with geography and elevation and includes *Juniperus deppeana, Juniperus monosperma*, *Juniperus osteosperma*, and *Juniperus scopulorum*. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with up to 35% cover. It typically occurs as a short shrub but can be a tall shrub on some sites. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Extremely open stands of this association, usually occurring on fractured slickrock exposures, may have as little as 5% total vegetation cover and an upper canopy only 2 m tall.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs in the Inner Canyon and Western Grand Canyon at 1150 to 2170 m (3760-7100 feet) elevation. It occurs on steep (10-30 degrees) mid and lower sideslopes, as well as on gently sloping (0-8 degrees) ridges. It tends to occur on north- and northwest-facing aspects. Soils are typically well-drained loams derived from sandstone. Ground cover is dominated by gravel (44%), bare soil (20%), surface rocks (16%), and litter (10%). This vegetation type can occur within a wide elevational range in distinctively different environments.

Global Environment: This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills and mesas. It can be found on any slope position (upper, middle, or lower), though lower slopes are the least common. Elevations range from 1472 to 2480 m (4830-8135 feet). Stands occur on gentle to steep (3- to 36-degree) slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. The unvegetated surface is characterized by bedrock, large and small rocks, and/or bare soil. Litter has low cover. Parent materials are often sandstone or shale, but others are possible.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This woodland association is characteristically sparse and typically supports 5-7% cover in the tree canopy, which is comprised of *Juniperus osteosperma* (4%) and *Pinus edulis* (2%). *Cercocarpus montanus* (5%) is the dominant shrub species in this association and is accompanied by *Glossopetalon spinescens* (2%), *Ceanothus greggii* (2%), *Ephedra viridis* (1%), and *Yucca baccata* (1%). Other less common shrubs include *Amelanchier utahensis, Quercus turbinella*, and *Purshia stansburiana* at low covers. The most notable dwarf-shrub species include *Thamnosma montana* and *Gutierrezia sarothrae*, both of which occur infrequently and with low cover. The herbaceous understory is sparse as well and includes *Poa fendleriana, Hesperostipa comata*, and *Achnatherum parishii* at low covers. Various forb species can occur in this association; however, no particular species occur across all stands.

Global Vegetation: This association is characterized by an open to moderately dense tree canopy (10-60% cover) dominated by a combination of *Pinus edulis* and *Juniperus* spp. The canopy averages 2-5 m tall, but some stands may be as tall as 10 m. *Pinus edulis* and *Juniperus* spp. codominate in most stands, but sometimes one may be more prevalent than the other. *Pinus edulis* and *Juniperus* spp. are also present as smaller individuals in the shrub and field strata. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in

north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. The total shrub cover may range from sparse to moderate. *Cercocarpus montanus* is the dominant shrub with 1-35% cover. It typically occurs as a short shrub <2 m tall but can be a tall shrub (2-5 m) on some sites. Other shrubs may be present, including *Amelanchier* spp., *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Fendlera rupicola, Fraxinus anomala, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Purshia stansburiana, Quercus gambelii* (<5% cover), *Quercus grisea, Rhus trilobata, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, Aristida purpurea, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Hesperostipa comata, Koeleria macrantha, Leymus salinus (= Elymus salinus), Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium*. Common forbs include species of *Chamaesyce, Cryptantha, Eriogonum, Machaeranthera, Packera, Penstemon, Petradoria, Phlox*, and *Tetraneuris*. Extremely open stands of this association occurring on exposed and fractured slickrock may have as little as 5% total vegetation cover and an upper canopy only 2 m tall. Biological soil crusts are patchy but may contribute up to 27% cover and are generally well-developed.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Cercocarpus montanus*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Cercocarpus montanus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum parishii*, *Amelanchier utahensis*, *Ceanothus greggii*, *Cercocarpus montanus*, *Ephedra viridis*, *Glossopetalon spinescens*, *Juniperus osteosperma*, *Pinus edulis*, *Poa fendleriana*, *Purshia stansburiana*, *Quercus turbinella*, *Thamnosma montana*, *Yucca baccata*
Global: *Amelanchier utahensis*, *Cercocarpus montanus*, *Juniperus monosperma*, *Juniperus osteosperma*, *Pinus edulis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Shepherdia rotundifolia* (G3G4); **Other**: *Ephedra viridis* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This is a widely distributed and variable association, found throughout much of the Colorado Plateau, edges of the Colorado Rockies and south into New Mexico. On dry, rocky or slickrock sites on the Colorado Plateau, this pinyon-juniper woodland association may include stands with very open tree canopies (5-10% cover) in cases where the total vegetation cover is less than 15%. These stands may be similar to open *Cercocarpus montanus* shrublands with scattered pinyon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.
Global Similar Associations:
Pinus edulis - Juniperus osteosperma / *Artemisia bigelovii* Woodland (CEGL002118)

Pseudotsuga menziesii / *Cercocarpus montanus* Woodland (CEGL000898)

Global Related Concepts:

- *Juniperus osteosperma - Pinus edulis* / *Amelanchier utahensis - Cercocarpus montanus* Marlstone Barrens Plant Association (Baker 1983b) =
- *Juniperus osteosperma - Pinus edulis* / *Cercocarpus montanus - Peraphyllum ramosissimum* Plant Association (Baker 1984a) =
- *Pinus edulis - Juniperus monosperma* / *Cercocarpus montanus* / *Andropogon gerardii* Habitat Type (Kennedy 1983a) =
- *Pinus edulis - Juniperus monosperma* / *Cercocarpus montanus* Habitat Type (Hess and Wasser 1982) =
- *Pinus edulis - Juniperus monosperma* / *Cercocarpus montanus* Plant Association (Johnston 1987) <
- *Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis - Cercocarpus montanus* Plant Association (Johnston 1987) ><
- *Pinus edulis - Juniperus osteosperma* / *Cercocarpus montanus* Plant Association (Johnston 1987) <
- *Pinus edulis - Juniperus osteosperma* / *Cercocarpus montanus* Plant Association (Vories 1974) =
- *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland (Bradley et al. 1992) =
- *Pinus edulis* / *Cercocarpus montanus* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis* / *Cercocarpus montanus* Plant Association (Larson and Moir 1987) =
- *Pinus edulis*/*Cercocarpus montanus* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from near Poston Butte, near Siegfried Pyre, and on the Drummond Plateau; and from the Western Grand Canyon, where it was sampled from Horse Spring Canyon.

Global Range: This widespread woodland association is found from southern Colorado and north-central New Mexico to the Mogollon Rim of Arizona, north across the Colorado Plateau into western Colorado and adjacent Utah.

Nations: US

States/Provinces: AZ:S3, CO:S4, NM:S5, OK?, UT, WY

TNC Ecoregions: 9:C, 10:C, 18:C, 19:C, 20:C, 21:C, 24:C, 27:C

USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313E:CC, 321A:CC, 331J:CC, 341B:CC, M313A:CC, M313B:CC, M331E:CC, M331F:CC, M331G:CC, M341C:CC

Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Bryce Canyon, Canyon de Chelly, Canyonlands, Capitol Reef, Capulin Volcano, Cedar Breaks, Chaco Culture, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Great Sand Dunes, Hovenweep, Natural Bridges, Walnut Canyon, Zion); USFS (Lincoln)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (4 plots): GRCA.01102, GRCA.01581, GRCA.01584, GRCA.02632.

Local Description Authors: S. Fugate

Global Description Authors: K.A. Schulz, mod. J. Drake and J. Coles

References: Baker 1983b, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Hansen et al. 2004a, Hess and Wasser 1982, Isaacson 1967, Johnston 1987, Kennedy 1983a, Larson and Moir 1987, Marr et al. 1979, Medina 1986, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Muldavin et al. 2011d, Pase and Lindenmuth 1971, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2010b, Salas et al. 2011, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011a, Tendick et al. 2011b, Thomas et al. 2010, USFS 1981a, USFS 1981b, USFS 1983a, USFS 1985d, USFS 1985e, USFS 1985g, Von Loh et al. 2007, Von Loh et al. 2008, Vories 1974, WNDD unpubl. data, Western Ecology Working Group n.d., Wright et al. 1979

***Pinus edulis - Juniperus spp. / Poa fendleriana* Woodland**

Two-needle Pinyon - Juniper species / Muttongrass Woodland
Identifier: CEGL000787

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland

ELEMENT CONCEPT

Global Summary: This association is widespread and common throughout the Colorado Plateau of Utah, Arizona, New Mexico and Colorado. It occurs on the slopes of canyons, ridges, toeslopes, alluvial fans, benches and plateaus at elevations ranging from 1525 to 2560 m (5000-8400 feet). Stands may occur on slopes ranging from 7 to 48% that are oriented to any aspect. Most stands are on sandy soils, with a few on silt loam or clay loam soils derived from sedimentary, granitic or metamorphic rocks. Total vegetation cover ranges from 40% to more than 75%. This woodland association is characterized by an open to moderately closed, mixed canopy of *Pinus edulis* and *Juniperus osteosperma* 2-10 m tall. In the southern part of the range, *Juniperus monosperma* and *Juniperus scopulorum* may be present in the canopy. The understory is dominated by the bunchgrass *Poa fendleriana* with between 1 and 25% cover. Scattered shrubs fail to form a stratum but may include *Amelanchier utahensis, Artemisia nova, Cercocarpus montanus, Ephedra viridis, Quercus gambelii, Purshia tridentata, Yucca baccata, Opuntia* spp., *Symphoricarpos oreophilus, Fallugia paradoxa*, and *Fendlera rupicola*. Other common herbaceous species (always with less cover than *Poa fendleriana*) include *Achnatherum hymenoides, Koeleria macrantha, Muhlenbergia montana, Blepharoneuron tricholepis, Pascopyrum smithii, Bouteloua gracilis, Balsamorhiza sagittata, Mirabilis multiflora, Penstemon linarioides*, and *Petradoria pumila*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on the high-level plateau of the South Rim at 2050 to 2200 m (6725-7250 feet) elevation, and also on the high-level plateau of the Powell Plateau on the North Rim at 2100 to 2275 m (6925-7475 feet). It typically occurs on gentle slopes (2-6 degrees), on south- or west-facing aspects. Soils tend to be sandy and are rapidly-drained. Bare soil (22%), litter (33%), and gravel (up to 50% on some sites) are dominant components of the ground cover. This association often occurs at the transition between pinyon-juniper and ponderosa pine vegetation types, and shows no evidence of a past fire history.
Global Environment: This association is widespread and common throughout the Colorado Plateau of Utah, Arizona, New Mexico and Colorado. It occurs on the gentle to moderate slopes of canyons, ridges, toeslopes, benches and plateaus at elevations ranging from 1525 to 2560 m (5000-8400 feet). Stands may occur on slopes ranging from 7 to 48% and oriented to any aspect. Most stands are on sandy soils, with a few on silt loam or clay loam soils derived from sedimentary, granitic or metamorphic rocks. A third to half the unvegetated ground surface is bare ground, and in some plots large rocks and gravel cover up to a third of the surface. In some cases, cryptogamic crusts and moss or litter cover up to 25% of the soil surface.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 30-35% in this woodland association, while *Juniperus osteosperma* (19%) tends to be slightly more abundant than *Pinus edulis* (13%) in the canopy. Shrubs are essentially lacking in this association, although a few scattered individuals occur on some sites. The understory is characteristically dominated by the graminoid *Poa fendleriana* (5%) which can range from 1-10% cover. *Bouteloua gracilis* does occur on some sites but at low cover (1%). *Penstemon linarioides* is a common forb on most sites; however, overall forb cover is quite sparse (1%) in this association. The mistletoe *Phoradendron juniperinum* seems to occur on most sites, but only at trace covers. Based upon the 5 stands sampled, this association hosts below-average species diversity among Grand Canyon plant communities, with 15 species per 400-square-meter plot.
Global Vegetation: This woodland association is widespread and relatively common at moderate elevations throughout the Colorado Plateau. Total vegetation cover ranges from 40% to more than 75%. This woodland association is characterized by an open to moderately closed, mixed canopy of *Pinus edulis* and *Juniperus osteosperma* 2-10 m tall. In the southern part of the range, *Juniperus monosperma* and *Juniperus scopulorum* may be present in the canopy. The understory is dominated by the bunchgrass *Poa fendleriana* with between 1 and 25% cover. Scattered

shrubs present include *Amelanchier utahensis, Artemisia nova, Cercocarpus montanus, Quercus gambelii, Purshia tridentata, Yucca baccata, Opuntia* spp., *Symphoricarpos oreophilus*, *Fallugia paradoxa*, and *Fendlera rupicola*. Other common herbaceous species (always with less cover than *Poa fendleriana*) include *Achnatherum hymenoides, Koeleria macrantha, Muhlenbergia montana*, *Blepharoneuron tricholepis*, *Pascopyrum smithii*, *Bouteloua gracilis*, *Balsamorhiza sagittata, Mirabilis multiflora*, *Penstemon linarioides*, and *Petradoria pumila*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Herb (field)	Forb	*Penstemon linarioides*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma, Pinus edulis*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Juniperus osteosperma*, *Pinus edulis*, *Poa fendleriana*
Global: *Achnatherum hymenoides*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Taraxacum officinale* (exotic)
Global: Vulnerable: *Arabis fernaldiana* var. *fernaldiana* (rare, endemic (known only from Dinosaur NM), G4T3T4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a well-developed graminoid layer; however, *Bouteloua gracilis* is the dominant grass species, and *Poa fendleriana* only exists at low covers.
Global Comments: Even if stands have relatively sparse cover of *Poa fendleriana* (<5%), if no other species are present with more than trace cover, they have been placed in this association rather than *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148).
Global Similar Associations:

- *Pinus edulis - (Juniperus osteosperma) / Bouteloua gracilis* Woodland (CEGL000778) also supports an open canopy of *Pinus edulis* and *Juniperus osteosperma* and a well-developed graminoid layer that is dominated by *Bouteloua gracilis* rather than *Poa fendleriana*.
- *Pinus edulis - Juniperus osteosperma / Purshia tridentata* Woodland (CEGL000789)
- *Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland (CEGL002148)

Global Related Concepts:

- *Pinus edulis - Juniperus osteosperma / Poa fendleriana* Plant Association (Johnston 1987) =
- *Pinus edulis / Poa fendleriana* Plant Association (Larson and Moir 1987) =
- *Pinus edulis/Poa fendleriana* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on both the North Rim and the South Rim. It was

sampled on the North Rim from Powell Plateau and on the South Rim from Signal Hill, near Yaki Point, and on the plateau south of Yaki Point.
Global Range: This association occurs at moderate elevations in the Colorado Plateau region of western Colorado, northern Arizona and New Mexico and eastern Utah.
Nations: US
States/Provinces: AZ:S2?, CO:S4?, NM:S5, UT, WY
TNC Ecoregions: 9:C, 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 331J:CC, M313A:CC, M313B:CC, M331E:CC, M331F:C?, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Curecanti, Dinosaur, Grand Canyon, Mesa Verde); USFS (Coconino, Kaibab)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.01116, GRCA.02114, GRCA.02118, GRCA.02223, GRCA.03211.
Local Description Authors: K. Christie
Global Description Authors: J. Coles
References: Baker 1982b, Barnes 1987, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Coles et al. 2008a, Coles et al. 2010, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Erdman et al. 1969, Floyd 2003, Floyd et al. 2001, Isaacson 1967, Johnston 1987, Larson and Moir 1987, Moir and Carleton 1987, Reid and Hall 2010, Tendick et al. 2010, Thomas et al. 2009b, Thomas et al. 2010, USFS 1985a, WNDD unpubl. data, Western Ecology Working Group n.d.

Pinus edulis - Juniperus spp. / Quercus gambelii Woodland

Two-needle Pinyon - Juniper species / Gambel Oak Woodland
Identifier: CEGL000791

USNVC CLASSIFICATION

Division	Western North American Cool Temperate Woodland & Scrub (1.B.2.Nc)
Macrogroup	Rocky Mountain Two-needle Pinyon - Juniper Woodland (M027)
Group	Colorado Plateau Pinyon - Juniper Woodland (G250)
Association	*Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland

ELEMENT CONCEPT

Global Summary: This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1509-2665 m but may be higher in stands in southern New Mexico. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesatops, and on moderate to steep, rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. The soils are variable and range from deep to shallow, silty clay to sandy loam, and often gravelly. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present in some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often over 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This pinyon-juniper woodland association occurs on the North Rim at approximately 2275 to 2475 m (7450-8125 feet) elevation. It occurs on various landforms, including the high-level plateau and upper sideslopes. It typically occurs on south- or west-facing slopes and can occur on gentle to extremely steep slopes (5-35 degrees). Soils tend to be rocky and derived from limestone parent materials. Bare soil (10-20%), gravel (15-30%), rocks (10-15%), and litter (40-45%) are the major components of the ground cover. This community perhaps can be expected on moderate to steep slopes that drop off of the North Rim and occur where areas of coniferous woodlands come in contact with chaparral or mountain-brush communities. It can also be expected sporadically on the plateau of the North Rim and potentially the South Rim as well.

Global Environment: This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1509-2665 m but may be higher in stands in southern New Mexico. Sites are variable but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesatops, and on moderate to steep, sometimes rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, or on northern aspects or where shaded by upper canyon walls. Stands are less common on hot south-facing slopes, unless they are located in a moisture-concentrating gully. Soils are variable and range from deep to shallow, silty clay to sandy loam, and are often gravelly or rocky. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). Parent materials include alluvial, colluvial or eolian deposits derived from sandstone, shale, limestone and rhyolite.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover ranges from 5-25% in this woodland association. *Pinus edulis* (7-25%) dominates the woodland canopy, while *Juniperus osteosperma* (5%) occurs in some stands. *Quercus gambelii* (4-10%) is the characteristic shrub species and acts as an indicator for this association. Various other tall and short shrubs (sometimes up to 20% total cover) such as *Purshia stansburiana* and *Garrya flavescens* can occur in this community type, and often with higher individual covers than *Quercus gambelii*. *Yucca baccata* (1%) occurs on most sites at low cover. Dwarf-shrubs are essentially absent. Graminoids, particularly *Poa fendleriana* (2%) and sometimes *Bouteloua gracilis* (2%), dominate the understory. A variety of forb species can occur, but overall forb cover is typically 1% or less.

Global Vegetation: This widespread association is characterized by an open to moderately dense tree canopy (10-70% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present is some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often with more than 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Other shrubs, depending on geography, may include *Artemisia tridentata, Artemisia nova, Arctostaphylos patula, Cercocarpus ledifolius, Ephedra viridis, Fendlera rupicola, Gutierrezia sarothrae, Garrya* spp., *Mahonia fremontii, Ptelea trifoliata, Prunus* spp., *Quercus X pauciloba, Robinia neomexicana*, or *Rosa* spp. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*. Common forbs may include *Artemisia frigida, Balsamorhiza sagittata, Geranium caespitosum, Lepidium montanum, Machaeranthera grindelioides, Packera neomexicana, Thalictrum fendleri, Tetraneuris acaulis*, or *Vicia americana*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus edulis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*

Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis, Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen tree	*Cercocarpus montanus*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Quercus gambelii*
Global: *Juniperus deppeana*, *Juniperus monosperma*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High)
Global: Vulnerable: *Galium wrightii* (G3G4), *Lupinus ammophilus* (G3G4), *Shepherdia rotundifolia* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Similar Associations:
- *Pinus discolor* / *Quercus gambelii* Woodland (CEGL000770)
- *Pinus ponderosa* / *Quercus gambelii* Woodland (CEGL000870)

Global Related Concepts:
- 122.4148 *Pinus edulis - Amelanchier utahensis - Quercus gambelii - Juniperus osteosperma* Plant Association (Warren et al. 1982) =
- *Pinus edulis - Juniperus osteosperma* / *Quercus gambelii* Plant Association (Vories 1974) =
- *Pinus edulis* / *Quercus gambelii* / *Carex geyeri* Habitat Type (Hess and Wasser 1982) =
- *Pinus edulis* / *Quercus gambelii* Plant Association (Stuever and Hayden 1997a) =
- *Pinus edulis* / *Quercus gambelii* Plant Association (Muldavin et al. 1994a) =
- *Pinus edulis* / *Quercus gambelii* Plant Association (Johnston 1987) =
- *Pinus edulis* / *Quercus gambelii* Plant Association (Larson and Moir 1987) =
- *Pinus edulis*/*Quercus gambelii* (Bourgeron and Engelking 1994) =
- Coronado Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- DRISCOLL FORMATION CODE:II.A.2.a. (Driscoll et al. 1984) >
- La Sal Province Pinyon - Juniper Woodlands (Isaacson 1967) >
- Pinyon Pine/Gambel's Oak PA (Muldavin et al. 2000b) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim, where it was sampled from Point Sublime and just west of the North Rim Lodge.
Global Range: This woodland association occurs in foothills and mesas from southern Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado.
Nations: US
States/Provinces: AZ, CO:S5, NM:S5, UT, WY
TNC Ecoregions: 18:C, 19:C, 20:C, 21:C, 24:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313E:CC, 321A:CC, 331I:CC, 331J:CC, 341B:CC, M313A:CC, M313B:CC, M331F:CC, M331G:CC, M341C:CC
Federal Lands: DOD (White Sands Missile Range); NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyon

de Chelly, Canyonlands, Capitol Reef, Capulin Volcano, Curecanti, Glen Canyon, Grand Canyon, Hovenweep, Mesa Verde, Natural Bridges, Zion); USFS (Arapaho-Roosevelt, White River NF)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (2 plots): GRCA.02132, GRCA.03657
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bassett 1987, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2010, Driscoll et al. 1984, Harmon 1980, Hess and Wasser 1982, Holm 1927, Isaacson 1967, Johnston 1987, Kallender 1959, Larson and Moir 1987, Marr et al. 1973b, Muldavin et al. 1994a, Muldavin et al. 2000b, Muldavin et al. 2011d, Reid and Hall 2010, Romme et al. 1993, Steinhoff 1978, Stuever and Hayden 1997a, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2008, Vories 1974, WNDD unpubl. data, Warren et al. 1982, Western Ecology Working Group n.d., Wright 1972, Wright et al. 1979

1.B.3. Temperate Flooded & Swamp Forest
1.B.3.Nc. Rocky Mountain & Great Basin Flooded & Swamp Forest

M034. Rocky Mountain & Great Basin Riparian Forest
G503. Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest

Acer negundo / Brickellia (grandiflora, longifolia) Woodland

Box-elder / (Tassel-flower Brickellbush, Splitleaf Brickellbush) Woodland
Identifier: CEGL002692

USNVC CLASSIFICATION

Division	Rocky Mountain & Great Basin Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup	Rocky Mountain & Great Basin Riparian Forest (M034)
Group	Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest (G503)
Association	*Acer negundo / Brickellia (grandiflora, longifolia)* Woodland

ELEMENT CONCEPT

Global Summary: This box-elder woodland association is currently known from Zion National Park in Utah and Grand Canyon National Park in Arizona, and the description is based on occurrences there. More survey and classification work are needed to fully characterize this type. At Zion, this association occurs on a narrow valley floor at an elevation of 1675 m (5500 feet) on sandy soils. At Grand Canyon, it occurs in drainages and along intermittent streams in the Inner Canyon. It generally occurs at 1225 to 1400 m (4100-4625 feet) elevation, but has been observed as low as 1050 m (3450 feet). It is typically found in shaded areas, on flat or very gentle slopes (up to 2 degrees). Soils are well- to rapidly-drained sandy loams or clays that typically lie on top of limestone. This association supports a moderately dense canopy and subcanopy of *Acer negundo*, and a short- or dwarf-shrub layer dominated by *Brickellia longifolia* (Arizona) or *Brickellia grandiflora* (Utah). Shrubs are scarce or absent. Native graminoid cover is extremely low. Other herbaceous species present are variable and contribute minimal cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This woodland association occurs in drainages and along intermittent streams in the Inner Canyon. It generally occurs at 1225 to 1400 m (4100-4625 feet) elevation, but has been observed as low as 1050 m (3450 feet). It is typically found in shaded areas, on flat or very gentle slopes (up to 2 degrees). Soils are well- to rapidly-drained sandy loams or clays that typically lie on top of limestone. Rocks (30%), litter (30%), gravel (15%), and bare soil or sand (13%) are the major components of the ground cover, while downed wood (4%) and water (1%) are present in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association supports moderately dense tree cover, and the canopy

and subcanopy typically average 25-40% total cover. This community is characterized by *Acer negundo* (25-40%) in the tree canopy and subcanopy, and a short- or dwarf-shrub layer dominated by *Brickellia longifolia* (6%). Tall shrubs (2%) are infrequent; however, *Ptelea trifoliata* and *Mahonia haematocarpa* sporadically occur in some stands. Along with *Brickellia longifolia*, *Encelia* sp., *Aloysia wrightii, Baccharis sergiloides*, and *Acacia greggii* infrequently exist in the short-shrub layer (6%). Native graminoid cover is extremely low. *Poa fendleriana* invariably occurs at trace covers; however, the exotic *Bromus rubens* occurs in the majority of stands at significant cover (7-10%). *Bromus tectorum* (1%) also occurs in most stands. *Artemisia ludoviciana* (1%) is the only consistently present component of the forb understory (7%), while *Parietaria pensylvanica* and *Mimulus cardinalis* occur occasionally but may have significant cover. *Acourtia wrightii, Datura wrightii, Erigeron lobatus, Galium stellatum, Nicotiana obtusifolia*, and *Monardella glauca* all occur sporadically and at low individual covers. Based upon the 3 stands sampled, this association hosts average species diversity among Grand Canyon plant communities, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree (canopy & subcanopy)	Broad-leaved deciduous tree	*Acer negundo*
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia longifolia*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acer negundo*, *Artemisia ludoviciana*, *Brickellia longifolia*, *Bromus rubens*, *Mimulus cardinalis*, *Parietaria pensylvanica*, *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: This association can be distinguished from other community types that are dominated by *Acer negundo* by having significant *Brickellia longifolia* cover (2-10%) in the shrub strata.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the eastern portion of the Inner Canyon, where it was sampled in South Canyon, Saddle Canyon, and Clear Creek.
Global Range: This association has currently only been described from Zion National Park in southwestern Utah and Grand Canyon National Park in northern Arizona.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.02038, GRCA.02531, GRCA.03606.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros and J. Thompson, mod. M.J. Russo
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

Acer negundo / Quercus gambelii Woodland

Box-elder / Gambel Oak Woodland
Identifier: CEGL002797

USNVC CLASSIFICATION

Division	Rocky Mountain & Great Basin Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup	Rocky Mountain & Great Basin Riparian Forest (M034)
Group	Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest (G503)
Association	*Acer negundo / Quercus gambelii* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is only known from along the Gunnison River in Curecanti National Recreation Area. Stands occur in riparian sites with natural or human disturbance, including constructed roadway fill slopes and rockfall or talus from adjacent cliffs. Sites are steep (75% slopes), occur between 2032 and 2073 m elevation, and are oriented to northeastern and southern aspects. The unvegetated surface has high cover of bedrock, large and small rocks, and low to moderate cover of litter. Soil was not present in the rockfill and rockfall substrate in the sampled stands. The vegetation is characterized by an open to moderately dense tree canopy of *Acer negundo* and *Quercus gambelii*. Occasional emergent *Pseudotsuga menziesii* trees or subcanopy *Juniperus scopulorum* may be present. The understory is typically sparse and variable in species composition. Tall, short, and dwarf-shrubs contribute low cover and include *Cornus sericea, Fendlerella utahensis, Holodiscus dumosus, Mahonia repens, Rhus trilobata, Ribes cereum, Ribes inerme*, and *Prunus virginiana*. The herbaceous layer is sparse and has low in species diversity. Species include *Piptatherum micranthum, Arabis* sp., *Brickellia grandiflora*, and *Artemisia michauxiana*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo, Quercus gambelii*

CHARACTERISTIC SPECIES

Global: *Acer negundo*, *Quercus gambelii*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (21-Jun-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: This association has only been sampled from one location in Curecanti National Recreation Area in western Colorado. More survey and classification work are needed to change the provisional status of this association.

ELEMENT DISTRIBUTION

Global Range: This association has only been sampled from one location in Curecanti National Recreation Area in western Colorado.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Curecanti, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz

References: Clark et al. 2009, Coles et al. 2010, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2010, Western Ecology Working Group n.d.

Acer negundo / Quercus turbinella Woodland [Park Special]

Box-elder / Turbinella Live Oak Woodland
Identifier: CEPS009676

USNVC CLASSIFICATION

Division	Rocky Mountain & Great Basin Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup	Rocky Mountain & Great Basin Riparian Forest (M034)
Group	Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest (G503)
Association	*Acer negundo / Quercus turbinella* Woodland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (1-Feb-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Celtis laevigata var. reticulata Slickrock Canyon Woodland

Netleaf Hackberry Slickrock Canyon Woodland
Identifier: CEGL002359

USNVC CLASSIFICATION

Division	Rocky Mountain & Great Basin Flooded & Swamp Forest (1.B.3.Nc)
Macrogroup	Rocky Mountain & Great Basin Riparian Forest (M034)
Group	Rocky Mountain & Great Basin Lowland & Foothill Riparian Forest (G503)
Association	*Celtis laevigata var. reticulata* Slickrock Canyon Woodland

ELEMENT CONCEPT

Global Summary: This netleaf hackberry slickrock woodland association is currently only known from Capitol Reef National Park in Utah, and the following description is based on occurrences there. Additional information will be added as it becomes available. The netleaf hackberry slickrock canyon community was observed in slickrock and associated drainage channels within the park. Sites are gentle to steep (1- to 30-degree slopes), occur between 1250 and 2409 m elevation, and are oriented to all aspects. The unvegetated surface has low to high exposure of bedrock, sand, and bare soil. The cover by litter is sparse to low, and live vegetation basal area can be low to moderate in cover. Parent materials are Navajo sandstone. Soils are rapidly drained and texturally are sand and sandy loam. This netleaf hackberry slickrock canyon community is rare within the park, occupying bedrock exposures and drainage channels in slickrock habitat. This woodland community is characterized by typically 2- to 5-m tall *Celtis laevigata var. reticulata* trees. The canopy tree layer is moderately diverse, provides sparse to moderate cover, and includes *Fraxinus anomala, Juniperus osteosperma, Pinus edulis, Acer negundo*, and *Populus tremuloides*, among several other tree species occasionally present. The shrub layer has moderate to high species diversity and provides low to moderate cover. Tall shrubs commonly to occasionally present include *Amelanchier utahensis, Fraxinus anomala, Mahonia fremontii*, and *Quercus gambelii*. Common short and dwarf-shrubs include *Ephedra viridis, Ericameria*

nauseosa, *Opuntia polyacantha*, and *Rhus trilobata*. The herbaceous layer is diverse in terms of species composition and provides low to moderate cover. Graminoids commonly present in the community include *Achnatherum hymenoides*, *Bromus tectorum, Poa fendleriana*, and *Vulpia octoflora*. Forbs often present include *Artemisia ludoviciana*, *Castilleja linariifolia*, *Heterotheca villosa*, and *Lepidium montanum*. The vine *Clematis ligusticifolia* is often present and typically provides sparse cover.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Tree canopy	Broad-leaved deciduous tree	*Celtis laevigata var. reticulata, Fraxinus anomala, Populus tremuloides*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis, Fraxinus anomala, Quercus gambelii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Mahonia fremontii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Rhus trilobata*
Short shrub/sapling	Dwarf-shurb	*Ephedra viridis*
Herb (field)	Vine/Liana	*Clematis ligusticifolia*
Herb (field)	Forb	*Artemisia ludoviciana*
Herb (field)	Graminoid	*Achnatherum hymenoides*

CHARACTERISTIC SPECIES

Global: *Achnatherum hymenoides*, *Artemisia ludoviciana*, *Celtis laevigata* var. *reticulata*, *Clematis ligusticifolia*, *Fraxinus anomala*, *Opuntia polyacantha*, *Poa fendleriana*, *Rhus trilobata*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Vanclevea stylosa* (G3); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Mar-2005).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Global Range: This woodland association is currently only known from Capitol Reef National Park in Utah. Additional range information will be added as it becomes available.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Von Loh and D. Clark, mod. M.J. Russo
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Western Ecology Working Group n.d.

1.B.3.Nd. Southwest North American Flooded & Swamp Forest

M036. Warm Southwest Riparian Forest
G508. Sonoran-Chihuahuan Warm Desert Riparian Scrub

Fraxinus velutina Riparian Woodland [Park Special]

Velvet Ash Riparian Woodland
Identifier: CEPS009531

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Fraxinus velutina* Riparian Woodland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This velvet ash woodland association occurs along perennial and intermittent streams in the Inner Canyon and Western Grand Canyon. It typically occurs along low-level riparian drainage channels at 550 to 1075 m (1850-3025 feet) elevation. Slopes are gentle (1-2 degrees) and aspects are typically south-trending. This association often occurs in poorly-developed sandy soils. Rocks (35%) and gravel (20-25%) dominate the ground cover, while bedrock (5-10%), sand (5%) and flowing water (5-10%) are also common. This community is restricted to riparian habitats in narrow, shaded canyons.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total tree cover typically averages 20-30% in this association, and *Fraxinus velutina* (20-30%) is the sole component of the canopy layer. Riparian species such as *Baccharis emoryi* and *Baccharis salicifolia*, as well as shade-loving or canyon-obligates such as *Cercis orbiculata, Frangula betulifolia*, and *Celtis laevigata var. reticulata*, occur sporadically and comprise a fairly well-developed tall-shrub stratum (6%). Short shrubs (3%) are less abundant, although *Bebbia juncea* and *Rhus trilobata* occur in most stands. Graminoid cover averages about 4-5%, although species composition is not consistent among stands. Native wetland graminoids such as *Cladium californicum* and *Muhlenbergia asperifolia* occur in some stands, while exotics such as *Cynodon dactylon* and *Polypogon viridis* occur in others. The composition of forbs (3%) is similarly variable, and at least 30 different species can occur. *Mimulus cardinalis* (1%) and *Typha domingensis* (1%) are characteristic wetland species, while *Funastrum cynanchoides* frequently occurs as well. *Tamarix ramosissima* seedlings (trace cover) are established at many sites. Based upon the 3 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 25 species per 400-square-meter plot. One classification plot hosted 46 different species.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Fraxinus velutina*
Short shrub/sapling	Broad-leaved deciduous shrub	*Bebbia juncea, Rhus trilobata*
Herb (field)	Forb	*Mimulus cardinalis, Typha domingensis*
Herb (field)	Other herbaceous	*Tamarix ramosissima*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Andropogon glomeratus*, *Baccharis emoryi*, *Baccharis salicifolia*, *Celtis laevigata* var. *reticulata*, *Cercis orbiculata*, *Cladium californicum*, *Frangula betulifolia*, *Fraxinus velutina*, *Mimulus cardinalis*, *Muhlenbergia asperifolia*, *Typha domingensis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Mimulus cardinalis* (state-vulnerable, G5); **Invasive/Exotic**: *Bromus rubens* (exotic), *Conyza canadensis* (exotic), *Cynodon dactylon* (exotic, Medium/Low), *Melilotus officinalis* (exotic, Medium/Low), *Melilotus officinalis* (exotic), *Polypogon viridis* (exotic, High/Low), *Tamarix ramosissima* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and canyons of the Western Grand Canyon. It was sampled in an unnamed canyon upstream from Havasu Canyon on river right, from Surprise Canyon, and from Twin Springs Canyon.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (3 plots): GRCA.01671, GRCA.02560, GRCA.02631.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

***Populus fremontii - Fraxinus velutina* Woodland**

Fremont Cottonwood - Velvet Ash Woodland
Identifier: CEGL000942

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Populus fremontii - Fraxinus velutina* Woodland

ELEMENT CONCEPT

Global Summary: This is a lowland forested riparian association known from central and southeastern Arizona, southwestern New Mexico and southwestern Utah. Elevations range from 1200-1550 m. Sites are typically rocky or sandy banks of moderate-gradient streams (1.5%) that are frequently flooded (two-year recurrence interval). Soils have been reported as coarse-loamy over fragmental Typic Torrifluvents, and as cobbly riverwash, reflecting the coarse substrates of sites. *Populus fremontii* and *Fraxinus velutina* codominate young, moderate to dense canopies (>50% cover). *Acer negundo, Salix gooddingii, Juglans major, Alnus oblongifolia*, and *Celtis laevigata var. reticulata* are occasional canopy or subcanopy associates. Undergrowth is moderately diverse, but cover is low. In the shrub layer there are usually scattered individuals of *Baccharis salicifolia* and *Amorpha fruticosa*. The herbaceous layer has sparse to moderate cover. Common associates may include *Juncus saximontanus, Sphenopholis obtusata, Sporobolus cryptandrus, Muhlenbergia wrightii*, and *Datura wrightii*. Disturbed stands often have high cover of the introduced *Bromus diandrus, Bromus tectorum*, or some other exotics.

ENVIRONMENTAL DESCRIPTION

Global Environment: This is a lowland forested riparian association known from central and southeastern Arizona, southwestern New Mexico and southwestern Utah. Elevations range from 1200-1550 m . Sites are typically rocky or sandy banks of moderate-gradient streams (1.5%) that are frequently flooded (two-year recurrence interval). However, stands are also reported from higher elevations in cool drainages or ravines. Soils have been reported as coarse-loamy over fragmental Typic Torrifluvents, and as cobbly riverwash, reflecting the coarse substrates of sites.

VEGETATION DESCRIPTION

Global Vegetation: This riparian association is characterized by an open to moderately dense canopy (20-60%

cover) that is codominated by large *Populus fremontii* and *Fraxinus velutina* trees. *Acer negundo, Salix gooddingii, Juglans major, Alnus oblongifolia, Celtis laevigata var. reticulata*, and *Populus angustifolia* (at higher elevations) are occasional canopy associates, but may be more common in the subcanopy (if present). Undergrowth is moderately diverse, but cover is low. In the shrub layer there are usually scattered individuals of *Amorpha fruticosa, Baccharis salicifolia*, and several other shrubs including *Baccharis emoryi, Brickellia californica*, and *Ericameria nauseosa*. The herbaceous layer has sparse to moderate cover. Common associates may include *Juncus saximontanus, Sphenopholis obtusata, Sporobolus cryptandrus, Muhlenbergia wrightii*, and *Datura wrightii*. Disturbed stands often have high cover of the introduced *Bromus diandrus, Bromus tectorum*, or some other exotics.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo, Fraxinus velutina, Populus fremontii*

CHARACTERISTIC SPECIES

Global: *Fraxinus velutina*, *Populus fremontii*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus diandrus* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G3 (1-Dec-2000). This lowland riparian association is limited to scattered stands in Arizona, New Mexico, and southwestern Utah where plants, particularly trees and shrubs, have access to an active groundwater table. High-quality occurrences are not likely to exceed 100 in number. As with many riparian zone communities in the Southwest, impacts over the past 150 years from livestock use, agricultural conversion, urbanization, recreational use, and the alteration of hydrological regimes have led to extensive fragmentation and loss of this community. Viable occurrences are mostly found along unregulated rivers where periodic flooding and sustained maintenance flows lead to successful reproduction and establishment of native riparian species. In the Southwest, such unregulated rivers are few, hence the community has become globally rare, still is threatened, and declines continue today. The rank was changed from G3 to G2G3 to reflect these trends.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This type may only be a variant of *Populus fremontii - Salix gooddingii* Woodland (CEGL000944) and similar types. Szaro (1989) describes a *Populus fremontii - Fraxinus pennsylvanica* Community Type that is probably equivalent. Similarly, Dick-Peddie (1993) reports a *Populus fremontii - Fraxinus pennsylvanica - Salix gooddingii* type without a description as part of his Montane Riparian, Broadleaf Cottonwood-Mixed Deciduous Series in the Mimbres watershed that is possibly also synonymous.
Global Similar Associations:
- *Populus fremontii - Salix gooddingii* Woodland (CEGL000944)
- *Salix gooddingii - Fraxinus velutina* Temporarily Flooded Woodland (CEGL003729)

Global Related Concepts:
- *Populus fremontii - Fraxinus pennsylvanica* Community Type (Szaro 1989) =
- *Populus fremontii - Fraxinus pennsylvanica* type (Boles and Dick-Peddie 1983) =
- *Populus fremontii-Fraxinus velutina* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:II.B.3.a. (Driscoll et al. 1984) >
- Group I in Table 3; dominated by *Populus fremontii* in tree canopy and *Baccharis salicifolia* shrub layer (Webb and Brotherson 1988) =

ELEMENT DISTRIBUTION

Global Range: This association occurs in lowlands along the Animas Creek of the eastern slope of the Black Range in the Rio Grande Basin (Sierra County) and elsewhere in southwestern New Mexico, southern Arizona, southwest-

ern Utah, and may occur in western Texas.
Nations: MX?, US
States/Provinces: AZ, MXSO?, NM:S3?, TX?, UT
TNC Ecoregions: 19:C, 21:C, 22:C, 24:?
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, M313A:CC, M313B:C?
Federal Lands: NPS (Grand Canyon, Zion); USFWS (Buenos Aires)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: E. Muldavin, mod. K. Schulz
References: Boles and Dick-Peddie 1983, Bourgeron and Engelking 1994, Cogan et al. 2004, Driscoll et al. 1984, Muldavin et al. 2000a, Reid and Hall 2010, Schulz 2004, Szaro 1989, Webb and Brotherson 1988, Western Ecology Working Group n.d.

Populus fremontii - Salix gooddingii Woodland

Fremont Cottonwood - Goodding's Willow Woodland
Identifier: CEGL000944

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Populus fremontii - Salix gooddingii* Woodland

ELEMENT CONCEPT

Global Summary: This community occurs as small isolated stands or as linear bands that parallel stream channels in the Trans-Pecos region of western Texas, in southwestern New Mexico, southeastern Arizona, and south into northern Mexico. It has also been reported from isolated tributary drainages in southern Utah. The vegetation is dependent upon a subsurface water supply and varies considerably with the height of the water table. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. Soils are typically stratified sands, loams, and gravels. This deciduous woodland typically towers above the surrounding vegetation. *Populus fremontii* and *Salix gooddingii* may be nearly equal in abundance, or either may dominate. Individuals of *Populus fremontii* are scattered or occur in groves and may reach 30 m in height and 2 m in diameter. Other species that may occur in the canopy/subcanopy include *Populus deltoides ssp. wislizeni, Salix lasiolepis, Salix amygdaloides, Fraxinus berlandieriana, Celtis laevigata var. reticulata, Juglans microcarpa, Prosopis pubescens, Prosopis glandulosa*, and *Prosopis velutina*. The understories of most examples have been considerably altered by grazing and other factors, thus the composition and cover of the native understory is difficult to ascertain but frequently consists of shrubs and small trees (1-5 m tall). The herbaceous stratum varies in composition and coverage but is characterized by mixed annuals and short-lived perennials.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Fremont cottonwood woodland association occurs in perennially wet canyons of the Inner Canyon, along riparian drainage channels. It typically occurs at 1275 to 1475 m (415-4800 feet) elevation, in east- or southeast-trending canyons, on gentle slopes (up to 5 degrees), and in sandy soils. Litter (55-75%) and rocks (5-10%) dominate the ground cover, and surface water (up to 15%) is present on most sites. This vegetation type occurs in linear swathes along canyon bottoms.
Global Environment: This deciduous woodland is best developed along alluvial floodplains of large, low-gradient, perennial streams that flow through wide, unconstrained valleys. It has also been recorded surrounding perennially wet potholes within intermittent canyon drainages, as well as in the floodplains of intermittent streams. The vegetation is dependent upon a subsurface water supply and varies considerably with the height of the water table. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. Soils are typically stratified sands, loams, and gravels classified as Torrifluvents or Ustifluvents, with Haplustolls on more stable sites. These coarse-textured, alluvial

sediments have a low water-holding capacity and low nutrient availability.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association supports relatively dense tree cover (50-60%), and trees and tall shrubs are the dominant lifeforms. *Salix gooddingii* (25-35%) and *Populus fremontii* (35%) typically codominate the canopy layer; however, *Populus fremontii* is sometimes absent from the canopy and instead occurs as an emergent at lower cover (5%). *Acer negundo* can form a dense subcanopy (up to 40%) when present, but does not occur in all stands. Scattered tall shrubs, including *Cercis orbiculata* (5%) and *Baccharis emoryi* (1%), occur in some stands, although the stratum is not always well-defined. Graminoid cover only averages about 1% and includes various riparian species such as *Carex* spp., *Juncus* spp., and *Poa* spp. Forbs are similarly sparse (1%), although the characteristic *Euthamia occidentalis (= Solidago occidentalis), Mimulus cardinalis*, and *Typha* spp. occur in many stands. *Equisetum hyemale* may be a significant component of the understory (15%) in some stands.

Global Vegetation: This community occurs as small isolated stands or as narrow bands that parallel the stream channel or border a pothole. This deciduous woodland typically towers above the surrounding vegetation, with *Populus fremontii* and *Salix gooddingii* as the dominant species. These species may be nearly equal in abundance, or either may dominate. Individuals of *Populus fremontii* are scattered or occur in groves and may reach 30 m in height and 2 m in diameter. Other species that may occur in the canopy/subcanopy include *Populus deltoides ssp. wislizeni, Salix lasiolepis, Salix amygdaloides, Fraxinus berlandieriana, Celtis laevigata var. reticulata, Fraxinus velutina, Juglans microcarpa, Prosopis pubescens, Prosopis glandulosa*, and *Prosopis velutina*. The understory of most examples has been considerably altered by grazing and other factors, thus the composition and cover of the native understory is difficult to ascertain. The understory can be dense to open and frequently consists of shrubs and small trees 1-5 m tall, including *Prosopis* spp., *Baccharis salicifolia, Salix exigua, Sambucus mexicana, Rhamnus* spp., *Morus microphylla*, and *Amorpha fruticosa*. The woody exotics *Elaeagnus angustifolia* and various species of *Tamarix* now dominate the understory of most examples. The herbaceous stratum varies in composition and coverage but is characterized by mixed annuals and short-lived perennials. While most examples now have a herbaceous flora dominated by exotic species, in particular *Cynodon dactylon*, native species reported from this community include *Amaranthus palmeri, Amsinckia* spp., *Anemopsis californica, Boerhavia coccinea, Bowlesia incana, Carex* spp., *Chloracantha spinosa, Conyza canadensis var. canadensis, Cucurbita* spp., *Datura wrightii, Distichlis spicata, Euthamia occidentalis, Gutierrezia sarothrae, Juncus balticus, Lemna* spp., *Oenothera* spp., *Sorghum halepense, Sporobolus wrightii*, and *Trifolium longipes ssp. shastense*. Exotic plant species found in this community include *Tamarix chinensis, Elaeagnus angustifolia, Cynodon dactylon, Bromus rubens, Hordeum murinum ssp. leporinum, Pennisetum setaceum, Schismus* spp., *Sisymbrium irio*, and *Erodium* spp.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii, Salix gooddingii*
Tree subcanopy	Broad-leaved deciduous tree	*Acer negundo*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Cercis orbiculata*
Herb (field)	Fern or fern ally	*Equisetum hyemale*
Emergent tree	Broad-leaved deciduous tree	*Populus fremontii*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii, Salix gooddingii*
Tree subcanopy	Broad-leaved deciduous tree	*Fraxinus velutina*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acer negundo*, *Baccharis emoryi*, *Equisetum hyemale*, *Populus fremontii*, *Salix gooddingii*
Global: *Populus fremontii*, *Salix gooddingii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Polypogon viridis* (exotic, High/Low)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic), *Cynodon dactylon* (invasive/exotic, Medium/Low), *Elaeagnus angustifolia* (invasive/exotic, High), *Hordeum murinum* ssp. *leporinum* (invasive/exotic), *Pennisetum setaceum* (invasive/exotic, High/Medium), *Sisymbrium irio* (invasive/exotic, Medium/Insignificant), *Sorghum halepense* (invasive/exotic, High/Medium), *Tamarix chinensis* (invasive/exotic), *Xanthium strumarium* (invasive/exotic); **Other**: *Trifolium longipes* ssp. *shastense* (G5T2T3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (23-Feb-1994). Few intact examples of this association remain in the southwestern United States. The association continues to be in decline, primarily as a function of major hydrological alterations (dams and diversions), grazing, off-road vehicles and agricultural conversion. The remaining functional stands are restricted to wild rivers such as the Gila and San Francisco rivers, and possibly along the Mimbres River in New Mexico, or the San Pedro River in Arizona. A few remnant stands are also known from the middle Rio Grande and a few locations in western Texas. This is a very significant association with respect to biodiversity and was once one of the major riparian communities of the Southwest. Stands that have not been invaded by exotic trees, shrubs and herbs are also very rare. Even protected examples are threatened by continued declines in upland watershed conditions and hydrological modification.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Populus fremontii* / *Baccharis emoryi* Woodland (CEGL002946) occurs in similar riparian habitats and also supports similar associated species. *Populus fremontii* is also present in the canopy layer; however, *Salix gooddingii* is absent from the canopy in this association.
Global Comments: In Trans-Pecos Texas this woodland is dependent on a subsurface water supply and varies considerably with the water table levels. Major flood events and consequent flood scour, overbank deposition of water and sediments, and stream meandering are important factors that shape this community. These woodlands once occupied the floodplains and riverbanks of most perennial waterways within its range, but have mostly been replaced by disturbance types dominated by exotic species.
Global Similar Associations:
- *Populus deltoides (ssp. wislizeni, ssp. monilifera) - Salix gooddingii* Forest (CEGL005964)
- *Populus fremontii - Fraxinus velutina* Woodland (CEGL000942)
- *Populus fremontii - Salix gooddingii* / *Baccharis salicifolia* Forest (CEGL002683)
- *Populus fremontii - Salix gooddingii* / *Salix exigua* Forest (CEGL002684)
- *Populus fremontii* / *Baccharis emoryi* Woodland (CEGL002946) occurs in similar riparian habitats; *Populus fremontii* is also present in the canopy, but *Salix gooddingii* is absent.
- *Salix gooddingii - Fraxinus velutina* Temporarily Flooded Woodland (CEGL003729)

Global Related Concepts:
- *Populus fremontii* / *Salix gooddingii* Community Type (Szaro 1989) **=**
- *Populus fremontii-Salix gooddingii* (Bourgeron and Engelking 1994) **=**
- Broadleaf Cottonwood / Willow Woodland (Boles and Dick-Peddie 1983) **=**
- Cottonwood-Willow Series (Diamond 1993) **?**
- DRISCOLL FORMATION CODE:II.B.3.a. (Driscoll et al. 1984) **>**

- IIA7d. Western Cottonwood - Willow Riverfront Forest (Allard 1990) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from side canyons in the Inner Canyon with perennial water. It was sampled from Phantom Creek and from an unnamed tributary of Unkar Creek.
Global Range: This community is found in the Trans-Pecos region of western Texas, in southwestern New Mexico, southeastern Arizona, and south into northern Mexico. This community type is known to occur along the southern middle Rio Grande, along smaller montane tributary basins that drain the eastern side of the Black Range, along the Gila and San Francisco rivers and in the Pecos basin in southern New Mexico along three tributaries (Rio Ruidoso, Rio Hondo and Black River). It has also been reported from isolated tributary drainages in southern Utah.
Nations: MX?, US
States/Provinces: AZ:S2, CA?, CO:S1, MXCH?, MXSO?, NM:S2, TX:S3, UT
TNC Ecoregions: 19:C, 21:C, 22:C, 23:?, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322B:C?, 341B:CC, M313A:CC
Federal Lands: NPS (Capitol Reef, Grand Canyon, Tuzigoot); USFWS (Buenos Aires)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01600, GRCA.04569.
Local Description Authors: K. Christie
Global Description Authors: E. Milford and E. Muldavin, mod. J. Coles
References: Allard 1990, Boles and Dick-Peddie 1983, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Diamond 1993, Diamond et al. 1992, Driscoll et al. 1984, Metcalfe 1902, NMNHP unpubl. data, Reid and Hall 2010, Romme et al. 1993, Schulz 2004, Stromberg 1993a, Szaro 1989, TNC 1992b, TNC 1995e, Western Ecology Working Group n.d.

***Populus fremontii* / *Acer negundo* Forest**

Fremont Cottonwood / Box-elder Forest
Identifier: CEGL000662

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Populus fremontii* / *Acer negundo* Forest

ELEMENT CONCEPT

Global Summary: This forested riparian association is known from canyon bottoms in southwestern New Mexico and southern Utah, but it is likely to occur in Arizona, Nevada and California. Stands occur on gently sloping, lower riparian terraces associated with perennial streams. These are sites that flood periodically but not annually. The principal species depend on the water table being within 1 meter of the surface throughout the growing season in order to become established. Once established, both *Populus fremontii* and *Acer negundo* are capable of persisting as terraces become isolated from the water table. Soils are coarse, sandy and generally are poorly developed. In this association, *Populus fremontii* and *Acer negundo* form moderate to dense canopies, usually accompanied by *Juglans major* as a codominant in the southern part of the range. There is no structural information for New Mexico occurrences, but other associated woody species in southern New Mexico include *Ptelea trifoliata var. angustifolia (= Ptelea angustifolia)* and *Amorpha fruticosa*. In the Colorado Plateau, total canopy cover ranges from 60% to more than 100%. Associated woody understory species include *Salix exigua, Rhus trilobata*, and *Brickellia longifolia*. The herbaceous component of the community is variable depending on the site, the depth to water table and the flood frequency.

ENVIRONMENTAL DESCRIPTION

Global Environment: This forested riparian association is known from canyon bottoms in southwestern New Mexico and southern Utah, but it is likely to occur in Arizona, Nevada and California. Stands occur on gently sloping, lower riparian terraces associated with perennial streams. These are sites that flood periodically but not annually.

Soils are coarse, sandy and generally are poorly developed.

VEGETATION DESCRIPTION

Global Vegetation: In this association, *Populus fremontii* and *Acer negundo* form moderate to dense canopies, sometimes accompanied by *Juglans major* as a codominant in the southern part of the range. There is no structural information for New Mexico occurrences, but other associated woody species in southern New Mexico include *Ptelea trifoliata var. angustifolia (= Ptelea angustifolia)* and *Amorpha fruticosa*. In the Colorado Plateau, total canopy cover ranges from 60% to more than 100%. Associated woody understory species include *Salix exigua, Rhus trilobata*, and *Brickellia longifolia*. The herbaceous component of the community is variable depending on the site, the depth to water table and the flood frequency.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Acer negundo, Populus fremontii*

CHARACTERISTIC SPECIES

Global: *Acer negundo*, *Populus fremontii*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2Q (1-Dec-2000). This lowland riparian association is limited to southwestern New Mexico and southern Utah where plants, particularly trees and shrubs, have access to an active groundwater table. As with many riparian zone communities in the Southwest, impacts over the past 150 years from livestock use, agricultural conversion, urbanization, recreational use, and the alteration of hydrological regimes have led to extensive fragmentation and loss of this community. Viable occurrences are mostly found along unregulated rivers where periodic flooding and sustained maintenance flows lead to successful reproduction and establishment of native riparian species. In the Southwest, such unregulated rivers are few, hence the community has become globally rare, still is threatened, and declines continue today. This association is ranked G2Q to reflect its rarity and the fact that it is reported only from a single research study. More vegetation inventory and classification work are needed to resolve this questionable status.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: Reported only by Henry (1981) but has also been documented in Capitol Reef National Park in Utah. Further east, in a zone of hybridization between *Populus fremontii* and *Populus deltoides ssp. wislizeni*, the very similar association *Populus deltoides ssp. wislizeni* / *Acer negundo* Woodland (CEGL002336) occurs in Natural Bridges National Monument.
Global Similar Associations:
- *Populus deltoides ssp. wislizeni* / *Acer negundo* Woodland (CEGL002336)

Global Related Concepts:
- *Populus fremontii - Acer negundo* Association (Vaghti 2003) **=**
- *Populus fremontii* (Fremont cottonwood forest) Alliance (Sawyer et al. 2009) **>**
- *Populus fremontii/Acer negundo* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Global Range: This association is known to occur in southwestern New Mexico and southern Utah. It may occur in northern Arizona, Nevada and California, but will not occur in Colorado, as *Populus fremontii* is replaced by *Populus deltoides ssp. monilifera* and *Populus deltoides ssp. wislizeni* there.

Nations: US
States/Provinces: AZ, CA?, NM:S2, NV?, UT
TNC Ecoregions: 11:C, 17:C, 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322A:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: E. Muldavin, mod. J. Coles
References: Bourgeron and Engelking 1994, Clark et al. 2009, Driscoll et al. 1984, Henry 1981, Reid and Hall 2010, Romme et al. 1993, Sawyer et al. 2009, Vaghti 2003, Western Ecology Working Group n.d.

Populus fremontii / *Baccharis emoryi* Woodland

Fremont Cottonwood / Emory's Seep-willow Woodland
Identifier: CEGL002946

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Populus fremontii* / *Baccharis emoryi* Woodland

ELEMENT CONCEPT

Global Summary: This association has only been described from Zion National Park. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Fremont cottonwood woodland association occurs in the Inner Canyon in the bottoms of perennial drainages and in other riparian habitats. It occurs from approximately 725 to 1200 m (2325-5175 feet) elevation on gently sloping (0-8 degrees) drainage channels on low levels and interfluves. Soils are typically sandy loams derived from various parent materials that are commonly obscured by the soil. Soil can range from poorly- to rapidly-drained depending on site conditions. Ground cover is dominated mostly by litter (40%) and surface rocks (31%), but may also have significant cover of bare soil (0-20%), sand (0-15%), water (1-16%), gravel (0-15%), or wood (0-10%). This is a riparian vegetation type and is restricted to areas with perennial creeks and/or reliable springs and seeps.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is somewhat variable depending on site conditions, but always has a tree canopy comprised almost exclusively of *Populus fremontii* (15%). Beneath the tree canopy is a well-defined tall-shrub layer consisting mostly of *Baccharis emoryi* (7%) and *Salix exigua* (9%); however, other tall shrubs, such as *Salix gooddingii, Fallugia paradoxa, Purshia stansburiana*, and *Cercis orbiculata*, can all occur with up to 2% cover each. The short-shrub stratum is typically less dense (4-5%) and can also include *Baccharis emoryi* (2%) and *Salix exigua* (3%), as well as *Baccharis salicifolia, Brickellia longifolia*, and *Tamarix ramosissima*. Dwarf-shrubs are essentially absent. Graminoid cover averages 5% and includes wetland species such as *Phragmites australis, Cladium californicum, Imperata brevifolia*, and *Muhlenbergia asperifolia*. Forb cover averages about 2% and includes species such as *Typha* spp, *Oenothera elata*, and *Artemisia ludoviciana*; *Equisetum hyemale* occurs in some stands as well. The undulating terrain in drainages and interfluves is capable of supporting xeric understory species as well, including *Aristida purpurea, Achnatherum speciosum*, and *Datura wrightii*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Populus fremontii*

Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Salix exigua*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Baccharis emoryi*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis emoryi*, *Populus fremontii*, *Salix exigua*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Imperata brevifolia* (globally imperiled, G2); **Invasive/Exotic**: *Bromus rubens* (exotic), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Tamarix ramosissima* (exotic, High)
Global: Vulnerable: *Imperata brevifolia* (G2)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: This vegetation type can be distinguished by its riparian habit and the dominance of *Populus fremontii* in the overstory.
Global Similar Associations:
- *Populus fremontii - Salix gooddingii* Woodland (CEGL000944)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from riparian areas in the Inner Canyon. It was sampled from near Deer Creek, Phantom Creek, Shinumo Creek, Clear Creek, Tapeats Creek, and Roaring Springs.
Global Range: This association has currently only been described from Zion National Park in southwestern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (9 plots): GRCA.01560, GRCA.01597, GRCA.01616, GRCA.03546, GRCA.03603, GRCA.03604, GRCA.03615, GRCA.04632, GRCA.02603.
Local Description Authors: S. Fugate
Global Description Authors:
References: Cogan et al. 2004, Reid and Hall 2010, Western Ecology Working Group n.d.

***Salix gooddingii / Baccharis emoryi* Woodland**

Goodding's Willow / Emory's Seep-willow Woodland
Identifier: CEGL005981

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Salix gooddingii / Baccharis emoryi* Woodland

ELEMENT CONCEPT

Global Summary: This type is known from around 1110 m (3660 feet) elevation along slow-moving reaches of the Black River in southeastern New Mexico. *Salix gooddingii* forms a moderately open canopy that overhangs the banks of low-gradient streams lined with *Baccharis emoryi*. The herbaceous cover is also abundant and dominated

by *Cynodon dactylon, Equisetum laevigatum, Juncus balticus, Juncus saximontanus, Schoenoplectus pungens (= Scirpus pungens), Muhlenbergia asperifolia*, *Polypogon monspeliensis*, *Typha latifolia*, *Verbena scabra*, and *Phyla lanceolata*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This willow woodland association predominantly occurs in drainage channels along intermittent and permanent streams, or on low slopes just above streams in the Inner Canyon and Western Grand Canyon. It occurs from approximately 380 to 1000 m (1200-3300 feet) elevation, on flat drainage bottoms, or near the base of slightly sloping (8%) hillsides adjacent to streams. Soils are wet, loamy sands that typically hide the underlying geology. Ground cover varies widely from stand to stand but is usually dominated by litter (60%), sand (25%), and wood (8%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characteristically dense and typically supports 40-80% tree and/or shrub cover. Density and canopy height can vary widely depending on the age of the stand and the availability of water. Some stands are dominated by an incredibly dense and closed canopy of *Salix gooddingii* (80%) trees, with relatively sparse *Baccharis emoryi* (2%) in the tall-shrub layer. In other sparser stands, *Baccharis emoryi* has higher cover (20%) than *Salix gooddingii* (4%), which assumes a shrub form. The tall shrubs *Prosopis glandulosa* (3%) and *Tamarix ramosissima* (2%), as well as the large graminoids *Phragmites australis* (15%) and *Cladium californicum* (3%), may also be present.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix gooddingii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Baccharis emoryi*
Herb (field)	Graminoid	*Phragmites australis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis emoryi*, *Phragmites australis*, *Salix gooddingii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Tamarix ramosissima* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2? (19-Jul-2004).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Salix gooddingii* Woodland (CEGL002743) is another riparian community dominated by *Salix gooddingii*; however, *Baccharis emoryi* is essentially absent. *Tamarix ramosissima* occurs in this community as well, but averages 8% cover as opposed to 2% cover in *Salix gooddingii* / *Baccharis emoryi* Woodland (CEGL005981).

Global Similar Associations:

- *Salix gooddingii* Woodland (CEGL002743) is another riparian community dominated by *Salix gooddingii*, but *Baccharis emoryi* is essentially absent.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Unkar Creek, and from the Western Grand Canyon, where it was sampled from Burnt Canyon.

Global Range: This association is found in the Black River drainage in southeastern New Mexico (Eddy County).

Nations: US

States/Provinces: AZ, NM:S2?

TNC Ecoregions: 19:C, 24:C

USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01685, GRCA.02545.
Local Description Authors: R. Meszaros
Global Description Authors: E. Muldavin et al.
References: Muldavin et al. 2000a, Reid and Hall 2010, Western Ecology Working Group n.d.

Salix gooddingii Woodland

Goodding's Willow Woodland
Identifier: CEGL002743

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Riparian Forest (M036)
Group	Sonoran-Chihuahuan Warm Desert Riparian Scrub (G508)
Association	*Salix gooddingii* Woodland

ELEMENT CONCEPT

Global Summary: This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora. Elevation range is wide, from 239-2210 m (780-7245 feet), but stands generally occur below 1300 m (4260 feet). Sites are flat to gently sloping and occur along the alluvial terraces of streams in mesic desert canyons and floodplains on basin floors. Stands also occur in isolated pockets in canyons and rocky floodplains of small, intermittent streams associated with seeps and springs. Alluvial substrates are variable but are often fine-textured loams or clays. The vegetation is characterized by abundant *Salix gooddingii* that dominates or codominates the open to moderately dense (20-60% cover) tree canopy. *Prosopis velutina*, *Prosopis glandulosa*, or *Fraxinus velutina* may codominate the 5- to 15-m tall tree canopy. *Populus fremontii* is generally absent or uncommon (<1%). *Populus angustifolia* is occasionally present in the canopy. Shrubs may be present but seldom form a stratum. Other tree and shrub species present may include *Baccharis salicifolia, Celtis laevigata var. reticulata, Juglans microcarpa, Mahonia haematocarpa (= Berberis haematocarpa), Quercus* spp., *Sapindus saponaria var. drummondii, Ungnadia speciosa*, and *Ziziphus obtusifolia*, depending on location and hydrology. The herbaceous layer is typically moderately dense to dense, often diverse and composed of mesic forbs and graminoids. Common species include *Ambrosia confertiflora, Berula erecta, Eleocharis palustris, Equisetum laevigatum, Ipomoea* spp., *Juncus arcticus, Juncus balticus, Muhlenbergia asperifolia, Physalis longifolia, Polygonum* spp, *Schoenoplectus* spp. *Veronica anagallis-aquatica*, and *Xanthium strumarium*. Disturbance is common in this woodland, and introduced species such as *Echinochloa crus-galli, Lactuca serriola, Lolium arundinaceum (= Festuca arundinacea), Rumex crispus, Sorghum halepense*, and *Tamarix* spp. are present in many stands. Diagnostic of the woodland is the dominance or codominance of *Salix gooddingii* in the tree canopy with *Populus fremontii* absent or uncommon.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This willow woodland association predominantly occurs on alluvial terraces along perennial or intermittent streams in the Inner Canyon and Western Grand Canyon. It occurs from approximately 430 to 730 m (1425-2425 feet) elevation on flat to gently sloping (2-3 degrees) sites. Soils are variable but are usually poorly-drained and contain loam, clay or silt. A litter layer (50%), as well as some exposed soil (13%), rocks (13%), and gravel (15%) dominate the ground cover.
Global Environment: This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora. Elevation range is wide, from 239-2210 m (780-7245 feet), but stands generally occur below 1300 m (4260 feet). Sites are flat to gently sloping and occur along the alluvial terraces of streams in mesic desert canyons and floodplains on basin floors. Stands also occur in isolated pockets in canyons and rocky floodplains of small, intermittent streams associated with seeps and springs. Alluvial substrates are variable but

are often fine-textured loams or clays.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association typically supports a dense shrub layer which averages 40-65% cover. The tall shrub *Salix gooddingii* (20-60%) dominates and characterizes this vegetation type. *Baccharis salicifolia* (up to 25%) and *Tamarix ramosissima* (8%) are also frequently present in this layer and may be codominant in some stands. Short- and dwarf-shrub layers are infrequent and mostly absent. A graminoid layer of *Phragmites australis* (10%), *Carex hystericina* (5%), and the exotics *Cynodon dactylon* (1%) and *Polypogon monspeliensis* (1%) may also occur. *Urtica dioica ssp. gracilis* (1%) and *Typha* spp. (2%) occasionally occur in what is typically a sparse forb layer. *Equisetum hyemale* (5%) and *Adiantum capillus-veneris* (1%) can sometimes occur in the herbaceous understory.
Global Vegetation: The vegetation is characterized by abundant *Salix gooddingii* that dominates or codominates the open to moderately dense (20-60% cover) tree canopy. *Prosopis velutina*, *Prosopis glandulosa*, or *Fraxinus velutina* may codominate the 5- to 15-m tall tree canopy. *Populus fremontii* is generally absent or uncommon (<1%). *Populus angustifolia* is occasionally present in the canopy. Shrubs may be present but seldom form a stratum. Other tree and shrub species present may include *Baccharis salicifolia, Celtis laevigata var. reticulata, Juglans microcarpa, Mahonia haematocarpa (= Berberis haematocarpa), Quercus* spp., *Sapindus saponaria var. drummondii, Ungnadia speciosa*, and *Ziziphus obtusifolia*, depending on location and hydrology. The herbaceous layer is typically moderately dense to dense, often diverse and composed of mesic forbs and graminoids. Common species include *Ambrosia confertiflora, Berula erecta, Eleocharis palustris, Equisetum laevigatum, Ipomoea* spp., *Juncus arcticus, Juncus balticus, Muhlenbergia asperifolia, Physalis longifolia, Polygonum* spp, *Schoenoplectus* spp. *Veronica anagallis-aquatica*, and *Xanthium strumarium*. Disturbance is common in this woodland, and introduced species such as *Echinochloa crus-galli, Lactuca serriola, Lolium arundinaceum (= Festuca arundinacea), Rumex crispus, Sorghum halepense*, and *Tamarix* spp. are present in many stands. Diagnostic of the woodland is the dominance or codominance of *Salix gooddingii* in the tree canopy with *Populus fremontii* absent or uncommon.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Salix gooddingii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Baccharis salicifolia*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Salix gooddingii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis salicifolia*, *Carex hystericina*, *Equisetum hyemale*, *Phragmites australis*, *Salix gooddingii*, *Tamarix ramosissima*
Global: *Salix gooddingii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Cynodon dactylon* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Tamarix ramosissima* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-May-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Salix gooddingii / Baccharis emoryi* Woodland (CEGL005981) is also dominated by *Salix gooddingii*; however, *Baccharis emoryi* is present as a codominant. *Tamarix ramosissima* oc-

curs in this community as well, but averages only 2% cover, as opposed to 8% cover in *Salix gooddingii* Woodland (CEGL002743).
Global Comments: This association has a limited distribution. Remaining examples have had many large trees removed, contain exotic species, and have been impacted by overgrazing. Disruption of the natural flooding regime, through damming, water diversions and stream channelization, is also a major threat to these woodlands.
Global Similar Associations:
- *Salix gooddingii* / *Baccharis emoryi* Woodland (CEGL005981) is also dominated by *Salix gooddingii* but with *Baccharis emoryi* as a codominant.

Global Related Concepts:
- *Salix gooddingii* Community (Szaro and DeBano 1985) =
- *Salix gooddingii* Community Type (Szaro 1989) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Deer Creek near Dear Spring, and from the Western Grand Canyon, where it was sampled from Separation Canyon.
Global Range: This palustrine woodland is found in the Trans-Pecos of western Texas, New Mexico, southern Arizona and possibly north of the Mogollon Rim, and Nevada. It is also found in the Mexican states of Chihuahua and Coahuila and possibly Sonora.
Nations: MX, US
States/Provinces: AZ, MXCH, MXCO, MXSO?, NM, NV:S3?, TX
TNC Ecoregions: 11:C, 17:?, 19:C, 21:C, 23:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322B:CC, M313B:CC, M341A:CC
Federal Lands: NPS (Grand Canyon, Salinas Pueblo Missions); USFWS (Buenos Aires)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01559, GRCA.03674.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz, mod. K.S. King
References: Barber pers. comm., Muldavin et al. 2000a, Muldavin et al. 2011c, Reid and Hall 2010, Schulz 2004, Szaro 1989, Szaro and DeBano 1985, Western Ecology Working Group n.d.

M298. Warm Southwest Ruderal Flooded & Swamp Forest
G510. Southwest North American Ruderal Riparian Forest & Scrub

Tamarix spp. Temporarily Flooded Semi-natural Shrubland

Tamarisk species Temporarily Flooded Semi-natural Shrubland
Identifier: CEGL003114

USNVC CLASSIFICATION

Division	Southwest North American Flooded & Swamp Forest (1.B.3.Nd)
Macrogroup	Warm Southwest Ruderal Flooded & Swamp Forest (M298)
Group	Southwest North American Ruderal Riparian Forest & Scrub (G510)
Association	*Tamarix* spp. Temporarily Flooded Semi-natural Shrubland

ELEMENT CONCEPT

Global Summary: This broadly defined association is composed of shrublands which form moderately dense to dense thickets on banks of larger streams across the western Great Plains, interior and southwestern U.S. and northern Mexico. Stands are dominated by introduced species of *Tamarix*, including *Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. *Tamarix* spp. were introduced from the Mediterranean and have become naturalized in various sites, including salt flats and other saline habitats, springs, and especially along streams and regulated rivers, where it replaces the native vegetation, such as shrublands dominated by species of *Salix* or *Prosopis* or woodlands of *Populus* spp. A remnant herbaceous layer may be present, depending on the age and

density of the shrub layer, although in many cases this layer also consists of aggressive exotic species such as *Lepidium latifolium*. *Tamarix* species have become a critical nuisance along most large rivers in the semi-arid West and, because of permanent changes in flood regimes and the difficulty of removing trees, reflect irreversibly changed vegetation on many sites.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This tamarisk shrubland association occurs throughout Grand Canyon National Park along the Colorado River corridor; and also in Grand Canyon-Parashant National Monument in the vicinity of Grand Wash Bay and Lake Mead. It predominantly occurs along the banks of Colorado River, but also occasionally occurs in low-level drainage channels or valley bottoms in tributary canyons of the Colorado River. It occurs at 350 to 900 m (1200-2900 feet) elevation, on flat or very gentle slopes (up to 2 degrees), across all aspects. Soils are silty or sandy. Litter (40-45%), bare soil (17%), rocks (13%), and gravel (12%) are the major components of the ground cover.

Global Environment: These widespread shrublands are common along larger streams, rivers, and around playas in the western U.S. and Mexico. Elevation ranges from 75 m below sea level to 1860 m. *Tamarix* spp. have become naturalized in various sites including riverbanks, floodplains, basins, sandbars, side channels, springs, salt flats, and other saline habitats. Stands grow especially well along regulated rivers where flood-regenerated native species such as *Populus* are declining, and the absence of regular scouring floods allows *Tamarix* seedlings to become established. Substrates are commonly thin sandy loam soil over alluvial deposits of sand, gravel or cobbles.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 50% in this association, which is strongly dominated by the phreatophytic tall shrub *Tamarix ramosissima* (50% cover). Dense stands can support up to 95% *Tamarix ramosissima* cover. Native shrubs, including *Pluchea sericea, Baccharis emoryi, Baccharis salicifolia, Baccharis sarothroides*, and *Salix exigua*, occasionally occur scattered among the dense *Tamarix ramosissima* at low individual covers (typically less than 5% each). Dwarf-shrubs are absent from this association. A graminoid layer (5-6%) occurs about half of the time, and is generally dominated by the non-native *Bromus rubens* (3%). Some stands can support an extremely dense graminoid understory of *Bromus rubens* and/or *Cynodon dactylon* (up to 50% cover total). Forb (1-2%) composition is extremely variable among stands. This community supports extremely low species diversity, among the lowest of any community type in Grand Canyon National Park.

Global Vegetation: This semi-natural shrubland occurs along streams, rivers and playas where it forms a moderate to dense tall-shrub layer that is solely or strongly dominated by species of *Tamarix*, including *Tamarix ramosissima, Tamarix chinensis*, *Tamarix gallica*, and *Tamarix parviflora*. Other shrubs may include species of *Salix* (especially *Salix exigua*) and *Prosopis, Rhus trilobata*, and *Sarcobatus vermiculatus* but with low cover (if shrub species are codominant, then the stand is classified as a natural shrubland). Scattered *Acer negundo, Salix amygdaloides, Populus* spp., or *Elaeagnus angustifolia* trees may also be present. Depending on stand age and density of the shrub layer, an herbaceous layer may be present. Associated native species include *Distichlis spicata* and *Sporobolus airoides*, and introduced species include *Agrostis gigantea, Agrostis stolonifera*, and *Poa pratensis*. Introduced herbaceous species such as *Polypogon monspeliensis, Conyza canadensis, Lepidium latifolium*, and others have been reported from shrublands in this association.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Herb (field)	Graminoid	*Bromus rubens*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Tamarix chinensis, Tamarix gallica, Tamarix parviflora, Tamarix ramosissima*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis emoryi*, *Baccharis salicifolia*, *Bromus rubens*, *Pluchea sericea*, *Salix exigua*, *Tamarix ramosissima*
Global: *Tamarix chinensis*, *Tamarix gallica*, *Tamarix parviflora*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Erodium cicutarium* (exotic, Medium/Low), *Lepidium latifolium* (exotic, High), *Lepidium perfoliatum* (exotic, Low/Insignificant), *Lolium arundinaceum* (exotic (= Schedonorus phoenix), High/Medium), *Melilotus officinalis* (exotic, Medium/Low), *Plantago lanceolata* (exotic, High/Low), *Plantago major* (exotic), *Polypogon viridis* (exotic, High/Low), *Salsola tragus* (exotic), *Schismus arabicus* (exotic, High/Medium), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant), *Sonchus asper* (exotic), *Sonchus oleraceus* (exotic), *Tamarix ramosissima* (exotic, High), *Taraxacum officinale* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Lepidium latifolium* (invasive/exotic, High), *Poa pratensis* (invasive, Medium), *Tamarix chinensis* (invasive/exotic), *Tamarix gallica* (invasive/exotic), *Tamarix parviflora* (invasive/exotic), *Tamarix ramosissima* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (24-Jul-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This is a broadly defined plant association that is composed of many diverse *Tamarix* spp.-dominated vegetation communities from a wide variety of environments. Muldavin et al. (2000a) described 8 community types that will be reviewed as possible USNVC associations.
Global Similar Associations:
- *Tamarix* spp. - (*Baccharis halimifolia*) Shrubland (CEGL004918)

Global Related Concepts:
- *Tamarix chinensis* Community Type (Hansen et al. 1995) **<**
- *Tamarix pentandra* Community Type (Szaro 1989) **?**
- *Tamarix ramosissima* (Salt cedar) Association (Nachlinger and Reese 1996) **?**
- *Tamarix ramosissima* Shrubland (Carsey et al. 2003a) **=**
- Palustrine (Cowardin et al. 1979) **>**
- Salt cedar series (Paysen et al. 1980) **?**
- Tamarisk Scrub (Holland 1986b) **=**
- Tamarisk series (Sawyer and Keeler-Wolf 1995) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from throughout the Inner Canyon and Western Grand Canyon, where it was sampled from numerous locations along the Colorado River corridor. It is also known from Grand Canyon-Parashant National Monument from around Grand Wash Bay and Lake Mead. It is prevalent in areas at the lake's edge that were previously inundated but have become exposed with the dropping water levels.
Global Range: This semi-natural shrubland is found along drainages in the semi-arid western Great Plains, interior and southwestern U.S. and northern Mexico, from central and eastern Montana, south to Colorado, western Oklahoma and Texas, west to California.
Nations: MX, US
States/Provinces: AZ, CA, CO, MT, MXCH, MXCO, MXSO, NM, NV, OK, TX, UT, WY
TNC Ecoregions: 5:C, 9:C, 10:C, 12:C, 13:C, 15:C, 16:C, 17:C, 19:C, 21:C, 22:C, 23:C, 24:C, 26:C, 27:C, 28:C
USFS Ecoregions (1994/95): 261A:CC, 261B:CC, 262A:CC, 313A:CC, 313B:CC, 313C:CC, 313D:CC, 313E:CC, 315B:CC, 321A:CC, 322A:CC, 331I:CC, 341B:CC, 341C:CC, M261A:CC, M261E:CC, M261F:CC, M262A:CC, M262B:CC, M331E:CC
Federal Lands: NPS (Arches, Big Bend, Canyonlands, Capitol Reef, Dinosaur, Grand Canyon, Grand Canyon-Parashant, Lake Meredith, Petrified Forest, Wupatki, Zion); USFS (Humboldt-Toiyabe, Spring Mountains);

USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.01509, GRCA.01510, GRCA.01521, GRCA.01679, GRCA.01686, GRCA.02045, GRCA.04001, GRCA.04700, GRCA.04718; and 128 Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Baalman 1965, Carsey et al. 2003a, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Hansen et al. 1995, Hansen et al. 2004b, Hoagland 2000, Holland 1986b, MTNHP 2002b, Muldavin et al. 2000a, Nachlinger and Reese 1996, Ortenberger and Bird 1933, Paysen et al. 1980, Reid and Hall 2010, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Smith and Douglas 1989, Stevens and Shannon 1917, Szaro 1989, TNHS unpubl. data, Thomas et al. 2009a, Ungar 1968, Von Loh et al. 2002, WNDD unpubl. data, Ware and Penfound 1949, Western Ecology Working Group n.d.

2. Shrubland & Grassland

2.B.2. Temperate Grassland, Meadow & Shrubland
2.B.2.Na. Western North American Grassland & Shrubland

M168. Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow
G268. Southern Rocky Mountain Montane-Subalpine Grassland

Carex siccata - Carex rossii Herbaceous Vegetation

Dry-spike Sedge - Ross' Sedge Herbaceous Vegetation
Identifier: CEGL005388

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow (M168)
Group	Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Association	*Carex siccata - Carex rossii* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This high-elevation sedge herbaceous association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from 2467 to 2688 m (8094-8819 feet) elevation, predominantly on the high-level plateau, on south- and west-facing slopes. Slopes are quite gentle, averaging 7 degrees. Soils are well-drained or rapidly-drained silt loams. There is evidence of fairly recent, high-severity fire in all observed stands. This is a somewhat variable association but is characterized by a lack of tree cover, a very sparse shrub layer, and the dominance of *Carex rossii* and *Carex siccata* in the understory. Short shrubs are very uncommon and sparse, with the occasional small patch of *Robinia neomexicana*. Dwarf-shrubs are also sparse; however, *Ceanothus fendleri* is quite frequent. *Carex rossii* dominates the understory. *Bromus tectorum* and *Elymus elymoides* are also common at very low cover. Disturbance-adapted *Erigeron divergens, Chenopodium* sp., *Gayophytum diffusum, Pseudognaphalium macounii*, and *Conyza canadensis* are common forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This high-elevation association occurs on the North Rim from 2467 to 2688 m (8094-8819 feet) elevation. It occurs predominantly on the high-level plateau, on south- and west-facing slopes. Slopes are quite gentle, averaging 7 degrees. Soils are well-drained or rapidly-drained silt loams. As a result of recent fires, stands have the lowest litter cover (63%) and highest bare soil cover (11%) among high-elevation North

Rim communities. There is evidence of fairly recent, high-severity fire in all stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This is a somewhat variable association but is characterized by a lack of tree cover, a very sparse shrub layer, and the dominance of *Carex rossii* and *Carex siccata* in the understory. This vegetation type lacks both a tree canopy and subcanopy. Short shrubs are very uncommon and sparse, with the occasional small patch of *Robinia neomexicana*. Dwarf-shrubs are also sparse; however, *Ceanothus fendleri* (2%) is quite frequent. *Carex rossii* (10% cover) ubiquitously dominates the understory, sometimes at up to 25% cover. *Bromus tectorum* and *Elymus elymoides* are also common at very low cover. Disturbance-adapted *Erigeron divergens* (1%), *Chenopodium* sp. (9%), *Gayophytum diffusum* (trace), *Pseudognaphalium macounii* (trace), and *Conyza canadensis* (1%) are common forbs. This community seems to be at such an early successional stage that tree seedlings are sparse; however, *Populus tremuloides* (2%) and *Pinus ponderosa* (trace) do occur occasionally. This association supports below-average species richness (24 species per 400-square-meter plot) for high-elevation communities on the North Rim.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Ceanothus fendleri*
Herb (field)	Forb	*Conyza canadensis, Erigeron divergens, Gayophytum diffusum*
Herb (field)	Graminoid	*Carex rossii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Carex rossii*, *Carex siccata*, *Ceanothus fendleri*, *Conyza canadensis*, *Erigeron divergens*, *Populus tremuloides*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Cirsium vulgare* (exotic, Medium/Low), *Erysimum repandum* (exotic), *Poa pratensis* (exotic, Medium), *Polygonum aviculare* (exotic, Low), *Sonchus asper* (exotic), *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low), *Verbascum thapsus* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (19-May-2009).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This community occurs in scattered stands across the North Rim. It typically occurs at slightly lower elevations, close to the rim; and it always occurs in heavily-burned areas. Sampled locations include Kanabownits Canyon, north of the Widforss trail, and near Thompson Canyon.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (9 plots):

GRCA.02151, GRCA.02197, GRCA.03084, GRCA.03097, GRCA.03105, GRCA.03109, GRCA.03117, GRCA.03129, GRCA.03163.
Local Description Authors: L. Dickson and K. Christie
Global Description Authors: L. Dickson and K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Festuca (calligera, arizonica, brachyphylla) Herbaceous Vegetation

(Southwest Fescue, Arizona Fescue, Alpine Fescue) Herbaceous Vegetation
Identifier: CEGL005500

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow (M168)
Group	Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Association	*Festuca (calligera, arizonica, brachyphylla)* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This grassland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in high-elevation meadows typically in flat, low-level valley bottoms, or in wide open drainage bottoms, at 2550 to 2750 m (8350-9050 feet). Soils are silt loams and vary from dry to moist. This association is a purely herbaceous vegetation type and lacks tree and shrub cover. *Festuca* sp. (*Festuca calligera, Festuca arizonica, Festuca brachyphylla*) is the dominant component of the graminoid layer. *Muhlenbergia montana* consistently occurs and is more abundant on drier sites, while *Deschampsia caespitosa* can occur on more mesic sites. The presence of *Blepharoneuron tricholepis* is characteristic of this association as well. Forb species typically account for 15-20% total cover, and almost 50 different species may be present. *Potentilla hippiana, Achillea millefolium, Pseudocymopterus montanus*, and *Hymenoxys subintegra* are the most common forbs, while *Ranunculus cardiophyllus, Arenaria fendleri, Eriogonum racemosum, Antennaria rosulata*, and *Solidago nana* are also fairly common. Graminoids are typically dominant in this plant association; however, the forb component can be very well-developed and codominant on some sites. This plant community supports a uniquely southwestern floristic assemblage, but also hosts many higher-elevation or higher-latitude species from the Rocky Mountain region.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs in high-elevation meadows of the Kaibab Plateau on the North Rim. It typically occurs in flat, low-level valley bottoms, or in wide open drainage bottoms, at 2550 to 2750 m (8350-9050 feet). Soils are silt loams and vary from dry to moist. Herbaceous litter (59%), bare soil (23%), and gravel (5%) are common components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is a purely herbaceous vegetation type and lacks tree and shrub cover. Graminoid cover averages 40% but may be as high as 60%. *Festuca* sp. (*Festuca calligera, Festuca arizonica, Festuca brachyphylla*) is the dominant component of the graminoid layer and typically comprises about 25-35% cover. *Muhlenbergia montana* consistently occurs at 1-10% cover and is more abundant on drier sites, while *Deschampsia caespitosa* can occur at up to 20% cover on more mesic sites. The presence of *Blepharoneuron tricholepis* (up to 5% cover) is characteristic of this association as well. Forb species typically account for 15-20% total cover, and almost 50 different species may be present. *Potentilla hippiana* (up to 10% cover), *Achillea millefolium* (to 2%), *Pseudocymopterus montanus* (to 2%), and *Hymenoxys subintegra* (1%) are the most common forbs, while *Ranunculus cardiophyllus* (up to 5% cover), *Arenaria fendleri* (to 2%), *Eriogonum racemosum* (to 8%), *Antennaria rosulata* (to 8%), and *Solidago nana* (to 6%) are also fairly common. Graminoids are typically dominant in this plant association; however, the forb component can be very well-developed and codominant on some sites. Based upon the 9 stands sampled, this association hosts average species diversity for high-elevation communities in Grand Canyon, with 21 species per 400-square-meter plot; however, some sites can be extremely species-rich. This plant community supports a uniquely southwestern floristic assemblage, but also hosts many higher-elevation or higher-latitude species from the Rocky Mountain region.

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Antennaria rosulata*, *Blepharoneuron tricholepis*, *Eriogonum racemosum*, *Hymenoxys subintegra*, *Muhlenbergia montana*, *Potentilla hippiana*, *Ranunculus cardiophyllus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) is another montane grassland association that occurs on the North Rim. *Muhlenbergia montana* is the dominant graminoid species, and *Festuca* sp. is rarely present. Additionally, it occurs in drier, lower areas (typically at around 2470 m [8100 feet], as opposed to 2670 m [8750 feet] for this association). *Poa pratensis* Semi-Natural Seasonally Flooded Herbaceous Vegetation (CEGL003081) is another montane grassland association that occurs on the North Rim. *Poa pratensis* is the dominant graminoid species, and *Festuca* sp. is rarely present. It occurs at lower elevations (typically at around 2485 m [8150 feet], as opposed to 2670 m [8750 feet] for this association).

Global Similar Associations:

- *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) is another montane grassland, but *Muhlenbergia montana* is the dominant graminoid species, *Festuca* sp. is rarely present, and it occurs in drier, lower areas.
- *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation (CEGL003081) is another montane grassland, but *Poa pratensis* is the dominant graminoid species, *Festuca* sp. is rarely present, and it occurs at lower elevations.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs in the high-elevation, northern portion of the North Rim, close to Highway 67, mostly between the entrance station and the Point Imperial Road. It was sampled from the south fork of Big Springs Canyon near Fawn Lake, upper North Canyon, Upper Little Park, Lower Little Park, Thompson Canyon, and Kanab Canyon (north of Kanabownits Canyon).

Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (9 plots): GRCA.02143, GRCA.02176, GRCA.02178, GRCA.02211, GRCA.02220, GRCA.03120, GRCA.03125, GRCA.03189, GRCA.03197.

Local Description Authors: K. Christie

Global Description Authors: K. Christie

References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation**

Mountain Muhly - Needle-and-Thread Herbaceous Vegetation

Identifier: CEGL001647

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow (M168)

Group Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Association *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This association has been described from north-central and central Colorado, in the northeastern portion of the Roosevelt National Forest. The association also occurs in Rocky Mountain National Park in the Mummy Range, Florissant Fossil Beds National Monument, and extends east out onto the Palmer Divide. Sites where the association is found are typically xeric forest openings in the ponderosa pine zone, on south-facing slopes and ridgetops. Elevations range from 2286 to 2650 m (7500-8710 feet), and the slopes are moderately steep. Occasionally the association occupies rolling parklands. Strong westerly winds probably result in removal of snow cover from the open sites and increased desiccation of plants. Soils are moderately deep Mollisols, with high coarse-fragment content, sandy loam textures, and a distinct clay horizon. Bare soil, exposed gravels, and small rocks account for as much as 30% of the ground surface area. This typically moderately dense grassland is strongly dominated by the perennial bunch grasses *Muhlenbergia montana* and *Hesperostipa comata (= Stipa comata)*. Several other graminoids are commonly present, including *Carex duriuscula (= Carex eleocharis), Pascopyrum smithii, Koeleria macrantha, Danthonia parryi, Muhlenbergia filiculmis*, and *Poa secunda*. Total graminoid cover averages 45%. Forb species are much less abundant. The most important include *Allium geyeri, Antennaria* spp., *Harbouria trachypleura, Mertensia lanceolata*, and *Penstemon secundiflorus*. Shrubs are absent or scarce, except for the suffrutescent *Artemisia frigida*, with 5% average cover. This association can be distinguished from *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) by the abundance to codominance of *Hesperostipa comata*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland vegetation type typically occurs in xeric forest openings or parks in the ponderosa pine zone. It occurs on the North Rim at approximately 2425 m (7950 feet) elevation on flat to gentle slopes (1 degree), often with south or southeastern aspects. It exists in drainage bottoms or in forest openings on the plateau. Soils are moderately well-drained silt loams. Litter (72%) dominates the ground cover.
Global Environment: This type occurs in a mountainous region subject to a continental climate regime, with warm summers and cold winters. Precipitation patterns differ between the eastern and western sides of the Continental Divide, but the overall difference is warmer and drier winters on the east slope of the Front Range. Sites where found are typically xeric forest openings in the ponderosa pine zone, on south-facing slopes and ridgetops. Elevations range from 2205 to 2650 m (7230-8710 feet), and the slopes are moderately steep. Occasionally the association occupies rolling parklands. Strong westerly winds probably result in removal of snow cover from the open sites and increased desiccation of plants. Parent materials are primarily colluvium of granitic and gneiss origins. Soils are moderately deep Mollisols, with high coarse-fragment content, sandy loam textures, and a distinct clay horizon. Bare soil, exposed gravels, and small rocks account for as much as 30% of the ground surface area.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is a purely herbaceous vegetation type and lacks tree and shrub cover. Graminoid cover typically averages 50-60%, while forbs comprise 12-15% cover. *Muhlenbergia montana* (26%) and *Hesperostipa comata* (22%) overwhelmingly codominate the graminoid component, and other grass species only occur at trace covers. *Artemisia dracunculus* (5%) is the dominant forb, while at least a dozen other forbs, including *Cryptantha setosissima, Achillea millefolium, Artemisia carruthii, Lupinus argenteus*, and *Potentilla hippiana*, occur at up to 1% cover. Based upon the single stand sampled, this association hosts typical species diversity for montane communities in Grand Canyon, with 24 species per 400-square-meter plot.
Global Vegetation: This grassland association is strongly dominated by the perennial bunch grasses *Muhlenbergia montana* and *Hesperostipa comata (= Stipa comata)*, averaging 11% and 22% cover, respectively. Several other graminoids are commonly present, including *Carex duriuscula (= Carex eleocharis), Pascopyrum smithii, Koeleria macrantha, Danthonia parryi, Muhlenbergia filiculmis*, and *Poa secunda*. Total graminoid cover averages 45%. Forbs species are much less abundant, totaling <10% cover. The most important include *Allium geyeri, Antennaria rosea, Arenaria fendleri, Harbouria trachypleura, Mertensia lanceolata*, and *Penstemon secundiflorus*. Shrubs are absent or scarce, scattered in clumps, and include *Ribes cereum* and *Purshia tridentata*, the suffrutescent *Artemisia frigida*, and occasional *Acer glabrum*. Stands on harsher sites and those which have been intensively grazed have increased abundances of *Antennaria rosea* and *Muhlenbergia filiculmis*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Forb	*Artemisia dracunculus*
Herb (field)	Graminoid	*Hesperostipa comata, Muhlenbergia montana*

Global

Stratum	Lifeform	Species
Herb (field)	Forb	*Antennaria rosea*
Herb (field)	Graminoid	*Hesperostipa comata, Muhlenbergia montana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia dracunculus*, *Hesperostipa comata*, *Muhlenbergia montana*
Global: *Hesperostipa comata*, *Muhlenbergia montana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Tragopogon dubius* (exotic, Medium/Low)
Global: Vulnerable: *Cirsium wheeleri* (G3G4), *Harbouria trachypleura* (G3G4); **Other**: *Koeleria macrantha* (G5), *Muhlenbergia filiculmis* (found in stands on harsher sites and those which have been intensively grazed., G4), *Pascopyrum smithii* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G1G2 (7-Nov-1997). This association is a regional endemic known from north-central Colorado, primarily within the northern portion of the Front Range. Only four occurrences of this association have been documented, with a total acreage of less than 200 acres, and most documented stands are degraded either by overgrazing or by exotic species invasion. It is not certain how well the potential area of this association has been surveyed, so there may be more occurrences. However, given the usual settings for this association, it is unlikely that there are many large, high-quality occurrences. As with many montane grasslands, this association has probably declined precipitously over the past century.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Hesperostipa comata* Great Basin Herbaceous Vegetation (CEGL001705) also supports a strong *Hesperostipa comata* component in the graminoid layer; however, it lacks *Muhlenbergia montana*. Additionally, this vegetation type occurs in burned areas with dead standing trees and shrubs and supports roughly 5-6% live shrub cover. The closely related association *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) also occurs in xeric forest openings and parks, typically in the ponderosa pine zone; however, it can be distinguished by a very low cover or absence of *Hesperostipa comata*. It seems to be much more common in Grand Canyon than *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647), and it is difficult to say what abiotic factors drive the floristic differences between these two communities.
Global Similar Associations:

- *Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii)* Herbaceous Vegetation (CEGL002997)
- *Hesperostipa comata* Great Basin Herbaceous Vegetation (CEGL001705) also supports a strong *Hesperostipa comata* component in the graminoid layer but lacks *Muhlenbergia montana*.
- *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) also occurs in xeric forest openings and parks, typically in the ponderosa pine zone; however, it can be distinguished by a very low cover or absence of *Hesperostipa comata*.

Global Related Concepts:

- *Muhlenbergia montana-Stipa comata* (Bourgeron and Engelking 1994) =
- *Stipa comata / Muhlenbergia montana* Habitat Type (Wasser and Hess 1982) =
- *Stipa comata / Muhlenbergia montana* Habitat Type (Hess 1981) =

- *Stipa comata / Muhlenbergia montana* Plant Association (Johnston 1987) =
- DRISCOLL FORMATION CODE: V.B.4.b. (Driscoll et al. 1984) >
- Grass Turf-Shrub Type (Baumann 1978a) =
- Habitat Type 7: *Muhlenbergia montana, Festuca arizonica, Hymenoxys richardsonii, Artemisia frigida* (Shepherd 1975) >
- Natural Dry Meadows (Mutel 1976) >
- Open Aspen Area (Buttery 1955) >
- Study site K-79 (Fish 1966) =
- UNESCO FORMATION CODE: V.B.5b (UNESCO 1973) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim. It was sampled by a single classification plot from the Walhalla Plateau.
Global Range: This grassland association is described from north-central Colorado, primarily within the northern portion of the Front Range in Larimer County and farther south along the Front Range to Teller County and east into El Paso County in the Palmer Divide area.
Nations: US
States/Provinces: AZ, CO:S1S2, WY
TNC Ecoregions: 10:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331I:CC
Federal Lands: NPS (Florissant Fossil Beds, Grand Canyon, Rocky Mountain); USFS (Arapaho-Roosevelt)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.03139.
Local Description Authors: K. Christie
Global Description Authors: M.S. Reid, mod. K.A. Schulz
References: Baumann 1978a, Bourgeron and Engelking 1994, Buttery 1955, CONHP 2010, CONHP Ecology Team 2001, CONHP unpubl. data, Clary 1978, Driscoll et al. 1984, Fischer and Bradley 1987, Fish 1966, Hess 1981, Johnston 1987, Mutel 1976, Owns et al. 2004, Reid and Hall 2010, Salas et al. 2005, Shepherd 1975, UNESCO 1973, WNDD unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d.

Muhlenbergia montana Herbaceous Vegetation

Mountain Muhly Herbaceous Vegetation
Identifier: CEGL001646

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow (M168)
Group	Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Association	*Muhlenbergia montana* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and in north-central New Mexico. Sites are typically xeric forest openings or parks in the ponderosa pine zone with southern aspects on moderately steep slopes and ridgetops. Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand- to sandy loam-textured soils. Bare soil, exposed gravels, and small rocks account for as much as 50% of the ground surface area. The vegetation is characterized by a moderately dense herbaceous layer that is typically dominated by the warm-season, perennial bunchgrass *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum (= Trisetum montanum)* (in New Mexico). Other associated graminoids include *Bouteloua curtipendula, Bouteloua gracilis, Danthonia parryi, Festuca brachyphylla, Hesperostipa comata, Koeleria macrantha, Muhlenbergia filiculmis, Pascopyrum smithii, Poa secunda*, and *Schizachyrium scoparium*. In New Mexico, deer sedges (*Carex inops ssp. heliophila, Carex occidentalis*, and *Carex rossii*) and *Schizachyrium scoparium* are common associates. The typically

sparse forb layer often consists of *Allium geyeri, Antennaria rosea, Arenaria fendleri, Eriogonum umbellatum, Heterotheca villosa*, and *Phlox diffusa*. Except for the abundant dwarf-shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrub, or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. In New Mexico, shrubs are poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be present. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*. It can be distinguished from *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) by the very low cover or lack of *Hesperostipa comata*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs in xeric, montane meadows and forest openings on the North Rim (however a single stand was sampled from similar environments on the South Rim). It occurs in low-level valley bottoms at 2325 to 2675 m (7650-8800 feet) elevation on flat or gentle slopes (1-6 degrees) with southern exposures. Soils are typically rapidly- or moderately well-drained sandy or silty loams. This association occurs in openings within ponderosa pine woodlands or sometimes within mixed-conifer forests. Litter (51%) and bare soil (19%) dominate ground cover. Some sites occur in areas with evidence of past fire, yet it is unclear if fire drives the distribution of this plant community

Global Environment: This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and north-central New Mexico. Elevation ranges from 2300-2800 m (7540-9200 feet). Sites are typically xeric forest openings or parks in the ponderosa pine zone with southern aspects on moderately steep slopes and ridgetops. In New Mexico, stands occur commonly on moderate slopes (5-15%) but occasionally on steep canyonsides (up to 50%). Occasionally the stands occupy rolling parklands or volcanic cinder fields. The xeric nature of these sites appears to be an important environmental factor. Substrates are shallow to moderately deep, rocky, sand to sandy loam-textured soils sometimes with a distinct clay horizon. Parent materials are primarily colluvium derived from granite and gneiss or cinder, but may include clay loam soils, or latite and dacite slope alluvium parent materials (Hibner 2009). Bare soil, exposed gravels, and small rocks may account for as much as 50% of the ground surface area. In north-central New Mexico, the ground surface is typically characterized by bunch grasses with inter-grass spaces covered with leaf litter or some exposed soil.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is a purely herbaceous vegetation type and essentially lacks tree and shrub cover. Total herbaceous cover averages 65% but may be higher on some sites. This association is dominated by graminoids and typically hosts a rich assemblage of grass species. *Muhlenbergia montana* (31%) overwhelmingly dominates the graminoid stratum, sometimes at up to 50% cover. *Blepharoneuron tricholepis* (8%) is characteristic of this association but does not occur on every site; it can however comprise up to 20% cover on some sites. *Elymus elymoides* is also a characteristic component of the graminoid layer, but only at 1% cover. *Poa fendleriana* (6%) and *Bouteloua gracilis* (8%) frequently occur as well, sometimes comprising up to 30% cover each. Occasionally, *Bromus ciliatus* and *Bromus porteri* may be present at up to 10% cover each. In total, 20 different graminoid species can occur in this plant community. Forb cover averages 12-15%, and approximately 80 different forb species may be present. *Potentilla hippiana* (up to 4%), *Eriogonum racemosum* (to 3%), and *Achillea millefolium* (1%) are the most common components of the forb understory. Other characteristic forb species include *Artemisia dracunculus* (sometimes up to 15% cover), *Artemisia carruthii* (to 5%), *Antennaria parvifolia* (to 5%), *Antennaria rosulata* (to 3%), and *Potentilla pulcherrima* (to 3%). Based upon the 13 stands sampled, this association hosts average species diversity for high-elevation plant communities in Grand Canyon, with 24 species per 400-square-meter plot; however, some sites can be significantly more species-rich.

Global Vegetation: Vegetation is characterized by a moderately dense to dense herbaceous layer that is typically dominated by the warm-season, perennial bunchgrass *Muhlenbergia montana*, but may be codominated by *Blepharoneuron tricholepis* or *Trisetum spicatum (= Trisetum montanum)* (in New Mexico). Other associated graminoids include *Bouteloua curtipendula, Bouteloua gracilis, Carex duriuscula (= Carex eleocharis), Danthonia parryi, Elymus albicans (= Elymus lanceolatus ssp. albicans), Elymus lanceolatus ssp. lanceolatus (= Elytrigia dasystachya), Festuca brachyphylla, Festuca arizonica* (low cover), *Hesperostipa comata* (low cover), *Koeleria macrantha, Muhlenbergia filiculmis, Pascopyrum smithii, Poa secunda*, and *Schizachyrium scoparium*. In New Mexico, deer sedges (*Carex inops ssp. heliophila, Carex occidentalis*, and *Carex rossii*) and *Schizachyrium scoparium* are common associates. The typically sparse forb layer often consists of *Allium geyeri, Antennaria rosea, Arenaria*

fendleri, Eriogonum umbellatum, Harbouria trachypleura, Heterotheca villosa, Mertensia lanceolata, Opuntia polyacantha, Penstemon secundiflorus, and *Phlox diffusa*. Except for the abundant dwarf-shrub *Artemisia frigida*, scattered *Ericameria nauseosa* shrubs, or occasional *Pinus ponderosa* trees, woody species are very sparse or absent. In New Mexico, shrubs are poorly represented, but *Quercus gambelii* and *Robinia neomexicana* may be present. The exotic grasses *Poa pratensis* and *Bromus tectorum* are common in some of these stands. Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Muhlenbergia montana*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Blepharoneuron tricholepis, Muhlenbergia montana, Trisetum spicatum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia dracunculus*, *Blepharoneuron tricholepis*, *Muhlenbergia montana*
Global: *Blepharoneuron tricholepis*, *Muhlenbergia montana*, *Trisetum spicatum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Lactuca serriola* (exotic, Low/Insignificant), *Poa pratensis* (exotic, Medium), *Polygonum aviculare* (exotic, Low), *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low)
Global: Vulnerable: *Harbouria trachypleura* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High), *Poa pratensis* (invasive, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) also occurs in xeric forest openings and meadows and supports a relatively high cover of *Muhlenbergia montana*; however, it also supports a codominant component of *Hesperostipa comata*. *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation (CEGL003081) occurs in similar (but perhaps slightly more mesic) habitats and supports a very similar assemblage of forb species. *Poa pratensis*, and not *Muhlenbergia montana*, is the dominant graminoid component, however. It is difficult to determine what factors drive this floristic difference; potentially *Poa pratensis* overtakes the native *Muhlenbergia montana* and eventually functionally excludes it from this ecological niche.
Global Comments: Diagnostic of this grassland association is the dominance of *Muhlenbergia montana* in the herbaceous layer and low cover of *Festuca arizonica*. This association can be distinguished from *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) by the low cover (<10% absolute cover and <25% relative cover) or lack of *Hesperostipa comata*.
Muldavin and Tonne (2003) and Muldavin et al. (2006) describe a *Blepharoneuron tricholepis - Muhlenbergia montana* association for Valles Caldera National Preserve that is synonymous with this association.
Global Similar Associations:

- *Festuca (calligera, arizonica, brachyphylla)* Herbaceous Vegetation (CEGL005500)
- *Festuca arizonica - Muhlenbergia montana* Herbaceous Vegetation (CEGL001606)
- *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) also occurs in xeric forest openings and meadows and supports a relatively high cover of *Muhlenbergia montana*, but it also supports a codominant component of *Hesperostipa comata*.

- *Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation (CEGL003081) occurs in similar (but perhaps slightly more mesic) habitats and supports a very similar assemblage of forb species, but *Poa pratensis*, and not *Muhlenbergia montana*, is the dominant graminoid component.

Global Related Concepts:
- *Blepharoneuron tricholepis - Muhlenbergia montana* Plant Association (Muldavin et al. 2003) **=**
- *Blepharoneuron tricholepis - Muhlenbergia montana* Plant Association (Muldavin and Tonne 2003) **=**
- *Blepharoneuron tricholepis - Muhlenbergia montana* Plant Association (Muldavin et al. 2006) **=**
- *Bouteloua gracilis-Muhlenbergia montana-Poa* Community (Loveless 1967) **=**
- *Muhlenbergia montana* / *Blepharoneuron tricholepis* Plant Association (Johnston 1987) **?**
- *Muhlenbergia montana* / *Elytrigia dasystachya* Plant Association (Johnston 1987) **=**
- *Muhlenbergia montana* (Bourgeron and Engelking 1994) **=**
- *Muhlenbergia-Comandra* and *Muhlenbergia-Aragallus* Societies (Ramaley 1916a) **?**
- *Muhlenbergia-Comandra* and *Muhlenbergia-Aragallus* Societies (Ramaley 1916b) **?**
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) **>**
- Habitat Type 7: *Muhlenbergia montana, Festuca arizonica, Hymenoxys richardsonii, Artemisia frigida* (Shepherd 1975) **>**
- Kaibab Basin and Dry Park Meadows (Merkle 1962) **?**
- Montane Grassland (Reid 1974) **>**
- Rangeland Group H68 (Shanks 1977) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from xeric forest openings on the North Rim and the South Rim. On the North Rim, it was sampled from Swamp Ridge, the Walhalla Plateau, to the west of Thompson Canyon, Thompson Canyon, near Hades Lake, Upper Little Park, Walhalla Glades, and The Basin. On the South Rim, it was sampled from Long Jim Canyon, south of Shoshone Point.
Global Range: This plant association has been described from meadows in the mountains, plateaus and foothills of Colorado, Arizona, Utah, and north-central New Mexico.
Nations: US
States/Provinces: AZ, CO:S2?, NM, UT:S3S4, WY
TNC Ecoregions: 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, M313A:CC, M331F:CC, M331G:CC, M331I:CC
Federal Lands: NPS (Bandelier, Carlsbad Caverns, Florissant Fossil Beds, Grand Canyon, Great Sand Dunes, Rocky Mountain, Sunset Crater Volcano, Walnut Canyon?); USFS (Roosevelt, Valles Caldera)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (13 plots): GRCA.02127, GRCA.02158, GRCA.02163, GRCA.02202, GRCA.02207, GRCA.03070, GRCA.03089, GRCA.03122, GRCA.03147, GRCA.03155, GRCA.03186, GRCA.03188, GRCA.03212.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. G. Kittel and K.S. King
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clary 1978, Driscoll et al. 1984, Fischer and Bradley 1987, Hansen et al. 2004a, Hansen et al. 2004c, Hibner 2009, Johnston 1987, Loveless 1963, Loveless 1967, McIntosh 1923, McKown et al. 2003, Merkle 1962, Muldavin and Tonne 2003, Muldavin et al. 2003, Muldavin et al. 2006, Muldavin et al. 2011b, Owns et al. 2004, Ramaley 1915, Ramaley 1916a, Ramaley 1916b, Reid 1974, Reid and Hall 2010, Salas et al. 2005, Salas et al. 2010b, Shanks 1977, Shepherd 1975, Terwilliger et al. 1979b, USFS 1983b, WNDD unpubl. data, Western Ecology Working Group n.d.

***Poa fendleriana* Herbaceous Vegetation**

Muttongrass Herbaceous Vegetation
Identifier: CEGL001925

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Rocky Mountain-Vancouverian Subalpine & High Montane Mesic Grass & Forb Meadow (M168)

Group Southern Rocky Mountain Montane-Subalpine Grassland (G268)
Association *Poa fendleriana* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This herbaceous association was observed on lower slopes of hills and midslopes of ridges and mesas in western Colorado, eastern and southern Utah and is likely more widespread. Sites are flat, moderately steep to steep (11-55% slopes), occur between 2339 to 2700 m elevation, and include all aspects. The unvegetated surface has sparse to low cover of litter and low to high cover by large and small rocks and exposures of bare soil. Parent materials are Tertiary volcanic rocks that have eroded to colluvium or talus on slopes. Soils are rapidly drained and texturally range from loamy sand to sandy clay loam and sandy loam. This sparsely to moderately vegetated grassland is characterized by the bunchgrass *Poa fendleriana* that provides from up to 25% cover. The herbaceous layer is often diverse and may include low cover of graminoids such as *Achnatherum pinetorum, Agropyron cristatum, Bouteloua gracilis, Bromus tectorum*, and *Elymus elymoides*. Forbs commonly present include *Antennaria dimorpha, Eriogonum umbellatum, Lepidium montanum, Phlox hoodii, Senecio spartioides var. multicapitatus (= Senecio multicapitatus)*, and *Sphaeralcea parvifolia*. Scattered tall, short and dwarf-shrubs may be present, such as *Artemisia frigida, Chrysothamnus depressus, Fraxinus anomala, Gutierrezia sarothrae, Krascheninnikovia lanata, Mahonia fremontii*, and *Purshia tridentata*. Cryptogam cover is sparse for all sampled stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs on the North Rim in areas that have experienced high-intensity, stand-replacing fires in the past. It occurs within a matrix of live ponderosa pine vegetation types. It typically exists at 2475 to 2500 m (8150-8175 feet) elevation across all aspects (except north), on flat or gentle slopes (1-4 degrees) of the high-level plateau. Soils are predominantly rapidly-drained sandy loams. Bare soil (15-20%), gravel (5%), downed wood (12%), as well as litter (51%) are common components of the ground cover.
Global Environment: This herbaceous association was observed on lower slopes of hills and midslopes of ridges and mesas. Sites occur on moderately steep to steep (11-55%) slopes between 1750 and 2700 m elevation and include all aspects. The unvegetated surface has sparse to low cover of litter and low to high cover by large and small rocks and exposures of bare soil. Parent materials are Tertiary volcanic rocks that have eroded to colluvium or talus on slopes or sandstones that have been eroded to alluvium. Soils are well- to rapidly drained and texturally range from loamy sand to sandy clay loam and sandy loam. The cryptogamic soil community provides low cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover is essentially absent in this association, as sites have experienced stand-replacing fire events in the past. Shrub strata are almost absent as well; however, the dwarf-shrub *Ceanothus fendleri* consistently occurs at 1-3% cover. Graminoids dominate this herbaceous community type and typically comprise about 25-30% cover. *Poa fendleriana* (12%) cover can be as high as 25% on some sites, while *Elymus elymoides* (5%) cover can range up to 15% cover. Other graminoid species, including *Carex rossii* (2-4% cover), *Bromus tectorum* (up to 5% cover), and *Carex occidentalis* (up to 5% cover), as well as other montane grasses, can occur sporadically. Forb composition can vary somewhat from site to site and averages about 10% cover. *Eriogonum racemosum* (1%), *Heterotheca villosa* (1%), *Agoseris glauca* (trace cover), and *Achillea millefolium* (4-6%) are common components of the forb layer, while *Artemisia carruthii* (up to 6%), *Heliomeris multiflora* (2-3%), and *Solidago velutina* (1-2%) are also characteristic of the association. Tree seedling regeneration is uncommon; however, *Pinus ponderosa* or *Populus tremuloides* seedlings are present occasionally. Based upon the 3 stands sampled, this association hosts average species diversity for montane communities in Grand Canyon, with 22 species per 400-square-meter plot.
Global Vegetation: This herbaceous association is characterized by a sparse to moderately dense herbaceous layer (5-40% total cover) that is typically dominated by the bunchgrass *Poa fendleriana* that provides from up to 25% cover. The herbaceous layer is often diverse and may include graminoids that provide low cover of *Achnatherum pinetorum, Agropyron cristatum, Bouteloua gracilis, Bromus tectorum*, and *Elymus elymoides*. Forbs commonly present include *Antennaria dimorpha, Eriogonum umbellatum, Lepidium montanum, Phlox hoodii, Senecio spartioides var. multicapitatus (= Senecio multicapitatus)*, and *Sphaeralcea parvifolia*. Scattered tall, short and dwarf-shrubs may be present, such as *Artemisia frigida, Chrysothamnus depressus, Fraxinus anomala, Gutierrezia sarothrae, Krascheninnikovia lanata, Mahonia fremontii*, and *Purshia tridentata*. The cryptogamic soil community provides low cover and includes dark cyanobacteria, moss, *Collema* sp., and *Fulgensia* sp.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Ceanothus fendleri*
Herb (field)	Forb	*Achillea millefolium*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia carruthii*, *Ceanothus fendleri*, *Heliomeris multiflora*, *Heterotheca villosa*, *Poa fendleriana*, *Solidago velutina*
Global: *Poa fendleriana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Cirsium vulgare* (exotic, Medium/Low), *Lactuca serriola* (exotic, Low/Insignificant)
Global: Vulnerable: *Potentilla crinita* (G3G4); **Invasive/Exotic**: *Agropyron cristatum* (invasive/exotic, Medium/Low), *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GU (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak

Grand Canyon National Park Comments: *Poa fendleriana* Herbaceous Vegetation (CEGL001925) is closely allied with *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501). Both types occur in burned openings within a larger matrix of live *Pinus ponderosa* vegetation. The main difference between the two types is the amount of *Ceanothus fendleri* present. It typically occurs at about 11-13% in *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland, and seems to only occur at up to 3% cover in *Poa fendleriana* Herbaceous Vegetation. Seemingly, one type grades into the next as *Ceanothus fendleri* cover increases or decreases with succession.
Global Comments: Data from Loder (1964) and Olgeirson (1972, 1974) indicate that this association may also occur in the subalpine/alpine zones. The data contained in these references do not give enough information to say for certain that this is a valid association. More field inventories are needed.
Global Similar Associations:

- *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501) also occurs in burned openings within a larger matrix of live *Pinus ponderosa* vegetation but has more *Ceanothus fendleri* present.

Global Related Concepts:

- *Poa fendleriana* (Bourgeron and Engelking 1994) =
- *Potentilla diversifolia - Poa fendleriana* Alpine Meadow Unit (Olgeirson 1972) =
- *Potentilla diversifolia - Poa fendleriana* Alpine Meadow Unit (Olgeirson 1974) =
- DRISCOLL FORMATION CODE:V.C.6.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the plateau of the North Rim in areas that have experienced high-intensity, stand-replacing fires in the past. It occurs within a matrix of extant ponderosa pine vegetation. It was sampled from the Walhalla Plateau and the Walhalla Glades.
Global Range: This herbaceous association was observed on lower slopes of hills and midslopes of ridges and me-

sas in western Colorado and eastern Utah and is likely more widespread.
Nations: US
States/Provinces: AZ, CO:SU, UT, WY
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Cedar Breaks, Curecanti, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02161, GRCA.02164, GRCA.03148.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. G. Kittel
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Coles et al. 2010, Driscoll et al. 1984, Loder 1964, Olgeirson 1972, Olgeirson 1974, Reid and Hall 2010, Tendick et al. 2010, Tendick et al. 2011a, Tendick et al. 2011b, WNDD unpubl. data, Western Ecology Working Group n.d.

M049. Southern Rocky Mountain Montane Shrubland
G276. Southern Rocky Mountain Cercocarpus-Mixed Foothill Shrubland

Amelanchier utahensis Shrubland

Utah Serviceberry Shrubland
Identifier: CEGL001067

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Cercocarpus-Mixed Foothill Shrubland (G276)
Association	*Amelanchier utahensis* Shrubland

ELEMENT CONCEPT

Global Summary: This mountain shrubland association occurs at middle elevations in the foothills, mountains and mesas in north-central Utah, the Colorado Plateau and Great Basin of the western U.S. Stands occur on moderate to steep slopes characterized by talus or rockfall from further upslope. It is found on relatively warm southern aspects in the Wasatch Mountains but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are moderately deep, rocky loams and clays. The sparse to moderately dense tall-shrub layer (10-60% cover) is dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often dominates in the short-shrub layer. Other shrub associates may include low cover of *Acer grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Mahonia repens, Purshia tridentata, Rhus trilobata*, and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5%). Tree species are sometimes present with the tall shrubs or as a very sparse emergent layer. The sparse to moderately dense herbaceous layer is a mixture of perennial graminoids and forbs. Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

Global Environment: This shrubland association occurs on foothills, canyons, ridges, mountains and mesas at elevations from 1326-2440 m (4345-8000 feet). Stands occur on moderate to steep slopes (9-46 degrees) with a high proportion of talus or rockfall. It is found on relatively warm southern aspects in the Wasatch Mountains (Yake and Brotherson 1979) but also occurs on northern aspects or in cold-air drainages at lower elevations and more southern latitudes. Substrates are rapidly drained, moderately deep, rocky or sandy soils that range from sand to silt loams and clays . Parent materials include volcanic cinder, and alluvial or colluvial deposits of sandstone and shale. Canyons slopes are often shaly with sandstone cobble veneer.

VEGETATION DESCRIPTION

Global Vegetation: The vegetation is characterized by a sparse to moderately dense (10-60% cover) tall-shrub layer dominated by the cold-deciduous shrub *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer. Other shrub associates may include low cover of *Acer grandidentatum, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra viridis, Fraxinus anomala, Mahonia repens, Purshia tridentata, Rhus trilobata*, and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5% cover). Short trees of *Pinus edulis, Juniperus osteosperma*, or *Juniperus scopulorum* may be mixed in with the tall shrubs or emerge above as a very sparse tree layer. The sparse to moderate herbaceous layer is a mixture of perennial graminoids and forbs. Herbaceous species include *Bromus carinatus, Koeleria macrantha, Achnatherum nelsonii ssp. dorei (= Stipa columbiana), Poa fendleriana, Balsamorhiza sagittata, Chenopodium fremontii, Machaeranthera canescens*, and species of *Astragalus, Eriogonum, Mertensia*, and *Penstemon* (Yake and Brotherson 1979). Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Amelanchier utahensis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Global: *Amelanchier utahensis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Astragalus scopulorum* (G3G4), *Shepherdia rotundifolia* (G3G4); **Invasive/Exotic**: *Agropyron cristatum* (invasive/exotic, Medium/Low), *Bromus tectorum* (invasive/exotic, High); **Other**: *Arabis fernaldiana* var. *fernaldiana* (G4T3T4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (19-Sep-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This association is not well known. More survey work and classification work are needed to further define this type.
Global Similar Associations:
- *Fendlera rupicola* Talus Shrubland (CEGL002765)
- *Quercus gambelii* / *Amelanchier utahensis* Shrubland (CEGL001110)

Global Related Concepts:
- *Amelanchier utahensis* (Bourgeron and Engelking 1994) =
- *Amelanchier utahensis* Potential Native Plant Community (Eddleman and Jaindl 1994) >
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >
- Serviceberry Habitat Type (Yake and Brotherson 1979) =

ELEMENT DISTRIBUTION

Global Range: This shrubland association occurs in the foothills and mountain areas in north-central Utah, Colorado Plateau and Great Basin of the western U.S.
Nations: US
States/Provinces: AZ, CO, NV:S4?, UT:S3S4, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, 342E:CC, M331E:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands, Capitol Reef, Colorado, Dinosaur, Fossil Butte, Glen Canyon, Grand Canyon, Great Basin, Hovenweep, Mesa Verde, Zion)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz, mod. J. Drake
References: Bourgeron and Engelking 1994, Carmichael et al. 1978, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2010, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, Friesen et al. 2010, Reid and Hall 2010, Romme et al. 1993, Schulz and Hall 2011, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d., Yake and Brotherson 1979

***Cercocarpus intricatus - (Quercus turbinella)* Mixed Shrubland**

Littleleaf Mountain-mahogany - (Turbinella Live Oak) Mixed Shrubland
Identifier: CEGL005393

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Cercocarpus-Mixed Foothill Shrubland (G276)
Association	*Cercocarpus intricatus - (Quercus turbinella)* Mixed Shrubland

ELEMENT CONCEPT

Global Summary: This mixed shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It favors large slickrock expanses punctuated by shallow potholes and depressions filled with sand and typically occurs at 1375 to 1650 m (4500-5300 feet) elevation; however, one stand was sampled as high as 1850 m (6075 feet). This community chiefly occurs on flat to very gentle slopes (1-3 degrees) and seems to show no preference for any particular aspect. Soils are well- to rapidly-drained sandy or silty loams. Sandstone bedrock (37%) dominates the ground cover. Stunted *Pinus edulis* and *Juniperus osteosperma* assume shrublike forms and infrequently occur in this shrubland type. Other tall shrubs are essentially absent. A rich and varied short-shrub layer dominated by *Cercocarpus intricatus* and *Quercus turbinella* characterizes this association. No other individual species occurs at high cover, although at least 25 different short-shrub species can be present at low individual covers. *Ceanothus greggii, Glossopetalon spinescens, Nolina microcarpa*, and *Rhus trilobata* are among the most frequent components of this diverse assemblage. *Agave utahensis, Gutierrezia sarothrae*, and *Artemisia bigelovii* are the most frequent dwarf-shrubs, although at least 15 different species can occur. Scattered graminoids occur in fissures in the bedrock and shallow pockets of sandy soil. *Aristida purpurea* and *Tridens muticus* occur frequently, while *Achnatherum speciosum* and *Hesperostipa* spp. may occur in some stands. Forb cover is very sparse, although forb diversity can be very high; at least 50 different forb species can occur in this association. *Hymenopappus filifolius, Eriogonum alatum, Comandra umbellata, Heterotheca villosa, Psilostrophe sparsiflora, Chamaesyce fendleri*, and *Lesquerella arizonica* frequently occur at trace covers.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This mixed shrubland association occurs in the Inner Canyon and Western Grand Canyon on sandstone terraces and benches. It favors large slickrock expanses punctuated by shallow potholes and depressions filled with sand. It typically occurs at 1375 to 1650 m (4500-5300 feet) elevation; however, one stand was sampled as high as 1850 m (6075 feet). This community chiefly occurs on flat to very gentle slopes (1-3 degrees) and seems to show no preference for any particular aspect. Soils are well-drained to rapidly-drained sandy or silty loams. Sandstone bedrock (37%) dominates the ground cover, while bare soil (15%), gravel (14%), rocks (7%), and a very high amount of cryptogamic soil crust (10%) are also common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 15-20% in this association. Stunted *Pinus edulis* (2%) and *Juniperus osteosperma* (2%) assume shrublike forms and infrequently punctuate this shrubland vegetation type. Other tall shrubs are essentially absent. A rich and varied short-shrub layer (10-12%) dominated by *Cercocarpus intricatus* (3%) and *Quercus turbinella* (2%) characterizes this association. No other individual species occurs at high cover, although at least 25 different short-shrub species can be present at low individual covers. *Ceanothus greggii* (1-2%), *Glossopetalon spinescens* (1-2%), *Nolina microcarpa* (1%), and *Rhus trilobata* (1%) are among the most frequent components of this diverse assemblage. *Agave utahensis* (1%), *Gutierrezia sarothrae*

(1%), and *Artemisia bigelovii* (1%) are the most frequent dwarf-shrubs (3%), although at least 15 different species can occur. Scattered graminoids (3%) occur in fissures in the bedrock and shallow pockets of sandy soil. *Aristida purpurea* (2%) and *Tridens muticus* (trace) occur frequently, while *Achnatherum speciosum* (trace) and *Hesperostipa* spp. (2%) occur in some stands. Forb cover is very sparse (1%), although forb diversity can be very high; at least 50 different forb species can occur in this association. *Hymenopappus filifolius, Eriogonum alatum, Comandra umbellata, Heterotheca villosa, Psilostrophe sparsiflora, Chamaesyce fendleri*, and *Lesquerella arizonica* frequently occur at trace covers. Based upon the 12 stands sampled, this association hosts very high species diversity among plant communities in Grand Canyon, with 27 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Agave utahensis, Artemisia bigelovii, Gutierrezia sarothrae*
Herb (field)	Forb	*Eriogonum alatum, Hymenopappus filifolius*
Herb (field)	Graminoid	*Aristida purpurea*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Aristida purpurea*, *Ceanothus greggii*, *Cercocarpus intricatus*, *Comandra umbellata*, *Eriogonum alatum*, *Glossopetalon spinescens*, *Gutierrezia sarothrae*, *Heterotheca villosa*, *Hymenopappus filifolius*, *Juniperus osteosperma*, *Pinus edulis*, *Quercus turbinella*, *Tridens muticus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: See *Grand Canyon National Park Dynamics*. Other associations dominated by *Quercus turbinella* typically have much higher *Quercus turbinella* cover and do not support such a varied mixed-species short-shrub stratum.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from near Freya Castle, Horseshoe Mesa, Huxley Terrace, Drummond Plateau, Aztec Amphitheater, on the Esplanade below Monument Point, and Upper Deer Creek; and from the Western Grand Canyon, where it was sampled near Toroweap Point.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.01101, GRCA.01103, GRCA.01104, GRCA.01575, GRCA.02036, GRCA.02585, GRCA.02595, GRCA.03594, GRCA.03619, GRCA.03620, GRCA.04678, GRCA.04684.
Local Description Authors: K. Christie
Global Description Authors: K. Christie

References: Reid and Hall 2010, Western Ecology Working Group n.d.

G277. Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland

Ceanothus fendleri / *Poa fendleriana* Shrub-Steppe Shrubland

Fendler's Buckbrush / Muttongrass Shrub-Steppe Shrubland
Identifier: CEGL005501

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland

ELEMENT CONCEPT

Global Summary: This Fendler's buckbrush shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in areas that have experienced somewhat recent high-intensity fires, and typically occurs within a matrix of live *Pinus ponderosa* woodlands. It occurs from 2440 to 2575 m (8000-8422 feet) elevation on the high-level plateau or upper sideslopes, typically on south- or southeast-facing aspects. Slopes are usually gentle (1-7 degrees) but can occasionally be much steeper (up to 27 degrees). Soils are characterized by silty or sandy loams. Tree cover is essentially absent in this association, as sites have experienced stand-replacing fire events; however, scattered *Pinus ponderosa* occasionally persist. *Ceanothus fendleri* dominates the shrub component and can occur as either a short shrub or dwarf-shrub. No other shrub species are consistently present or comprise significant cover. *Poa fendleriana* dominates the herbaceous layer, while *Bromus tectorum* and *Elymus elymoides* also occur frequently. A variety of forbs occur at low cover, including the fire-loving *Erigeron divergens, Gayophytum diffusum, Chenopodium* sp., *Conyza canadensis*, and *Epilobium brachycarpum*. *Heterotheca villosa* and *Solidago velutina* occur fairly consistently and with substantial cover values.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Fendler's buckbrush shrubland association occurs on the North Rim in areas that have experienced somewhat recent high-intensity fires, and typically occurs within a matrix of live *Pinus ponderosa* woodlands. It occurs from 2440 to 2575 m (8000-8422 feet) elevation on the high-level plateau or upper sideslopes, typically on south- or southeast-facing aspects. Slopes are usually gentle (1-7 degrees) but can occasionally be much steeper (up to 27 degrees). Soils are characterized by silty or sandy loams. Gravel (20%) is an abundant component of the ground cover in these recently-burned areas, as well as bare soil (5-10%) and downed wood (5-10%). Litter cover is fairly low (40%) and essentially all standing trees have died in fires.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover is essentially absent in this association, as sites have experienced stand-replacing fire events; however, scattered *Pinus ponderosa* occasionally persist. *Ceanothus fendleri* averages 11-13% cover but can have as much as 20% cover. It dominates the shrub component of this association and can occur as either a short shrub or dwarf-shrub. No other shrub species are consistently present or comprise significant cover. Graminoid cover averages 10-12% but can sometimes be as high as 25%. *Poa fendleriana* (6-12%) dominates the herbaceous layer, while *Bromus tectorum* (up to 3%) and *Elymus elymoides* (up to 3%) also occur frequently. A variety of forbs occur in this association, including the fire-loving *Erigeron divergens, Gayophytum diffusum, Chenopodium* sp., *Conyza canadensis*, and *Epilobium brachycarpum*; however, most forbs tend to occur at trace covers. *Heterotheca villosa* (3%) and *Solidago velutina* (5%) occur fairly consistently and with substantial cover values. Based upon the 6 stands sampled, this association hosts average species diversity for plant communities in Grand Canyon, with 22 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Ceanothus fendleri*
Herb (field)	Forb	*Solidago velutina*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ceanothus fendleri*, *Heterotheca villosa*, *Poa fendleriana*, *Solidago velutina*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Lactuca serriola* (exotic, Low/Insignificant), *Tragopogon dubius* (exotic, Medium/Low)
Global: Vulnerable: *Cirsium wheeleri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Carex siccata - Carex rossii* Herbaceous Vegetation (CEGL005388) is an early-successional community that also occurs in areas that have experienced recent, high-intensity burns. It hosts many similar fire-adapted forb species, as well as *Bromus tectorum* and *Elymus elymoides*. It has a very sparse shrub layer, yet *Ceanothus fendleri* is common, but only at 2% cover. The *Poa fendleriana* component is essentially lacking from this community, and *Carex siccata* and *Carex rossii* are the dominant graminoid components. This vegetation type likely occurs in somewhat more mesic areas than *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501).
Populus tremuloides - Ceanothus fendleri / *Carex* spp. Shrubland (CEGL005504) is an early-successional community that also occurs in areas that have experienced somewhat recent, high-intensity burns; however, it supports a thick layer (sometimes up to 60% cover) of regenerating *Populus tremuloides*. *Ceanothus fendleri* is also a common component of the shrub layer but only at 2% cover. It hosts many similar fire-adapted forb species; however, sedges, as opposed to *Poa fendleriana*, are the major graminoid components. This vegetation type likely occurs in somewhat more mesic areas than *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501).
Poa fendleriana Herbaceous Vegetation (CEGL001925) is closely related to *Ceanothus fendleri* / *Poa fendleriana* Shrub-Steppe Shrubland (CEGL005501). The main difference between the two communities is the amount of *Ceanothus fendleri* present. It typically occurs at about 11-13% in this association (CEGL005501), and only at up to 3% cover in *Poa fendleriana* Herbaceous Vegetation. Both occur in burned openings within a larger matrix of live *Pinus ponderosa* vegetation. One community may transition into the next depending upon the successional stage of the community.
Global Similar Associations:

- *Poa fendleriana* Herbaceous Vegetation (CEGL001925) is closely related but contains much less *Ceanothus fendleri*.
- *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is an early-successional community that also occurs in areas that have experienced somewhat recent, high-intensity burns; however, it supports a thick layer (sometimes up to 60% cover) of regenerating *Populus tremuloides* and has *Ceanothus fendleri* as a common component of the shrub layer.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim in areas that have experienced fairly recent, high-intensity burns. It was sampled from the Widforss Trail, in an adjacent area between Outlet Canyon and The Transcept, and also from the Walhalla Plateau.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ

TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (6 plots): GRCA.02095, GRCA.02160, GRCA.02171, GRCA.03096, GRCA.03134, GRCA.03138.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Fendlera rupicola Talus Shrubland

Fendlerbush Talus Shrubland
Identifier: CEGL002765

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Fendlera rupicola* Talus Shrubland

ELEMENT CONCEPT

Global Summary: This tall-shrub association occurs in patches on cool colluvial slopes in Colorado Plateau canyons. Slopes are moderate to very steep and are often oriented to the north or east. Elevations range from 1268 to 1638 m (4160-5375 feet). The high cover of rock on the ground surface acts both to concentrate runoff and as mulch to slow evaporation from the soil. Thus, relatively mesic species are able to persist on otherwise dry sites. Soils are sandy, skeletal, and derived from sandstones over shale. Stands commonly occur where Wingate sandstone colluvium has fallen onto Chinle shale slopes in canyons. Total vegetation cover ranges from 7 to 35% and is characterized by an open tall-shrub canopy of *Fendlera rupicola* that provides 1 to 12% cover. *Juniperus osteosperma* is usually present as scattered seedlings and saplings. Associated shrubs vary from site to site, depending on the underlying substrate, and may include *Atriplex* spp., *Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria nauseosa, Cercocarpus montanus, Fraxinus anomala, Rhus trilobata*, and several species of *Opuntia*. The herbaceous layer is sparse in cover and may include *Leymus salinus, Pleuraphis jamesii, Achnatherum hymenoides*, and *Hesperostipa comata*. Forbs provide sparse cover with no one species providing more than 1% cover. Cryptogam cover is also restricted, rarely covering more than 5% of the ground surface.

ENVIRONMENTAL DESCRIPTION

Global Environment: This tall-shrub association occurs in patches on cool colluvial slopes in Colorado Plateau canyons. Slopes are moderate to very steep and are often oriented to the north or east. Elevations range from 1268 to 1638 m (4160-5375 feet). Rocks and litter cover most of the unvegetated ground surface. The high cover of rock on the ground surface acts both to concentrate runoff and as mulch to slow evaporation from the soil. Thus, relatively mesic species are able to persist on otherwise dry sites. Soils are sandy, skeletal, and derived from sandstones over shale. Stands commonly occur where Wingate sandstone colluvium has fallen onto Chinle shale slopes in canyons. The combination of sandy rock and soils overlying a substrate that is usually a marine shale allows for both mesic and saline desert species to co-exist.

VEGETATION DESCRIPTION

Global Vegetation: This shrubland association is rare, occurring in small stands on colluvial canyon slopes. The total vegetation cover ranges from 7 to 35% and is characterized by an open tall-shrub canopy up to 3 m tall of *Fendlera rupicola* that provides 1 to 12% cover. *Juniperus osteosperma* is usually present as scattered seedlings and saplings. Associated shrubs vary from site to site, depending on the underlying substrate, and may include *Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Cercocarpus montanus, Fraxinus anomala, Rhus trilobata*, and several species of *Opuntia*. The herbaceous layer is moderate in species composition but provides sparse cover. Common graminoids include *Leymus salinus,*

Pleuraphis jamesii, Achnatherum hymenoides, and *Hesperostipa comata*. Forbs provide sparse cover with no one species providing more than 1% cover. Cryptogam cover is restricted, rarely covering more than 5% of the ground.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Fendlera rupicola*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*

CHARACTERISTIC SPECIES

Global: *Atriplex confertifolia*, *Ericameria nauseosa*, *Fendlera rupicola*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (12-Apr-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: *Fendlera rupicola* is an element, and sometimes codominant, of several shrub communities described from colluvial slopes, including *Amelanchier utahensis* Shrubland (CEGL001067). There is a great deal of uncertainty in the classification of these rocky slope shrublands in general, and assignments and concepts should be continually reviewed as new data become available.
Global Similar Associations:
- *Amelanchier utahensis* Shrubland (CEGL001067)

ELEMENT DISTRIBUTION

Global Range: This association occurs on rocky canyon slopes in at least two areas of the northern Colorado Plateau of Colorado and Utah. It may also occur in northeastern Arizona.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC
Federal Lands: NPS (Arches, Canyon de Chelly, Colorado, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles, mod. K.A. Schulz
References: Coles et al. 2009a, Reid and Hall 2010, Thomas et al. 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

***Fraxinus anomala - Rhus trilobata* Talus Shrubland**

Singleleaf Ash - Skunkbush Sumac Talus Shrubland
Identifier: CEGL003963

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Fraxinus anomala - Rhus trilobata* Talus Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association occurs on steep, rocky colluvial slopes as well as on thin soils near the edges of canyon and mesa rims. Sites are located on gentle to steep (1- to 34-degree) slopes between 1195 and 1536 m elevation, with a strong orientation toward northerly aspects. The unvegetated surface is mostly covered by rocks, gravel, boulders, bedrock and bare soil, with little litter or dead wood evident. Soils tend to be sandy, with a few stands on silt loams or clay loams derived from sandstone and shale. This open shrubland is characterized by sparse to low cover (<15% total cover) from a mix of xeric shrubs, among which *Fraxinus anomala* and *Rhus trilobata* are conspicuous and usually at least codominant. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ephedra torreyana, Chrysothamnus viscidiflorus var. stenophyllus*, and *Gutierrezia sarothrae*. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Achnatherum hymenoides, Stanleya pinnata, Chamaesyce fendleri*, and *Xylorhiza* spp. are the most consistent species. Biological soil crust formation is rare on these active slopes.

ENVIRONMENTAL DESCRIPTION

Global Environment: This shrubland association occurs on steep, rocky colluvial slopes as well as on thin soils near the edges of canyon and mesa rims. Sites are located on gentle to steep (1- to 34-degree) slopes between 1195 and 1536 m elevation, with a strong orientation toward northerly aspects. The unvegetated surface is mostly covered by rocks, gravel, boulders, bedrock and bare soil, with little litter or dead wood evident. Soils tend to be sandy, with a few stands on silt loams or clay loams derived from sandstone and shale.

VEGETATION DESCRIPTION

Global Vegetation: This open shrubland is characterized by sparse to low cover (<15% total cover) from a mix of xeric shrubs, among which *Fraxinus anomala* and *Rhus trilobata* are conspicuous and usually at least codominant. Many other shrub species are usually present, including *Artemisia bigelovii, Atriplex confertifolia, Ephedra torreyana, Chrysothamnus viscidiflorus var. stenophyllus*, and *Gutierrezia sarothrae*. The herbaceous layer may include many species but never provides more than a few percent cover; *Pleuraphis jamesii, Achnatherum hymenoides, Stanleya pinnata, Chamaesyce fendleri*, and *Xylorhiza* spp. are the most consistent species. Biological soil crust formation is rare on these active slopes.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (10-Jul-2006).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak

ELEMENT DISTRIBUTION

Global Range: This associations is described from Canyonlands National Park and Glen Canyon National Recreation Area and likely occurs elsewhere in canyons of the Colorado Plateau.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Canyonlands, Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Ostrya knowltonii* Woodland**

Knowlton's Hophornbeam Woodland
Identifier: CEGL003971

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Ostrya knowltonii* Woodland

ELEMENT CONCEPT

Global Summary: This woodland association is known from a single occurrence in Glen Canyon National Recreation Area from an intermittently flooded alcove on a wash bottom. The site is a moderate slope oriented to the west at 1603 m elevation. Litter and exposed soil cover most of the unvegetated surface, with lesser cover by sand, bedrock and dead wood. The soil is a rapidly drained loamy sand derived from alluvium. This riparian woodland is rare within the recreation area. Total vegetation cover is 92%. The stand is characterized by a dense canopy of the tall shrub *Ostrya knowltonii* with up to 40% cover. Scattered *Populus fremontii, Pinus edulis*, and *Juniperus osteosperma* emerge from the shrub canopy but do not constitute a tree layer. Associated shrubs include *Amelanchier utahensis, Fraxinus anomala, Rhus trilobata, Symphoricarpos longiflorus*, and *Yucca angustissima*. The riparian vine *Clematis ligusticifolia* provides sparse cover. The herbaceous layer is diverse and provides significant cover. Common grasses include *Sporobolus airoides* and *Poa fendleriana*. The forbs *Solidago canadensis* and *Heterotheca villosa* provide low to moderate cover, and *Aquilegia micrantha, Cirsium calcareum, Thelypodium integrifolium*, and *Castilleja linariifolia* are generally present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This woodland association mostly occurs on high-level sideslopes of the Inner Canyon which lie to the east of the North Rim. It occurs at 1600 to 1750 m (5275-5750 feet) elevation, on very steep gradients (30-50 degrees), and typically favors north- to northeast-facing aspects. Soils are moderately to rapidly-drained silty or sandy loams. When unobscured, the underlying bedrock is typically limestone or sandstone. Ground cover tends to be dominated by litter (50%) and rocks (25%), with lesser amounts of gravel (10%) and bare soil (9%).

Global Environment: This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is moderately dense and typically supports 20-30% tree cover and 10-15% shrub cover. It is characterized by the subcanopy tree (or tall shrub) *Ostrya knowltonii* (15-30%), but also supports various other shrub and tree species. Depending upon the stand, *Pseudotsuga menziesii* (8%), *Acer glabrum* (6%), *Acer grandidentatum* (4%), and *Pinus edulis* (6%) can all sporadically occur in the tree canopy (6-8%). Along with *Ostrya knowltonii*, the subcanopy also sometimes includes *Juniperus osteosperma* (1%). A well-developed tall-shrub layer (7%) exists in which *Ptelea trifoliata* (1%), *Fraxinus anomala* (4%), and *Cercis orbiculata* (1%) frequently occur. Other chaparral shrub species such as *Quercus X pauciloba, Fendlera rupicola*, and *Fraxinus cuspidata* can also occur in some stands. *Amelanchier utahensis* (2%), *Glossopetalon spinescens* (1%), *Cercocarpus montanus* (1%), and *Ephedra viridis* (1%) commonly occur in the short-shrub layer (5%). Dwarf-shrubs do not occur with any significant cover in this association. *Poa fendleriana* (1%) is regularly present in a very sparse graminoid layer. *Galium* sp. (up to 1%) and *Phlox austromontana* (up to 1%) frequently occur in the forb understory (3%). Based upon the 4 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

Global Vegetation: This association is documented from a single occurrence and will require further documentation to develop a thorough global description.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree subcanopy	Broad-leaved deciduous tree	*Ostrya knowltonii*
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala*

Short shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acer glabrum*, *Acer grandidentatum*, *Amelanchier utahensis*, *Cercis orbiculata*, *Cercocarpus montanus*, *Fraxinus anomala*, *Glossopetalon spinescens*, *Juniperus osteosperma*, *Ostrya knowltonii*, *Phlox austromontana*, *Poa fendleriana*, *Pseudotsuga menziesii*, *Ptelea trifoliata*
Global: *Ostrya knowltonii*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Ostrya knowltonii* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (12-Jul-2006).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: This association is unique within Grand Canyon National Park, as no other community contains such significant *Ostrya knowltonii* cover.
Global Comments: With only one plot to represent it, this type is very provisional, and with further classification work, could be merged into some other association.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon where it was sampled from near Banta Point, Juno Temple, Colter Butte, and in Roaring Springs Canyon.
Global Range: Documented from a single plot in Glen Canyon National Recreation Area.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01537, GRCA.01579, GRCA.01590, GRCA.02615.
Local Description Authors: R. Meszaros
Global Description Authors: M.E. Hall
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Quercus gambelii - Arctostaphylos pungens* Shrubland [Park Special]**

Gambel Oak - Pointleaf Manzanita Shrubland
Identifier: CEPS009528

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii - Arctostaphylos pungens* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on upper sideslopes that fall into the Inner Canyon from the North Rim, or on ridges and plateaus near the edge of the North Rim. It typically occurs at 2475 to 2525 m (8100-8250 feet) elevation, but can also occur as low as 2325 m (7625 feet). It is typically found

on moderately steep (15-35 degrees) southeast- to southwest-facing slopes, but can also occur on much gentler gradients. Soils are well- to rapidly-drained sandy loams. Litter (75%) strongly dominates the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is fairly dense and typically supports 40-65% shrub cover. It is codominated by the short shrubs *Quercus gambelii* (15-25%) and *Arctostaphylos pungens* (20-25%). A tall-shrub layer containing substantial *Cercocarpus ledifolius* rarely occurs in some stands. Along with *Quercus gambelii* and *Arctostaphylos pungens*, the short-shrub layer also invariably includes *Amelanchier utahensis* (7-10%). Dwarf-shrubs are essentially absent from this association. *Poa fendleriana* (1%) consistently occurs in a sparse graminoid layer. Various species including *Packera multilobata* (trace cover) can occur in the sparse forb understory (3%). Based upon the 3 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos pungens*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Arctostaphylos pungens*, *Packera multilobata*, *Poa fendleriana*, *Quercus gambelii*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: *Quercus gambelii* / *Amelanchier utahensis* Shrubland (CEGL001110) is also dominated by *Quercus gambelii* and supports significant cover of *Amelanchier utahensis*; however, *Arctostaphylos pungens* is absent from this community.
Global Similar Associations:

- *Quercus gambelii* / *Amelanchier utahensis* Shrubland (CEGL001110) is also dominated by *Quercus gambelii* and supports significant cover of *Amelanchier utahensis*, but *Arctostaphylos pungens* is absent.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from just below Uncle Jim Point; and from the North Rim, where it was sampled on the Powell Plateau.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.02090, GRCA.02110, GRCA.03660.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Quercus gambelii / *Amelanchier utahensis* Shrubland

Gambel Oak / Utah Serviceberry Shrubland
Identifier: CEGL001110

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii* / *Amelanchier utahensis* Shrubland

ELEMENT CONCEPT

Global Summary: This mixed mountain shrubland occurs in southern Utah and western Colorado. Stands occur in canyons, or on mesas, benches, plateaus, ridges, foothills scarps and mountains. Elevation ranges from 1525 to 2700 m (5000-8860 feet). Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks. The vegetation is characterized by a sparse to dense (10-100+% cover) tall-shrub layer (2-5 m tall) codominated by *Quercus gambelii* and *Amelanchier utahensis*. Common shrub associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Purshia tridentata*, and *Prunus virginiana*. Graminoids, such as *Pascopyrum smithii, Achnatherum hymenoides, Carex geyeri, Hesperostipa comata*, or *Poa fendleriana*, dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri*, or *Vicia americana*. Occasionally, scattered individual trees are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii*, or *Juniperus osteosperma*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Gambel's oak shrubland association occurs in the Inner Canyon on relatively steep, rocky slopes (30-40 degrees) that plunge down from the North Rim. It typically occurs at 1850 to 1900 m (6150-6250 feet) elevation, but likely exists within a broader elevational range. It favors mid or upper sideslopes, across all aspects other than south-facing. Soils are rapidly-drained sandy loams. Litter (up to 75%) strongly dominates the ground cover in denser stands, while gravel and bare soil (up to 75%) are common in less dense stands.

Global Environment: This mountain shrubland occurs in southern Utah and western Colorado. Elevation ranges from 1525 to 2700 m (5000-8860 feet). Stands occur in canyons or on mesas, benches, plateaus, ridges, foothills scarps and mountains. Slopes are gentle to steep (1-100%) and may be oriented to any aspect. Soil are generally deep, well-developed and are derived from a variety of sources, including sandstones, shales and metamorphic rocks.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: A thick and dense shrub layer of 50-60% or more is common in this association. Trees and tall shrubs are essentially absent; however, scattered *Pinus edulis* or other tall chaparral shrubs occasionally punctuate stands at very low individual covers. The short-shrub stratum is codominated by *Quercus gambelii* (20-40%) and *Amelanchier utahensis* (10-30%). *Cercocarpus montanus* (3%) and *Ephedra viridis* (1%) are also quite common in the short-shrub layer. Due to the extreme predominance of other larger shrubs, dwarf-shrubs seem to be crowded out and are essentially absent from this association, although *Gutierrezia sarothrae* does occur at low cover in some stands. Patchy *Poa fendleriana* (1-3%) is the only notable component of the graminoid understory. *Phlox austromontana* (1%) occurs in some stands; however, forbs are very sparse and infrequent in this community. Due to the high shrub cover and often thick litter layer, this association supports below-average species diversity among plant communities in Grand Canyon, with only 12 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a sparse to dense (10-100+% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* and codominated by *Amelanchier utahensis*. Sparse stands tend to occur in areas that have burned recently. Common associates include *Artemisia tridentata* and *Symphoricarpos oreophilus*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Chrysothamnus viscidiflorus, Ephedra viridis, Gutierrezia sarothrae, Mahonia repens, Opuntia* spp., *Purshia tridentata*, and *Prunus virginiana*. Graminoids, such as *Pascopyrum smithii, Achnatherum hymenoides, Carex*

geyeri, Hesperostipa comata, or *Poa fendleriana*, dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Allium acuminatum, Comandra umbellata, Erigeron speciosus, Lathyrus lanszwertii, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri*, or *Vicia americana*. Occasionally, tree species are present in the overstory, including *Pinus edulis, Pseudotsuga menziesii*, or *Juniperus osteosperma*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis, Quercus gambelii*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Amelanchier utahensis, Quercus gambelii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Cercocarpus montanus*, *Phlox austromontana*, *Poa fendleriana*, *Quercus gambelii*
Global: *Amelanchier utahensis*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Ostrya knowltonii* (state-vulnerable, G3G4)
Global: Vulnerable: *Lupinus ammophilus* (G3G4), *Ostrya knowltonii* (G3G4); **Other**: *Symphoricarpos oreophilus* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This community can be somewhat similar to other "mountain-brush" or chaparral community types, but is distinguished by the codominance of *Quercus gambelii* and *Amelanchier utahensis* in the short-shrub stratum, with relatively few other shrub associates.
Global Comments: This plant association is similar to other montane Gambel oak shrublands except for the co-dominance of *Amelanchier utahensis* with only minor amounts (<10% or 5% cover, respectively) of *Artemisia tridentata* or *Cercocarpus montanus*.
Global Similar Associations:
- *Amelanchier utahensis* Shrubland (CEGL001067)
- *Quercus gambelii - Arctostaphylos pungens* Shrubland [Park Special] (CEPS009528) is also dominated by *Quercus gambelii* and supports significant cover of *Amelanchier utahensis*, along with *Arctostaphylos pungens*.
- *Quercus gambelii - Holodiscus dumosus* Shrubland (CEGL002341)
- *Quercus gambelii / Amelanchier alnifolia* Shrubland (CEGL001109)
- *Quercus gambelii / Artemisia tridentata* Shrubland (CEGL001111)
- *Quercus gambelii / Prunus virginiana* Shrubland (CEGL005994)
- *Quercus gambelii / Symphoricarpos oreophilus* Shrubland (CEGL001117)

Global Related Concepts:
- *Quercus gambelii/Amelanchier utahensis* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) **>**
- Mountain Brush Community (Cedar Creek Associates, Inc. 1987) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled in Roaring Springs Canyon and upper Kwagunt Creek.
Global Range: This montane shrubland occurs in southern Utah and western Colorado. It occurs in small scattered patches on Dry Bench in Capitol Reef National Park, and on high alluvial terraces in the canyons of Natural Bridges National Monument. It is one of the most abundant and widespread shrubland types in Black Canyon of the Gunnison National Park and Curecanti National Recreation Area.
Nations: US
States/Provinces: AZ, CO:SU, UT:S3S5, WY
TNC Ecoregions: 9:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331D:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Capitol Reef, Curecanti, Grand Canyon, Mesa Verde, Natural Bridges, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (2 plots): GRCA.01589, GRCA.02101.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Carmichael et al. 1978, Cedar Creek Associates, Inc. 1987, Clark et al. 2009, Clary 1992, Cogan et al. 2004, Coles et al. 2008c, Coles et al. 2010, Crane 1982, Driscoll et al. 1984, Muldavin et al. 1998b, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2010, Thomas et al. 2009b, WNDD unpubl. data, Western Ecology Working Group n.d.

Quercus gambelii / *Poa fendleriana* Shrubland

Gambel Oak / Muttongrass Shrubland
Identifier: CEGL002949

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii* / *Poa fendleriana* Shrubland

ELEMENT CONCEPT

Global Summary: This montane shrubland association has been described from the Colorado Plateau and the western slope of the southern Rocky Mountains. Elevation ranges from 1770-2337 m (5800-7660 feet). Sites are on nearly level mesas to steep hillslopes (to 59%). Soils are rapidly drained loamy sand and sandy loam derived from sandstones. There is typically high cover of litter and moderate cover of large rocks and bare ground. The vegetation is characterized by an open to moderately dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. Other shrubs may be present with low cover and do not form a separate short-shrub layer (generally <10% total). Species include *Amelanchier utahensis, Artemisia tridentata ssp. wyomingensis, Purshia tridentata, Mahonia repens*, and *Symphoricarpos* spp. The herbaceous layer may be diverse and provides low to high cover depending on overstory canopy density. The bunchgrass *Poa fendleriana* is usually dominant (to 30% cover) and occurs consistently. Additional graminoids provide sparse to low cover, such as *Achnatherum hymenoides, Bouteloua gracilis, Carex geyeri*, and *Hesperostipa comata*. Forbs typically have low cover but may be diverse. Common forbs include *Arenaria* spp., *Artemisia ludoviciana*, *Eriogonum* spp., *Petradoria pumila*, and *Phlox austromontana*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs in Grand Canyon-Parashant National Monument on the Shivwits Plateau at approximately 1800 m (5900 feet) elevation. It typically occurs on fairly steep (20-30 degrees), low to mid-level sideslopes, sometimes near the heads of canyons. It occurs in well-drained clay or silty clay soils derived from limestone. Litter (80-90%) strongly dominates the ground cover.
Global Environment: This montane shrubland association has been described from the Colorado Plateau and the

western slope of the southern Rocky Mountains. Elevation ranges from 1770-2337 m (5800-7660 feet). Sites are on nearly level mesas to steep hillslopes (to 59%). Soils are rapidly drained loamy sand and sandy loam derived from sandstones. There is typically high cover of litter and moderate cover of large rocks and bare ground.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrubland community typically supports a sparse (5%) woodland canopy of *Juniperus osteosperma* (4%) and *Pinus monophylla* (1%). *Quercus gambelii* (45-55%) strongly dominates the dense short-shrub stratum, while *Purshia stansburiana* may occasionally occur at low cover. *Poa fendleriana* (8-12%) is essentially the sole component of a relatively well-developed graminoid understory, although scattered *Bouteloua gracilis* (1-2%) may also occur in some stands. Species such as *Eriogonum umbellatum, Frasera albomarginata*, and *Penstemon linarioides* sporadically occur in the sparse forb layer (less than 1%).
Global Vegetation: The vegetation is characterized by an open to moderately dense (10-65% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. Other shrubs may be present with low cover and do not form a separate short-shrub layer (generally <10% total). Species include *Amelanchier utahensis*, *Artemisia tridentata ssp. wyomingensis, Purshia tridentata, Mahonia repens*, and *Symphoricarpos* spp. The herbaceous layer may be diverse and provides low to high cover depending on overstory canopy density. The bunchgrass *Poa fendleriana* is usually dominant (to 30% cover) and occurs consistently. Additional graminoids provide sparse to low cover, such as *Achnatherum hymenoides, Bouteloua gracilis, Carex geyeri*, and *Hesperostipa comata*. Forbs typically have low cover but may be diverse. Common forbs include *Arenaria fendleri, Arenaria macradenia, Artemisia ludoviciana, Eriogonum racemosum, Eriogonum umbellatum, Petradoria pumila*, and *Phlox austromontana*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos rotundifolius*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Poa fendleriana*, *Quercus gambelii*
Global: *Carex geyeri*, *Poa fendleriana*, *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).
CLASSIFICATION
Status: Standard
Grand Canyon National Park Comments: This association differs from other *Quercus gambelii*-dominated types by its lack of codominant or associate shrub species. It also occurs on or immediately adjacent to the plateau and not within the actual Grand Canyon.
Global Similar Associations:

- *Quercus gambelii* / *Carex geyeri* Shrubland (CEGL005995)
- *Quercus gambelii* / Sparse Understory Shrubland (CEGL002337)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau near the head of Twin Creek Canyon.
Global Range: This montane shrubland association has been described from the Colorado Plateau and the western slope of the southern Rocky Mountains in southwestern Utah and west-central Colorado.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Curecanti, Grand Canyon-Parashant, Grand Canyon?, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.04102, GRCA.04113.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Cogan et al. 2004, Coles et al. 2010, Reid and Hall 2010, Tendick et al. 2010, Western Ecology Working Group n.d.

Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius Shrubland

Gambel Oak / New Mexico Locust / Roundleaf Snowberry Shrubland
Identifier: CEGL001116

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland

ELEMENT CONCEPT

Global Summary: This poorly known association is reported from the Sandia Mountains in north-central New Mexico and the Mogollon Rim in north-central Arizona. Sites include steep, exposed slopes at higher elevation, or north aspect midslopes and riparian areas in canyons at lower elevation. Slopes and aspects are variable. Substrates are generally coarser textured soils with a high percentage of mixed gravel, cobble and/or boulder-sized rock. Vegetation is characterized by a moderately dense to dense, deciduous tall-shrub layer that is dominated by *Quercus gambelii* with *Robinia neomexicana* often codominating. Scattered conifer trees may be present including *Pinus edulis, Pinus ponderosa, Pseudotsuga menziesii*, or *Juniperus* spp. Riparian stands may have an occasional *Acer negundo* tree or *Salix* spp. shrub. The short-shrub layer is dominated by species of *Symphoricarpos* that vary depending on geography and include *Symphoricarpos rotundifolius, Symphoricarpos oreophilus*, or *Symphoricarpos palmeri*. Other shrubs may include *Amelanchier utahensis, Chamaebatiaria millefolium, Forestiera pubescens*, or *Rosa woodsii*. The herbaceous layer is generally sparse because of shading from dense shrub cover. Associates include *Achillea millefolium, Artemisia ludoviciana, Campanula rotundifolia, Hedeoma drummondii, Heterotheca villosa, Penstemon* spp., *Poa fendleriana, Solidago velutina*, and *Thalictrum fendleri*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Gambel's oak shrubland association primarily occurs in the Inner Canyon on upper sideslopes below the North Rim. It typically occurs adjacent to or in openings in ponderosa pine woodlands at 2150 to 2525 m (7100-8250 feet) elevation. It favors steep slopes (15-40 degrees) on southern or western aspects, although it occasionally occurs on gentler gradients in drainage channels. Soils are rapidly-drained sandy loams, often derived from limestone substrates. Litter (60%), gravel (15%), rocks (11%), and bare soil (8%) are major components of the ground cover. This association was sampled from a similar, although lower-elevation (1750 m [5800 feet]) environment in the far Western Grand Canyon. It was also sampled from a post-fire plateau environment in Grand Canyon-Parashant National Monument.
Global Environment: This poorly known shrubland association is reported from the Sandia Mountains in north-central New Mexico and the Mogollon Rim in northern central Arizona. Elevation ranges from 1510-3050 m

(4950-10,000 feet). Sites include steep, exposed sites at higher elevations or north aspect midslopes and riparian areas in canyons at lower elevations. Slopes and aspects are variable. Substrates are generally coarser textured soils with a high percentage of mixed gravel, cobble and/or boulder-sized rock. Litter cover is often over 10%.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrubland association lacks a defined tree canopy, although scattered tree species, including *Pinus ponderosa, Pinus edulis, Juniperus osteosperma*, or *Abies concolor*, sporadically occur in some stands at 1-3% cover. Total shrub cover typically averages 50-60% and is almost entirely composed of short shrubs. *Quercus gambelii* (35-40%) dominates the short-shrub layer, while *Robinia neomexicana* (8-10%) is also consistently present. *Symphoricarpos* spp. (*Symphoricarpos rotundifolius, Symphoricarpos oreophilus*) characteristically occur as well, typically at 4-5% cover. *Amelanchier utahensis* (6%) occurs in the majority of stands. Dwarf-shrubs are essentially absent from this community. The graminoid understory is fairly sparse (2%); *Poa fendleriana* occurs in most stands (2%), while *Elymus elymoides* sometimes occurs at trace cover. Forb composition is variable among stands, and approximately 50 different species can occur in this stratum (3%). *Solidago velutina, Machaeranthera canescens*, and *Phacelia heterophylla* are some of the most common constituents, all at trace covers. Based upon the 8 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a moderately dense to dense, deciduous tall-shrub layer that is dominated by *Quercus gambelii* with *Robinia neomexicana* often codominating. Scattered conifer trees may be present including *Pinus edulis, Pinus ponderosa, Pseudotsuga menziesii, Juniperus scopulorum, Juniperus osteosperma*, or *Juniperus monosperma*. Riparian stands may have an occasional *Acer negundo* tree or *Salix* spp. shrub. The short-shrub layer is dominated by species of *Symphoricarpos* that vary depending on geography and include *Symphoricarpos rotundifolius, Symphoricarpos oreophilus*, or *Symphoricarpos palmeri*. Other shrubs may include *Amelanchier utahensis, Chamaebatiaria millefolium, Forestiera pubescens*, or *Rosa woodsii*. The herbaceous layer is generally sparse because of shading from dense shrub cover. Associates include *Achillea millefolium, Artemisia ludoviciana, Campanula rotundifolia, Hedeoma drummondii, Heterotheca villosa, Penstemon* spp., *Poa fendleriana, Solidago velutina*, and *Thalictrum fendleri*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Quercus gambelii, Robinia neomexicana*
Short shrub/sapling	Broad-leaved deciduous shrub	*Symphoricarpos rotundifolius*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Elymus elymoides*, *Machaeranthera canescens*, *Poa fendleriana*, *Quercus gambelii*, *Robinia neomexicana*, *Solidago velutina*

Global: *Quercus gambelii*, *Robinia neomexicana*, *Symphoricarpos rotundifolius*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Melilotus officinalis* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GU (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak
Global Comments: This poorly known plant association is reported both as chaparral from Sandia Mountains in New Mexico and riparian vegetation canyons in northern Arizona. It is similar to stands of *Quercus gambelii* / *Robinia neomexicana* Shrubland (CEGL001115) described from the Mazatzal Mountains in central Arizona (Warren and Treadwell 1980) and stands of *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland (CEGL001117) described from White Sands Missile Range in New Mexico (Muldavin et al. 2000b). These related stands are all dominated by *Quercus gambelii* with *Symphoricarpos* spp. and *Robinia neomexicana* potentially present. Further review is needed to better understand this association and its relationship to the other associations.
Global Similar Associations:
- *Quercus gambelii - Robinia neomexicana* / *Carex inops ssp. heliophila* Shrubland (CEGL005379)
- *Quercus gambelii - Robinia neomexicana* / *Muhlenbergia montana* Shrubland (CEGL005380)
- *Quercus gambelii* / *Robinia neomexicana* Shrubland (CEGL001115)
- *Quercus gambelii* / Sparse Understory Shrubland (CEGL002337)
- *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland (CEGL001117)

Global Related Concepts:
- *Quercus gambelii/Robinia neomexicana/Symphoricarpos rotundifolius* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) **>**
- Gambel Oak - New Mexico Locust - Deerbrush Association (Warren and Treadwell 1980) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled below Uncle Jim Point, upper Roaring Springs Canyon, on the slopes above Transept Canyon, on the slopes below and southwest of Walla Valley, and below Swamp Point. In the Western Grand Canyon, it was sampled from upper Twin Springs Canyon, and in Grand Canyon-Parashant National Monument, it was sampled to the north of Mount Emma.
Global Range: This association is reported from central New Mexico and northern central Arizona along the Mogollon Rim.
Nations: US
States/Provinces: AZ, NM:SU
TNC Ecoregions: 19:C, 20:C, 21:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 313E:CC, 321A:CC, 331J:CC, M313A:CC, M313B:CC, M331F:CC, M331G:C?
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Walnut Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (8 plots): GRCA.01624, GRCA.01630, GRCA.02102, GRCA.02133, GRCA.03599, GRCA.03659, GRCA.03661, GRCA.04690.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen et al. 2004a, Muldavin et al. 2000b, Reid and Hall 2010, Warren and Treadwell 1980, Watson 1912, Western Ecology Working Group n.d.

***Quercus gambelii* / *Robinia neomexicana* Shrubland**

Gambel Oak / New Mexico Locust Shrubland
Identifier: CEGL001115

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii* / *Robinia neomexicana* Shrubland

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:
- *Quercus gambelii - Robinia neomexicana / Carex inops ssp. heliophila* Shrubland (CEGL005379)
- *Quercus gambelii - Robinia neomexicana / Muhlenbergia montana* Shrubland (CEGL005380)
- *Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius* Shrubland (CEGL001116)
- *Quercus gambelii* / Sparse Understory Shrubland (CEGL002337)

Global Related Concepts:
- *Quercus gambelii/Robinia neomexicana* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ:S4, NM
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren and Treadwell 1980, Warren et al. 1982, Western Ecology Working Group n.d.

Quercus gambelii Shrubland

Gambel Oak Shrubland
Identifier: CEGL002477

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Quercus gambelii* Shrubland

ELEMENT CONCEPT

Global Summary: This tall shrubland is known from northeastern Arizona and southwestern Colorado and southeastern Utah in the Colorado Plateau north into the Wasatch Range. It also occurs in the high plateaus of southern Utah. Stands occur on southeastern to western aspects at 1884 to 2379 m (6181-7805 feet) elevation on gentle to moderately steep slopes (0-30%). Sites include canyons, mesas, stream terraces and a toeslope at the base of a cliff. The frequently sandy soils have low cover of rock and moderate to high cover of littler on the ground surface. There is frequently evidence of past fires. The vegetation is characterized by an open to dense (25-75% cover), tall-shrub (>10 m) canopy dominated by *Quercus gambelii*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present. Other shrubs (all with <1% cover) are *Ericameria nauseosa, Gutierrezia sarothrae, Mahonia repens, Opuntia phaeacantha*, and *Purshia tridentata*. The herbaceous stratum is variable. *Artemisia ludoviciana* and *Elymus elymoides* are important species as is the exotic annual grass and forb species *Bromus tectorum* and *Erodium cicutarium*, respectively. The herbaceous stratum has a diversity of other species with low cover (<1%).

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Gambel oak woodland association occurs on the South Rim in areas that have experienced historical burns. It occurs in openings in ponderosa pine and pinyon-juniper woodlands, typically on flat slopes of the plateau, at approximately 2150 m (7100 feet) elevation. Soils are limestone-derived,

rapidly drained silt loams. Due to past fire events and slow establishment of post-fire vegetation, bare soil (40%) dominates the ground cover. Rocks (15%), downed wood (5%), and litter (30%) are other major components of the ground cover. This community seems to occur in disturbed or ruderal environments.

Global Environment: This tall shrubland is known from northeastern Arizona, southwestern Colorado and southern Utah in the Colorado Plateau and extends north into the Wasatch Range, and south into the high plateaus of southern Utah. Stands occur on southeastern to western aspects at 1884 to 2379 m (6181-7805 feet) elevation on gentle to moderately steep slopes (0-30%). Sites include canyons, ravines, mesas, stream terraces and toeslopes at the base of cliffs. The soils are often sandy loams but may include silty clay loams with low cover of rock and moderate to high cover of litter on the ground surface. There is frequently evidence of past fires.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This vegetation type lacks significant tree cover; however, stunted *Juniperus osteosperma* (1%) occasionally occur. Shrub strata are sparse as well, and total shrub cover typically averages 10-15%. Scattered *Quercus gambelii* (5-7%) dominates the sparse shrub layers, while *Gutierrezia sarothrae* (4%) is a common dwarf-shrub ground cover. This association usually supports a well-developed graminoid layer dominated by *Bouteloua gracilis* (10-15%). *Elymus elymoides* (1%) and the exotic *Bromus tectorum* (3%) are also common. The forb understory is usually well-developed and sometimes supports up to 15-18% cover. Various species, such as *Chaetopappa ericoides, Erigeron divergens*, and *Chamaesyce fendleri*, as well as the weedy *Amaranthus* sp., *Verbascum thapsus, Portulaca oleracea*, and *Erodium cicutarium*, may be present. This vegetation type seems to represent a transitional phase that may eventually return to a more mixed-shrub type with denser cover; or in some cases, it may become increasingly dominated by exotic herbaceous species. Based upon the single stand, this association hosts very high species diversity among Grand Canyon plant communities, with 37 species per 400-square-meter plot. Much of this diversity results from exotic and weedy species.

Global Vegetation: This tall shrubland is characterized by an open to dense (25-75% cover) tall-shrub (>10 m) dominated by *Quercus gambelii*. Scattered *Pinus edulis* and *Juniperus osteosperma* trees may be present. Other shrubs (all with <1% cover) are *Amelanchier utahensis, Ericameria nauseosa, Gutierrezia sarothrae, Mahonia repens, Opuntia phaeacantha, Rhus trilobata*, and *Purshia tridentata*. The herbaceous stratum is variable and often has a high diversity of species with low cover (<1%), such as *Achillea millefolium var. occidentalis, Achnatherum hymenoides, Artemisia ludoviciana, Balsamorhiza sagittata, Eriogonum racemosum, Elymus elymoides, Elymus trachycaulus ssp. trachycaulus, Galium aparine, Maianthemum stellatum, Poa fendleriana, Pseudoroegneria spicata, Solidago velutina*, and *Vicia americana*. Exotic annual grass and forb species *Bromus tectorum* and *Erodium cicutarium* are frequently present to abundant.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Forb	*Chamaesyce fendleri, Verbascum thapsus*
Herb (field)	Graminoid	*Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Quercus gambelii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Quercus gambelii*, *Verbascum thapsus*

Global: *Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Me-

dium/Low), *Portulaca oleracea* (exotic), *Verbascum thapsus* (exotic, Medium)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Erodium cicutarium* (invasive/exotic, Medium/Low); **Other**: *Achillea millefolium* var. *occidentalis* (G5T5), *Achnatherum hymenoides* (G5), *Artemisia ludoviciana* (G5), *Balsamorhiza sagittata* (G4G5), *Elymus elymoides* (G5), *Elymus trachycaulus* ssp. *trachycaulus* (G5T5), *Ericameria nauseosa* (G5), *Eriogonum racemosum* (G5), *Mahonia repens* (G5), *Poa fendleriana* ssp. *longiligula* (G5TNR), *Purshia tridentata* (G3G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Mar-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: See the *Grand Canyon National Park Dynamics* section for a discussion of similar plant communities.
Global Comments: This association is intended for shrublands of oak with no other shrubs associated with mixed mountain shrublands (e.g., *Amelanchier* spp., *Symphoricarpos oreophilus, Prunus virginiana, Cercocarpus montanus*, etc.) or a distinctive herbaceous layer. Many stands are in unusual settings, such as recent burns (e.g., Mesa Verde National Park). It is likely to be a transitional phase that will eventually return to a more mixed shrub canopy understory or in some cases become dominated by exotic herbaceous species.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, where it was sampled from south of Yaqui Point.
Global Range: This association has been reported from southwestern Colorado, on the Colorado Plateau in northeastern Arizona, and from the Wasatch Range of northern Utah and the high plateaus of southern Utah. It likely occurs elsewhere in the region, especially in areas relatively recently disturbed.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 341B:CC, M331D:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Canyon de Chelly, Grand Canyon, Mesa Verde, Timpanogos Cave)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.03201.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Coles et al. 2009b, Reid and Hall 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thomas et al. 2010, Western Ecology Working Group n.d.

***Robinia neomexicana* Shrubland**

New Mexico Locust Shrubland
Identifier: CEGL005505

USNVC CLASSIFICATION

Division	Western North American Grassland & Shrubland (2.B.2.Na)
Macrogroup	Southern Rocky Mountain Montane Shrubland (M049)
Group	Southern Rocky Mountain Gambel Oak-Mixed Montane Shrubland (G277)
Association	*Robinia neomexicana* Shrubland

ELEMENT CONCEPT

Global Summary: This New Mexico locust shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs

from 2402 to 2698 m (7881-8852 feet) elevation in areas that have recently experienced high-severity, stand-replacing fires. It occurs on plateaus, on flat or very gentle slopes (typically 3 degrees), across all aspects, and often in silty loam soils. Tree cover is completely lacking in this association, as extant conifers (mostly *Pinus ponderosa*) have experienced full mortality from fire. *Robinia neomexicana* can occur as either a tall or short shrub depending upon duration since the last fire. *Mahonia repens* is common at low cover. While infrequent, stands can sometimes have significant cover of *Ceanothus fendleri*. Graminoid composition varies significantly among stands. More mesic sites can have dense covers of *Poa pratensis* and *Poa fendleriana*, while drier sites have moderate amounts of *Bromus tectorum*. Forb cover is variable as well; fire-adapted *Gayophytum diffusum, Erigeron divergens, Solidago velutina*, and *Chenopodium* sp. are common components of the understory. This community type is associated with very high-intensity stand-replacing fires, and typically occurs within a larger matrix of unburned *Pinus ponderosa* woodlands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This New Mexico locust shrubland occurs on the North Rim from 2402 to 2698 m (7881-8852 feet) elevation in areas that have recently experienced high-severity, stand-replacement burns. It occurs on plateaus, on flat or very gentle slopes (typically 3 degrees), across all aspects, and often in silty loam soils. Stands have some bare soil (4%), a moderate litter load (68%), and many dead, burned logs (9%) on the ground. This community type is associated with very high-intensity stand-replacement fires, and typically occurs within a larger matrix of unburned *Pinus ponderosa* woodlands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover is completely lacking in this association, as extant conifers (mostly *Pinus ponderosa*) have experienced full mortality from fire. *Robinia neomexicana* is ubiquitous at 15-35% cover and can occur as either a tall or short shrub depending upon duration since the burn. *Mahonia repens* is common but only at about 1% cover. While infrequent, stands can sometimes have significant cover of *Ceanothus fendleri* (up to 15% cover). Graminoid composition varies significantly among stands. More mesic sites can have dense covers of *Poa pratensis* and *Poa fendleriana*, while drier sites have moderate amounts of *Bromus tectorum* (4%). Forb cover is variable as well, but sometimes can total up to about 15%. The fire-adapted *Gayophytum diffusum, Erigeron divergens, Solidago velutina*, and *Chenopodium* sp. are common components of the understory. Tree seedlings are essentially lacking in this vegetation type. Based upon the four stands sampled, this association has typical species richness for North Rim communities, with 23 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Mahonia repens*
Herb (field)	Forb	*Achillea millefolium, Cirsium wheeleri, Conyza canadensis, Erigeron divergens, Gayophytum diffusum, Heliomeris multiflora, Lactuca serriola, Phacelia heterophylla, Solidago velutina, Tragopogon dubius*
Herb (field)	Graminoid	*Bromus tectorum, Carex geophila, Elymus elymoides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Robinia neomexicana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Lactuca serriola* (exotic, Low/Insignificant), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low), *Verbascum thapsus* (exotic, Medium)
Global: Vulnerable: *Cirsium wheeleri* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jan-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is another very early-successional vegetation type that can occur in similar environments, but it has significant cover of *Populus tremuloides* seedlings. *Populus tremuloides* / *Robinia neomexicana* Woodland (CEGL005503) is another very early-successional vegetation type that can occur in similar environments, but it has significant cover of regenerating *Populus tremuloides* as well as *Robinia neomexicana*.
Global Similar Associations:

- *Populus tremuloides - Ceanothus fendleri* / *Carex* spp. Shrubland (CEGL005504) is another very early-successional vegetation type that can occur in similar environments, but it has significant cover of *Populus tremuloides* seedlings.
- *Populus tremuloides* / *Robinia neomexicana* Woodland (CEGL005503) is another very early-successional vegetation type that can occur in similar environments, but it has significant cover of regenerating *Populus tremuloides* as well as *Robinia neomexicana*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim in areas that have experienced fairly recent, stand-replacement fires. It was sampled from Galahad Point, near Tiyo Point, the Walhalla Plateau near Atoko Point, and from Point Imperial.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02168, GRCA.03099, GRCA.03127, GRCA.03182.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

2.B.2.Nd. Western North American Interior Sclerophyllous Chaparral Shrubland

M094. Cool Interior Chaparral
G282. Western North American Montane Sclerophyll Scrub

Arctostaphylos patula Shrubland

Greenleaf Manzanita Shrubland
Identifier: CEGL002696

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Cool Interior Chaparral (M094)
Group	Western North American Montane Sclerophyll Scrub (G282)
Association	*Arctostaphylos patula* Shrubland

ELEMENT CONCEPT

Global Summary: This association has been found mostly in southwestern Utah but observed in at least one stand in western Colorado. Most sites are on gentle to moderate slopes between 1770 and 2655 m (5800-8700 feet) elevation. The short-shrub canopy can have low to high cover (5-90%) but is consistently dominated by

Arctostaphylos patula. Other shrubs may be found at low cover, including *Amelanchier utahensis, Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Quercus gambelii*, and *Tetradymia canescens*. The herbaceous stratum has sparse to low cover and is composed of species common to dry sites on the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This greenleaf manzanita shrubland association occurs on the North Rim at approximately 2700 m (8850 feet) elevation in previously burned areas. It occurs on the flat plateau, in the vicinity of Point Imperial and near the Saddle Mountain fire. Slopes are essentially flat (1 degree), and thus the affects of aspect seem negligible. Soils are well-drained sandy loams. Stands have relatively low litter cover (37%) and high cover of bare soil (28%) and gravel (15%). Burned *Pinus ponderosa* snags as well as charred downed logs (10%) are frequent. This vegetation type results from high-severity fire and lacks a live tree canopy.
Global Environment: This association usually occurs on mesatops and plateaus between 1737 and 2377 m elevation. Slopes can have any aspect and are gentle to moderately sloping. One lower elevation site (1558 m) was observed on a steep northeast slope. Soils are sands to sandy loams.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association lacks a live canopy layer as the once dominant *Pinus ponderosa* and occasional *Populus tremuloides* have all been killed by fire. Snags remain, but all of the trees have died. The short shrub *Robinia neomexicana* (4%) is regenerating post-fire. *Arctostaphylos patula* (12%) dominates and characterizes this vegetation type, while *Ceanothus fendleri* (8%) is also a notable component of the dwarf-shrub stratum. *Carex rossii* (6%) and *Poa secunda* (3%) are the dominant graminoids, while both *Carex occidentalis* and *Carex siccata* can occur at low covers (1%). *Achillea millefolium, Chamerion angustifolium*, and *Solidago velutina* are the dominant forbs (all at about 1% cover). There is no tree seedling regeneration in these stands; however, both *Populus tremuloides* and *Robinia neomexicana* seem to be regenerating vigorously in adjacent areas.
Global Vegetation: This shrubland association can have variable cover but is dominated by *Arctostaphylos patula* with 5-90% cover. The shrub canopy is between 1-2 m tall. Other shrubs contribute only limited cover. These associates include *Amelanchier utahensis, Artemisia tridentata, Ericameria nauseosa, Purshia tridentata, Quercus gambelii*, and *Tetradymia canescens*. Widely scattered trees may be found. The herbaceous stratum has sparse to low cover and is composed of species common to dry sites. These include the graminoids *Achnatherum hymenoides, Carex rossii, Hesperostipa comata, Poa fendleriana*, and *Sporobolus cryptandrus*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Robinia neomexicana*
Herb (field)	Dwarf-shurb	*Ceanothus fendleri*
Herb (field)	Forb	*Achillea millefolium, Chamerion angustifolium, Solidago velutina*
Herb (field)	Graminoid	*Carex rossii, Poa secunda*
Submerged aquatic	Dwarf-shurb	*Arctostaphylos patula*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos patula*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Arctostaphylos patula*, *Ceanothus fendleri*, *Chamerion angustifolium*
Global: *Arctostaphylos patula*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Taraxacum officinale* (exotic), *Tragopogon dubius* (exotic, Medium/Low)
Global: Other: *Yucca elata* var. *utahensis* (endemic variety, G5T3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: Stands of the similar *Pinus ponderosa* / *Arctostaphylos patula* Woodland (CEGL000842) have not burned and still support an open canopy of *Pinus ponderosa*.
Global Comments: Nearly all the plots for this association are from Zion National Park with one from Colorado National Monument. The description may be skewed based on this.
Global Similar Associations:

- *Arctostaphylos pungens* Shrubland (CEGL000958)
- *Pinus ponderosa* / *Arctostaphylos patula* Woodland (CEGL000842) in addition, supports an open canopy of *Pinus ponderosa*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the North Rim, north of Point Imperial. It is documented by a single classification plot.
Global Range: This association has been sampled extensively from Zion National Park in southwestern Utah with additional stands observed in Colorado National Monuments in western Colorado.
Nations: US
States/Provinces: AZ, CO:S2, NV, UT
TNC Ecoregions: 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M341A:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Cedar Breaks, Colorado, Grand Canyon, Great Basin, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02099.
Local Description Authors: K. Christie
Global Description Authors: J. Drake
References: CONHP unpubl. data 2003, Cogan et al. 2004, Reid and Hall 2010, Schulz and Hall 2011, Tendick et al. 2011a, Tendick et al. 2011b, Von Loh et al. 2007, Western Ecology Working Group n.d.

***Purshia stansburiana* Shrubland**

Stansbury's Cliffrose Shrubland
Identifier: CEGL002957

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Cool Interior Chaparral (M094)
Group	Western North American Montane Sclerophyll Scrub (G282)
Association	*Purshia stansburiana* Shrubland

ELEMENT CONCEPT

Global Summary: This cliffrose shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs near the edge of canyon rims, and often occurs adjacent to pinyon-juniper or ponderosa pine woodlands. It typically occurs at 1800 to 2000 m (5950-6775 feet) elevation, but can be found as high as 2425 m (7975 feet). This association favors xeric south- or west-facing exposures on the high-level plateau or upper sideslopes below the rim. It typically occurs on flat ground (1-4 degrees), but can be found on steeper gradients (18 degrees) when occurring on sideslopes. Limestone is a common parent material, and exposed bedrock occurs in most stands. Trees are usually absent; however, scattered *Pinus edulis* or *Juniperus osteosperma* may sporadically occur in some stands. The shrub *Purshia stansburiana* dominates and characterizes this association, while other components of the shrub and understory strata often vary. The short shrubs *Ephedra viridis* and

Artemisia tridentata are common. Dwarf-shrub cover and composition are somewhat variable; *Gutierrezia sarothrae* occurs in most stands, while various *Opuntia* species are also common. The graminoid understory is typically well-developed; however, stands lacking a graminoid understory are not uncommon. Either *Poa fendleriana* or *Bouteloua gracilis* usually dominates this layer, while various other native bunch grasses, such as *Elymus elymoides*, *Sporobolus cryptandrus, Hesperostipa comata, Bouteloua curtipendula*, and *Aristida arizonica*, can occur. The exotic *Bromus tectorum* is commonly present. Forbs are typically well-represented, although again, composition varies among stands. *Sanvitalia abertii* and *Artemisia ludoviciana* commonly occur.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This cliffrose shrubland association occurs on the South Rim, North Rim, and in Grand Canyon-Parashant National Monument. It typically occurs near the edge of canyon rims, and often occurs adjacent to pinyon-juniper or ponderosa pine woodlands. It typically occurs at 1800 to 2000 m (5950-6775 feet) elevation, but can be found as high as 2425 m (7975 feet) on the North Rim. This association favors xeric south- or west-facing exposures on the high-level plateau or upper sideslopes below the rim. It typically occurs on flat ground (1-4 degrees), but can be found on steeper gradients (18 degrees) when occurring on sideslopes. Limestone is a common parent material, and exposed bedrock occurs in most stands; however, overall ground cover varies among stands. Some sites support a high cover of litter, while others support more gravel and bare soil.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 20-25% in this association, and trees are usually absent; however, scattered *Pinus edulis* (3%) or *Juniperus osteosperma* (1%) may sporadically occur in some stands. The shrub *Purshia stansburiana* (10-15%) dominates and characterizes this association, while other components of the shrub and understory strata often vary. The short shrubs *Ephedra viridis* (1%) and *Artemisia tridentata* (2%) are common. Dwarf-shrub cover and composition are somewhat variable; *Gutierrezia sarothrae* (2%) occurs in most stands, while various *Opuntia* species are also common at low to moderate covers. The graminoid understory is typically well-developed; however, stands lacking a graminoid understory are not uncommon. Either *Poa fendleriana* (13%) or *Bouteloua gracilis* (14%) usually dominates this layer, while various other native bunch grasses, such as *Elymus elymoides, Sporobolus cryptandrus, Hesperostipa comata, Bouteloua curtipendula*, and *Aristida arizonica*, can occur at low individual covers. The exotic *Bromus tectorum* (2%) is commonly present. Forbs are typically well-represented (7%) in this association, although again, composition varies among stands. *Sanvitalia abertii* and *Artemisia ludoviciana* commonly occur. Based upon the 5 stands sampled, this association hosts above-average species diversity among Grand Canyon plant communities, with 24 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua gracilis, Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia ludoviciana*, *Artemisia tridentata*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Purshia stansburiana*, *Sanvitalia abertii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic), *Tragopogon dubius* (exotic, Medium/Low)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (16-Oct-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Pinus ponderosa* / *Purshia stansburiana* Woodland (CEGL000854) supports a similar tall-shrub component of *Purshia stansburiana* and a similar overall composition of plant species; however, it also supports a notable, yet sparse *Pinus ponderosa* (5-10%) overstory. It occurs in similar environments. *Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL000782) supports a well-developed woodland canopy (25-45%) of *Pinus edulis* and *Juniperus osteosperma*, as well as a strong component of *Purshia stansburiana*. It occurs in similar environments.
Global Similar Associations:

- *Pinus edulis - Juniperus osteosperma* / *Purshia stansburiana* Woodland (CEGL000782) occurs in similar environments and supports a well-developed woodland canopy of *Pinus edulis* and *Juniperus osteosperma*, as well as a strong component of *Purshia stansburiana*.
- *Pinus ponderosa* / *Purshia stansburiana* Woodland (CEGL000854) occurs in similar environments and supports a similar tall-shrub component; however, it also supports a *Pinus ponderosa* overstory.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, North Rim, and Grand Canyon-Parashant National Monument. It was sampled from near Piute Point on the South Rim; from Obi Point on the North Rim; and from the rim of Twin Point in Grand Canyon-Parashant National Monument.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.03137, GRCA.03204, GRCA.03206, GRCA.04196, GRCA.04227.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

M091. Warm Interior Chaparral
G281. Arizonan Desert Margin Chaparral

Arctostaphylos pungens Shrubland

Pointleaf Manzanita Shrubland
Identifier: CEGL000958

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Arctostaphylos pungens* Shrubland

ELEMENT CONCEPT

Global Summary: This chaparral association has been described from the Virgin Mountains in southern Nevada, Markagunt Plateau in southwestern Utah, the Mogollon Rim in Arizona south to the Animas Mountains in southwestern New Mexico. Sites include dry, gentle to moderate slopes of mountains and plateaus. Substrates are variable and range from rocky, coarse-textured soil to clay loam. The vegetation is characterized by a typically dense, tall-shrub layer dominated by *Arctostaphylos pungens* (50-70% cover) with sparse short-shrub or herbaceous layers. Associated shrubs vary geographically with *Arctostaphylos patula, Amelanchier utahensis, Ceanothus* spp.,

Cercocarpus ledifolius, Ephedra viridis, Garrya flavescens, Mahonia fremontii, Quercus gambelii, Quercus turbinella, or *Robinia neomexicana* present in the northern extant and *Arctostaphylos pringlei, Ceanothus* spp., *Garrya wrightii, Nolina microcarpa, Quercus hypoleucoides, Quercus turbinella*, or scattered *Quercus rugosa* or *Pinus discolor* trees present in the southern extent. The herbaceous layer, if present, consists of sparse cover of grasses or forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This manzanita shrubland association occurs on slopes that drop off the North Rim into the Inner Canyon. It occurs from 1950 to 2175 m (6400-7150 feet) elevation, on xeric, west- or southwest-facing slopes. It typically occurs on midslope talus fields or on moderately steep sideslopes (24-30 degrees), usually in rapidly-drained, loamy, sandstone-derived substrates. Exposed rock commonly dominates the ground cover, with bare soil (10-15% cover), gravel (15-30%), rocks (20%), and bedrock (5-10%). This shrubland or chaparral association occurs in areas with a history of past fire events.

Global Environment: This chaparral association has been described from the Virgin Mountains in southern Nevada, Markagunt Plateau in southwestern Utah, the Mogollon Rim in Arizona south to the Animas Mountains in southwestern New Mexico. Elevation ranges from 980-2470 m (3200-8100 feet). Sites include dry gentle to moderate slopes of mountains and plateaus. Substrates range from coarse textured, gravelly soils with rocks to clay loam. Parent material includes rhyolite, granite, quartzite and sandstone.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 55% in this association, but can reach up to 70% or more in dense stands. *Arctostaphylos pungens* dominates the shrub layer (typically at 40-50% cover), either as a tall or short shrub. Scattered *Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*, and *Garrya flavescens* are common in the tall-shrub stratum, typically at 3-5% cover each. *Arctostaphylos pungens* remains the dominant shrub species in this association; however, the composition and percent cover of associated species can vary considerably from stand to stand. The short-shrub layer is usually ill-defined in this association, but depending upon site conditions, all of the species listed above may be shorter and occupy the short-shrub stratum. The herbaceous layer is quite sparse, and graminoids and forbs account for only 1-2% cover. *Poa fendleriana* is a dominant graminoid, but only at trace covers. Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with only 13 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a dense tall-shrub layer dominated by *Arctostaphylos pungens* with sparse short-shrub and herbaceous layers. Stands in Nevada include associated species such as *Cercocarpus ledifolius, Robinia neomexicana, Garrya flavescens, Ephedra viridis, Quercus turbinella, Amelanchier utahensis, Mahonia fremontii*, and *Ceanothus greggii*. In Utah the shrub layer was open (about 20% cover) with 10% cover of *Arctostaphylos pungens*. *Arctostaphylos patula, Amelanchier utahensis, Quercus gambelii*, and *Ceanothus fendleri* were present in small amounts. *Penstemon caespitosus* and other scattered forbs were present. In Arizona, stands averaged 86% shrub canopy cover and were dominated by *Arctostaphylos pungens* (55%), with 12% cover *Ceanothus* spp., 9% cover *Arctostaphylos pringlei*, and scattered *Quercus turbinella* and other shrub species. In New Mexico stands were less diverse. *Arctostaphylos pungens* canopy cover was 70% with less than 5% tree cover of *Quercus hypoleucoides, Quercus rugosa* and *Pinus discolor*. Other species were sparse and included less than 5% cover of *Nolina microcarpa* and *Garrya wrightii*. Introduced annual species are common in some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Arctostaphylos pungens*
Herb (field)	Dwarf-shurb	*Eriogonum fasciculatum*
Herb (field)	Forb	*Eriogonum alatum*
Herb (field)	Graminoid	*Poa fendleriana*

Global

Stratum	Lifeform	Species
Tree canopy	Broad-leaved deciduous tree	*Amelanchier utahensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Arctostaphylos pungens*, *Garrya flavescens*
Global: *Arctostaphylos pungens*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Garrya flavescens* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Arctostaphylos patula* Shrubland (CEGL002696) occurs on plateaus of the North Rim in forested areas, and occurs within a matrix of *Pinus ponderosa* woodlands. Typically, fires remove overstory tree species and leave *Arctostaphylos patula* in the shrub layer. *Arctostaphylos pungens* Shrubland (CEGL000958), on the other hand, is essentially an Inner Canyon vegetation type and occurs on slopes which drop from the North Rim into the Inner Canyon.
Global Similar Associations:

- *Arctostaphylos patula* Shrubland (CEGL002696) occurs on high plateaus in forested areas within a matrix of *Pinus ponderosa* woodlands. Typically, fires remove overstory tree species and leave Arctostaphylos patula in the shrub layer.
- *Pinus edulis - Juniperus osteosperma / Arctostaphylos pungens* Woodland (CEGL000775)
- *Quercus turbinella - Garrya flavescens - Arctostaphylos pungens* Shrubland (CEGL000977)

Global Related Concepts:

- *Arctostaphylos pungens / Bouteloua curtipendula* PA (Muldavin et al. 1998a) =
- *Arctostaphylos pungens* (Bourgeron and Engelking 1994) =
- *Arctostaphylos pungens* PA (Bourgeron et al. 1993b) =
- *Arctostaphylos pungens* PA (Bourgeron et al. 1995a) =
- Chaparral Community (Armstrong 1969) =
- DRISCOLL FORMATION CODE:III.A.1.d. (Driscoll et al. 1984) >
- Pointleaf Manzanita Association (Carmichael et al. 1978) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Inner Canyon slopes just off of the North Rim. It was sampled from near Swamp Point and Saddle Canyon.
Global Range: This association occurs from the Virgin Mountains in extreme southeastern Nevada and adjacent Utah to the Gray Ranch in extreme southwestern New Mexico. It likely occurs in adjacent Mexico.
Nations: US
States/Provinces: AZ, NM, NV:S4, UT
TNC Ecoregions: 6:C, 17:C, 18:C, 19:C, 21:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 342B:CC, M313A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.02120, GRCA.02221.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Armstrong 1969, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, Bourgeron et al. 1995a, Carmichael et al. 1978, Cogan et al. 2004, Driscoll et al. 1984, Muldavin et al. 1998a, Reid and Hall 2010, Western Ecology Working Group n.d.

Mortonia utahensis Shrubland

Utah Mortonia Shrubland
Identifier: CEGL005153

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Mortonia utahensis* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes and plateaus at 1050 to 1300 m (3450-4175 feet) elevation, but can be found as high as 1550 m (5080 feet). It is primarily found on gentle to moderate gradients (up to 15 degrees) and occurs across all aspects. Soils are well- to rapidly-drained silty or sandy loams that are typically derived from sandstone. Vegetation is characterized by a strong *Mortonia utahensis* component in the short-shrub stratum. Trees are uncommon and tall shrubs are essentially absent; however, *Pinus edulis* and *Juniperus osteosperma* occasionally occur. The short-shrub layer also commonly includes *Yucca baccata*, *Ephedra torreyana*, *Quercus turbinella*, and *Coleogyne ramosissima*. A sparse dwarf-shrub layer exists in which *Gutierrezia sarothrae* regularly occurs. *Opuntia polyacantha*, *Agave utahensis*, and *Thamnosma montana* also occur from time to time. *Pleuraphis jamesii*, *Aristida purpurea*, *Bouteloua eriopoda*, and *Achnatherum speciosum* occasionally occur in the graminoid layer. The composition of the forb understory varies considerably among stands; *Thymophylla acerosa* is the only species that occurs in the majority of them.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This mortonia shrubland association typically occurs on sideslopes and plateaus in the Western Grand Canyon. It usually occurs at 1050 to 1300 m (3450-4175 feet) elevation, but can be found as high as 1550 m (5080 feet). It is primarily found on gentle to moderate gradients (up to 15 degrees) and occurs across all aspects. Soils are well- to rapidly-drained silty or sandy loams that are typically derived from sandstone. Gravel (28%), rocks (22%), sandstone bedrock (20%), and bare soil (15%) are major components of the ground cover, and a relatively high cover of cryptogamic soil crust (6%) occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized by a strong *Mortonia utahensis* (7-10%) component in the short-shrub stratum. Trees are uncommon and tall shrubs are essentially absent; however, *Pinus edulis* (1%) and *Juniperus osteosperma* (1%) occasionally punctuate some stands. Along with *Mortonia utahensis*, the short-shrub layer (13%) also commonly includes *Yucca baccata* (1%), *Ephedra torreyana* (2%), *Quercus turbinella* (2%), and *Coleogyne ramosissima* (1%). A sparse dwarf-shrub layer (3%) exists in which *Gutierrezia sarothrae* (1%) regularly occurs. *Opuntia polyacantha* (up to 1%), *Agave utahensis* (1%), and *Thamnosma montana* (1%) also occur from time to time. *Pleuraphis jamesii* (2%), *Aristida purpurea* (1%), *Bouteloua eriopoda* (3%), and *Achnatherum speciosum* (1%) occasionally occur in the graminoid layer (up to 5%). The composition of the forb understory (2%) varies considerably among stands, and *Thymophylla acerosa* (1%) is the only species that occurs in the majority of them. Based upon the 13 stands sampled, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Mortonia utahensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Aristida purpurea*, *Bouteloua eriopoda*,

Coleogyne ramosissima, *Ephedra torreyana*, *Gutierrezia sarothrae*, *Mortonia utahensis*, *Pleuraphis jamesii*, *Quercus turbinella*, *Thamnosma montana*, *Thymophylla acerosa*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Xanthium strumarium* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: This association is unique within Grand Canyon National Park. No other local community contains significant *Mortonia utahensis* cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon between Tuckup Canyon and Surprise Canyon.

Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (13 plots): GRCA.01644, GRCA.01647, GRCA.02664, GRCA.02667, GRCA.03629, GRCA.04601, GRCA.04603, GRCA.04604, GRCA.04605, GRCA.04607, GRCA.04614, GRCA.04656, GRCA.04659.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Quercus turbinella - (Rhus trilobata, Artemisia tridentata)* Shrubland**

Turbinella Live Oak - (Skunkbush Sumac, Big Sagebrush) Shrubland

Identifier: CEGL005168

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Quercus turbinella - (Rhus trilobata, Artemisia tridentata)* Shrubland

ELEMENT CONCEPT

Global Summary: This scrub oak shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona, and the description is based on occurrences there. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes, plateaus, and in drainages, often in areas with large amounts of exposed bedrock. This association typically occurs from 1050 to 1475 m (3500-4825 feet) elevation, but can occur as high as 1850 m (6050 feet). It is typically found on gentle to moderate gradients (up to 20 degrees), but can sometimes occur on steeper slopes (23-35 degrees), across all aspects, besides those with northern exposures. Soils are well- to rapidly-drained silty or sandy loams. The underlying geology is typically limestone or sandstone. Vegetation is strongly dominated by the short shrub *Quercus turbinella*, which can be very dense (up to 60% cover). Trees are essentially absent; however, *Pinus edulis* and *Juniperus osteosperma* very rarely occur. Tall shrubs are also essentially absent. The short-shrub layer commonly includes *Rhus trilobata* and

Yucca baccata. Other chaparral shrub species, including *Purshia stansburiana, Ceanothus greggii*, and *Bernardia myricifolia*, occur less commonly. *Gutierrezia sarothrae* and *Agave utahensis* are fairly common in the dwarf-shrub layer. *Achnatherum speciosum, Poa fendleriana, Aristida purpurea*, and *Bromus rubens* are the most frequent graminoids, although graminoid composition varies among stands. A variety of species sporadically occur in a very sparse and inconsistent forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This scrub oak shrubland association occurs on sideslopes, plateaus, and in drainages in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument, often in areas with large amounts of exposed bedrock. It typically occurs from 1050 to 1475 m (3500-4825 feet) elevation, but can occur as high as 1850 m (6050 feet). It is typically found on gentle to moderate gradients (up to 20 degrees), but can sometimes occur on steeper slopes (23-35 degrees) as well. This association occurs across all aspects, besides those with northern exposures. Soils are well- to rapidly-drained silty or sandy loams. When unobscured, the underlying geology is typically limestone or sandstone. Gravel (30%), litter (20%), bedrock (18%), rocks (15%), and bare soil (10%) are common components of the ground cover; cryptogamic soil crust (2%) also occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 20-30% in this association which is strongly dominated by the short shrub *Quercus turbinella* (15-20%). In some stands, *Quercus turbinella* can be very dense (up to 60% cover). Woodland trees are essentially absent from this community; however, *Pinus edulis* (2%) and *Juniperus osteosperma* (1%) very rarely punctuate some stands. Tall shrubs are also essentially absent. Along with *Quercus turbinella*, the short-shrub layer (20%) also commonly includes *Rhus trilobata* (2%) and *Yucca baccata* (2%). Other chaparral shrub species, including *Purshia stansburiana, Ceanothus greggii*, and *Bernardia myricifolia*, occur less commonly. *Gutierrezia sarothrae* (4%) and *Agave utahensis* (1%) are fairly common in the dwarf-shrub layer. *Achnatherum speciosum* (2%), *Poa fendleriana* (1%), *Aristida purpurea* (1%), and *Bromus rubens* (1%) are the most frequent graminoids (4%), although graminoid composition varies among stands. A variety of species, including *Comandra umbellata, Heterotheca villosa*, and *Sphaeralcea ambigua* (1%), sporadically occur in a very sparse and inconsistent forb layer. Based upon the 22 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	Gutierrezia sarothrae

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Aristida purpurea*, *Comandra umbellata*, *Gutierrezia sarothrae*, *Heterotheca villosa*, *Poa fendleriana*, *Quercus turbinella*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Amaranthus albus* (exotic), *Bromus racemosus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Marrubium vulgare* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: The name *Quercus turbinella* - (*Rhus trilobata, Artemisia tridentata*) Shrubland can be misleading as it relates to this community in Grand Canyon National Park. The name is used here

within the context of how this association may fit into a larger global vegetation classification. It is important to note that *Rhus trilobata* is not characteristic of this particular community (in fact it is common to almost all of the *Quercus turbinella* types in Grand Canyon National Park), and *Artemisia tridentata* very rarely occurs in this community. *Quercus turbinella - Coleogyne ramosissima* Shrubland (CEGL000982) supports a significant layer of *Coleogyne ramosissima* in the short-shrub stratum. *Quercus turbinella - Ptelea trifoliata - Fraxinus anomala* Mesic Shrubland (CEGL005160) supports the mesic tall shrubs *Ptelea trifoliata* and *Fraxinus anomala* and often occurs in shaded canyon environments. *Quercus turbinella - Juniperus osteosperma* Shrubland (CEGL000981) has a sparse canopy layer *Juniperus osteosperma* (5-15%).

Global Similar Associations:

- *Quercus turbinella - Coleogyne ramosissima* Shrubland (CEGL000982) supports a significant layer of *Coleogyne ramosissima* in the short-shrub stratum.
- *Quercus turbinella - Juniperus osteosperma* Shrubland (CEGL000981) has a sparse canopy layer *Juniperus osteosperma*.
- *Quercus turbinella - Ptelea trifoliata - Fraxinus anomala* Mesic Shrubland (CEGL005160) supports the mesic tall shrubs *Ptelea trifoliata* and *Fraxinus anomala* and often occurs in shaded canyon environments.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled in Kwagunt Valley, near Nankoweap Butte, Ottoman Terrace, Bright Angel Canyon, Haunted Canyon, Hermit Canyon, White Creek/Muav Canyon, Panameta Terrace, and upper Deer Creek; the Western Grand Canyon, where it was sampled in Whitmore Canyon, Horse Spring Canyon, and Twin Creek Canyon; and from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau near Twin Springs Canyon, Twin Point, and Burnt Canyon Point.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (22 plots): GRCA.01596, GRCA.01612, GRCA.02533, GRCA.02534, GRCA.02559, GRCA.02608, GRCA.02610, GRCA.02634, GRCA.02639, GRCA.03539, GRCA.03605, GRCA.03647, GRCA.04079, GRCA.04083, GRCA.04090, GRCA.04118, GRCA.04123, GRCA.04213, GRCA.04580, GRCA.04581, GRCA.04671, GRCA.04679.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Quercus turbinella - Coleogyne ramosissima Shrubland

Turbinella Live Oak - Blackbrush Shrubland
Identifier: CEGL000982

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Quercus turbinella - Coleogyne ramosissima* Shrubland

ELEMENT CONCEPT

Global Summary: This scrub oak shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes and terraces in at 1200 to 1700 m (3925-5500 feet) elevation, and is typically found on gentle slopes (5-8 degrees)

with eastern exposures. Soils are well- to rapidly-drained silty or sandy loams that typically lie above sandstone or limestone. Total shrub cover averages 20-30% and is codominated by the short shrubs *Quercus turbinella* and *Coleogyne ramosissima*. The canopy tree *Pinus edulis* and the subcanopy tree *Juniperus osteosperma* are occasionally found. The short-shrub layer also occasionally includes *Amelanchier utahensis*, *Ephedra fasciculata*, and *Yucca baccata*. *Agave utahensis* is invariably present in a sparse dwarf-shrub stratum. *Aristida purpurea* consistently occurs in an extremely weak graminoid layer. Scattered forbs do exist, but their cover is so low that they hardly constitute a layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This scrub oak shrubland association occurs on sideslopes and terraces in the Inner Canyon. It occurs at 1200 to 1700 m (3925-5500 feet) elevation, and is typically found on gentle slopes (5-8 degrees) with eastern exposures. Soils are well- to rapidly-drained silty or sandy loams that typically lie above sandstone or limestone. Gravel (48%), bedrock (17%), bare soil (14%), litter (11%), and moss (3%) are the major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 20-30% in this association which is codominated by the short shrubs *Quercus turbinella* (6-8%) and *Coleogyne ramosissima* (10-15%). The canopy tree *Pinus edulis* (3%) and the subcanopy tree *Juniperus osteosperma* (1%) occasionally punctuate this shrub-dominated community. Along with *Quercus turbinella* and *Coleogyne ramosissima*, the short-shrub layer (20-25%) also occasionally includes *Amelanchier utahensis* (5%), *Ephedra fasciculata* (2%), and *Yucca baccata* (2%). *Agave utahensis* (1%) is invariably present in a sparse dwarf-shrub stratum. *Aristida purpurea* (trace cover) consistently occurs in an extremely weak graminoid layer. Scattered forbs do exist, but their cover is so low that they hardly constitute a layer. Based upon the 2 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 25 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus edulis*
Tree subcanopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	*Agave utahensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Amelanchier utahensis*, *Aristida purpurea*, *Coleogyne ramosissima*, *Juniperus osteosperma*, *Pinus edulis*, *Quercus turbinella*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: Many associations in Grand Canyon National Park are dominated by *Quercus turbinella*, but this is the only one that has such a significant *Coleogyne ramosissima* component.
Global Comments: Warren et al. (1982) classified these stands as *Quercus turbinella - Gutierrezia sarothrae - Nolina microcarpa - Coleogyne ramosissima* desertscrub.
Global Similar Associations:

- *Coleogyne ramosissima* Shrubland (CEGL001332)
- *Quercus turbinella - (Rhus trilobata, Artemisia tridentata)* Shrubland (CEGL005168)

Global Related Concepts:
- *Quercus turbinella - Gutierrezia sarothrae - Nolina microcarpa - Coleogyne ramosissima* desertscrub (Warren et al. 1982) **?**
- *Quercus turbinella*/Shrubs (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.A.1.d. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from the Huxley Terrace and White Creek (North Bass).
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona likely extending into Utah. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ:S4, UT?
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (2 plots): GRCA.01613, GRCA.02031.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

***Quercus turbinella - Garrya flavescens - Arctostaphylos pungens* Shrubland**

Turbinella Live Oak - Ashy Silktassel - Pointleaf Manzanita Shrubland
Identifier: CEGL000977

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Quercus turbinella - Garrya flavescens - Arctostaphylos pungens* Shrubland

ELEMENT CONCEPT

Global Summary: This scrub oak shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs from approximately 2100 to 2450 m (6950-8100 feet) elevation, typically on very steep (30-40 degrees), mid and upper sideslopes. This association strongly favors southern exposures. Soils are rapidly-drained sandy loams derived from various geologic parent materials. This vegetation type often forms large expanses across these environments. This association is characteristically dense and typically supports 60-80% shrub cover. Rich and varied assemblages of chaparral shrub species dominate this association, and the particular composition of species varies somewhat among stands. Dominant shrub species can exist as either tall or short shrubs depending upon site conditions. One major manifestation of this association occurs when *Quercus gambelii, Amelanchier utahensis*, and *Garrya flavescens* codominate the thick shrub layer. Another major phase can be seen when *Quercus turbinella* and *Arctostaphylos pungens* codominate the short-shrub stratum, and the other shrub species mentioned occur as associates. The full continuum of variation can be seen in many stands. *Robinia neomexicana* and *Cercocarpus montanus* occasionally add to the diversity of the tall-shrub stratum. *Symphoricarpos* spp. sometimes occurs along the ground; however, due to the preponderance of the taller layers, dwarf-shrubs are otherwise absent from this community. Overall, the understory is poorly-developed, but patches of *Poa fendleriana* occur in most stands. A variety of different species, including *Penstemon linarioides, Hymenopappus filifolius, Comandra umbellata, Arabis* spp., *Packera multilobata*,

Castilleja linariifolia, and *Penstemon rostriflorus*, can occur.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This scrub oak shrubland association predominantly occurs in the Inner Canyon on slopes that plummet from the North Rim; however, it also occasionally occurs on the plateau of the North Rim, directly adjacent to the rim. It occurs from approximately 2100 to 2450 m (6950-8100 feet) elevation, typically on very steep (30-40 degrees), mid and upper sideslopes. This association strongly favors southern exposures. Soils are rapidly-drained sandy loams derived from various geologic parent materials. A thick litter layer (60%), as well as some exposed soil (6%), rocks (8%), and gravel (13%) dominate ground cover. This vegetation type often forms large expanses across these environments.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characteristically dense and typically supports 60-80% shrub cover. Rich and varied assemblages of chaparral shrub species dominate this association, and the particular composition of species varies somewhat among stands. *Quercus turbinella* codominates with *Arctostaphylos pungens* and/or *Garrya flavescens* and may exist as either tall or short shrubs depending upon site conditions. Other short- and tall-shrub associates include *Rhus trilobata*, *Fraxinus anomala*, *Amelanchier utahensis*, *Purshia stansburiana*, and *Ephedra viridis*. Dwarf-shrubs are otherwise absent from this community. Overall, the understory is poorly-developed, but patches of *Poa fendleriana* occur in most stands, while total forb cover averages just 1-2%. A variety of different species, including *Penstemon linarioides, Cordylanthus parviflorus, Achnatherum speciosum, Tragia ramosa, Lathyrus brachycalyx, Leptodactylon pungens (= Linanthus pungens)*, and *Comandra umbellata*, can occur.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Amelanchier utahensis, Quercus gambelii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Arctostaphylos pungens, Garrya flavescens*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amelanchier utahensis*, *Arctostaphylos pungens*, *Garrya flavescens*, *Poa fendleriana*, *Quercus gambelii*, *Quercus turbinella*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Garrya flavescens* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This association is similar to several other mountain-brush or chaparral communities in the park, but can be distinguished by the notable *Garrya flavescens* component in the shrub strata. In some stands, *Garrya flavescens* has lower cover, but in these cases, the codominance of *Quercus* spp., *Amelanchier utahensis*, and *Arctostaphylos pungens* is representative of this association.
Global Similar Associations:
- *Arctostaphylos pungens* Shrubland (CEGL000958)

Global Related Concepts:
- *Quercus turbinella - Arctostaphylos pungens* Association (Warren et al. 1982) =
- *Quercus turbinella-Arctostaphylos* spp. (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.A.1.d. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from both the North Rim and the Inner Canyon. It was sampled on the North Rim from near Uncle Jim Point and on the Powell Plateau, and in the Inner Canyon from the head of Roaring Springs Canyon, and near the Muav Saddle.
Global Range: This association is currently described from Grand Canyon National Park in Arizona. It is also reported from Utah. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ:S4, UT
TNC Ecoregions: 18:C, 19:C, 22:C
USFS Ecoregions (1994/95): 313A:CC, 313C:CC, 322:?, M341C:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02090, GRCA.02110, GRCA.02119.
Local Description Authors: K. Christie, mod. M.E. Hall
Global Description Authors: K. Christie
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Kemp 1965, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

Quercus turbinella - Juniperus osteosperma Shrubland

Turbinella Live Oak - Utah Juniper Shrubland
Identifier: CEGL000981

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Quercus turbinella - Juniperus osteosperma* Shrubland

ELEMENT CONCEPT

Global Summary: This scrub oak shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from Nevada and Wyoming and possibly Utah. More survey and classification work are needed to fully characterize this type. It typically occurs on moderate to steep (15-40 degrees) mid and upper sideslopes at 1075 to 1825 m (3475-6025 feet) elevation, across all aspects. Soils are rapidly-drained sandy or silty loams derived from sandstone or limestone. This predominantly shrub-dominated community supports an open and scattered tree layer. *Juniperus osteosperma* dominates and characterizes this stratum but typically assumes a stunted and shrublike physiognomy. Other tall shrubs are essentially absent. Along with *Juniperus osteosperma*, the short shrub *Quercus turbinella* codominates this association. *Rhus trilobata*, *Yucca baccata*, and *Ephedra fasciculata* also frequently occur in the short-shrub layer, while up to 25 different species can sporadically occur here. *Gutierrezia sarothrae* and occasionally *Thamnosma montana* occur in the dwarf-shrub layer. Graminoid cover is relatively sparse; *Achnatherum speciosum* occurs in most stands, while *Aristida purpurea* and *Poa fendleriana* sometimes occur as well. Forb composition varies considerably among stands, and approximately 60 different species can occur in the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This scrub oak association typically occurs on moderate to steep (15-40 degrees) mid and upper sideslopes in the Western Grand Canyon, Inner Canyon, and Grand Canyon-Parashant National Monument. It occurs at 1075 to 1825 m (3475-6025 feet) elevation, across all aspects. Soils are rapidly-drained sandy or silty loams derived from sandstone or limestone. Rocks (33%), gravel (32%), litter (13%), and bare soil (10%) are the major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This predominantly shrub-dominated community supports an

open and scattered tree layer (6-8%); however, some denser stands may support up to 20% tree cover. *Juniperus osteosperma* (3-7%) dominates and characterizes this stratum but typically assumes a stunted and shrublike physiognomy. Other tall shrubs are essentially absent. Along with *Juniperus osteosperma*, the short shrub *Quercus turbinella* (7%, up to 20% in denser stands) codominates this association. *Rhus trilobata* (2%), *Yucca baccata* (1%), and *Ephedra fasciculata* (2%) also frequently occur in the short-shrub layer (18%), while up to 25 different species can sporadically occur here. *Gutierrezia sarothrae* (2%) and occasionally *Thamnosma montana* (1%) occur in the dwarf-shrub layer (3%). Graminoid cover is relatively sparse (3%); *Achnatherum speciosum* (1%) occurs in most stands, while *Aristida purpurea* (1%) and *Poa fendleriana* (1%) sometimes occur as well. Forb composition varies considerably among stands, and approximately 60 different species can occur in the forb understory (2%). Based upon the 14 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 22 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Needle-leaved shrub	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Achnatherum speciosum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Ephedra fasciculata*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Quercus turbinella*, *Rhus trilobata*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (19-Sep-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: This association can be distinguished from other *Quercus turbinella* vegetation types by the relatively high cover of *Juniperus osteosperma*, which does not codominate any of the other *Quercus turbinella* vegetation types.
Global Similar Associations:

- *Quercus turbinella - (Rhus trilobata, Artemisia tridentata)* Shrubland (CEGL005168)

Global Related Concepts:

- *Quercus turbinella/Juniperus osteosperma* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.A.1.d. (Driscoll et al. 1984) **>**
- Evergreen Broad-Sclerophyll Shrub Formation at 4300-4800 feet. (Wells 1960) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from north of Freya Castle and Manzanita Creek; from Grand Canyon-Parashant National Monument, where it was sampled from Twin Point; and from the Western Grand Canyon, where it was sampled near Toroweap Point, near 220-Mile Canyon, Twin Creek Canyon, Twin Springs Canyon, Green Springs Canyon, and Horse Springs Canyon.
Global Range: This association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from Nevada and Wyoming and possibly Utah. More survey work is needed to fully document its global range.
Nations: US

States/Provinces: AZ, NV, UT?, WY
TNC Ecoregions: 11:C, 17:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (14 plots): GRCA.01626, GRCA.01629, GRCA.01632, GRCA.01634, GRCA.02590, GRCA.02596, GRCA.02604, GRCA.02633, GRCA.02635, GRCA.02636, GRCA.02640, GRCA.04070, GRCA.04214, GRCA.04568.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, WNDD unpubl. data, Wells 1960, Western Ecology Working Group n.d.

Quercus turbinella - Ptelea trifoliata - Fraxinus anomala Mesic Shrubland

Turbinella Live Oak - Common Hoptree - Singleleaf Ash Mesic Shrubland
Identifier: CEGL005160

USNVC CLASSIFICATION

Division	Western North American Interior Sclerophyllous Chaparral Shrubland (2.B.2.Nd)
Macrogroup	Warm Interior Chaparral (M091)
Group	Arizonan Desert Margin Chaparral (G281)
Association	*Quercus turbinella - Ptelea trifoliata - Fraxinus anomala* Mesic Shrubland

ELEMENT CONCEPT

Global Summary: This scrub oak shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes and in drainages at 975 to 1350 m (3200-3950 feet) elevation, but can occur as high as 1600 m (5300 feet). It favors moderately steep gradients (23-35 degrees) on northern aspects, but can also occur on much gentler slopes (4-6 degrees). Soils are well- to rapidly-drained silty loams or loamy sands. The underlying geology is typically limestone or sandstone. Vegetation is codominated by three different shrub species: the tall shrub *Ptelea trifoliata*, the tall shrub *Fraxinus anomala*, and the short shrub *Quercus turbinella*. The canopy trees *Pinus edulis* and *Juniperus osteosperma* occasionally occur. The short-shrub stratum also commonly includes *Rhus trilobata, Ephedra fasciculata*, and *Ceanothus greggii*. *Agave utahensis* and *Gutierrezia sarothrae* occur from time to time in a very sparse dwarf-shrub layer. *Poa fendleriana*, *Bromus rubens*, and *Achnatherum speciosum* occasionally occur in the very sparse graminoid layer. *Artemisia ludoviciana* is the only species which regularly occurs in the fairly weak forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This scrub oak shrubland association occurs on sideslopes and in drainages in the Inner Canyon. It typically occurs at 975 to 1350 m (3200-3950 feet) elevation, but can occur as high as 1600 m (5300 feet). It favors moderately steep gradients (23-35 degrees) on northern aspects, but can also occur on much gentler slopes (4-6 degrees). Soils are well- to rapidly-drained silty loams or loamy sands. When unobscured, the underlying geology is typically limestone or sandstone. Rocks (43%), litter (22%), and gravel (19%) are the major components of the ground cover, while moss (2%) also occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 30-40% in this association which is codominated by three different shrub species: the tall shrub *Ptelea trifoliata* (5-10%), the tall shrub *Fraxinus anomala* (5-8%), and the short shrub *Quercus turbinella* (15-25%). The canopy trees *Pinus edulis* (2%) and *Juniperus osteosperma* (1%) occasionally punctuate this shrub-dominated community. Along with *Quercus turbinella*, the short-shrub stratum (25%) also commonly includes *Rhus trilobata* (2%), *Ephedra fasciculata* (1%), and *Ceanothus greggii* (2%). *Agave utahensis* (1%) and *Gutierrezia sarothrae* (1%) occur from time to time in a very sparse dwarf-shrub layer. *Poa fendleriana* (2%), *Bromus rubens* (1%), and *Achnatherum speciosum* (up to 1%) occasionally occur in the graminoid layer (4%). *Artemisia ludoviciana* (1%) is the only species which regularly occurs in the fairly

weak forb understory (2%). Based upon the 9 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Fraxinus anomala, Ptelea trifoliata*
Short shrub/sapling	Broad-leaved evergreen shrub	*Quercus turbinella*
Herb (field)	Dwarf-shurb	*Agave utahensis, Gutierrezia sarothrae*
Herb (field)	Forb	*Artemisia ludoviciana*
Herb (field)	Graminoid	*Poa fendleriana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Artemisia ludoviciana*, *Ceanothus greggii*, *Fraxinus anomala*, *Gutierrezia sarothrae*, *Poa fendleriana*, *Ptelea trifoliata*, *Quercus turbinella*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: Many associations in Grand Canyon National Park are dominated by *Quercus turbinella*, but this is the only *Quercus turbinella* community that has significant *Ptelea trifoliata* and *Fraxinus anomala* cover.

Global Similar Associations:

- *Quercus turbinella - (Rhus trilobata, Artemisia tridentata)* Shrubland (CEGL005168)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon where it was sampled in upper Phantom Creek, Bass Canyon, Muav Canyon/White Creek, Crystal Canyon, Serpentine Canyon, Matkatamiba Canyon, and Matkatamiba Terrace.

Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.01112, GRCA.01561, GRCA.01601, GRCA.01621, GRCA.01622, GRCA.02030, GRCA.02550, GRCA.02630, GRCA.03564.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Reid and Hall 2010, Western Ecology Working Group n.d.

2.B.2.Ne. Southeastern North American Grassland & Shrubland

M307. Southeastern Ruderal Grassland & Shrubland

G583. Southeastern Old Field

Cynodon dactylon Herbaceous Vegetation

Bermuda Grass Herbaceous Vegetation
Bermuda Grass Semi-natural Pasture
Identifier: CEGL004701

USNVC CLASSIFICATION

Division	Southeastern North American Grassland & Shrubland (2.B.2.Ne)
Macrogroup	Southeastern Ruderal Grassland & Shrubland (M307)
Group	Southeastern Old Field (G583)
Association	*Cynodon dactylon* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This association is comprised of improved pastures dominated by *Cynodon dactylon*, with varying degrees of native composition remaining, on a wide variety of soils and sites. It is currently reported from Arizona, Florida, Georgia, Oklahoma, and possibly other states, primarily in the southeastern Coastal Plain, but also in other ecoregions. Vegetation is dominated by the introduced grass *Cynodon dactylon*, with various remnant native species. Although originally planted, *Cynodon dactylon* maintains itself spontaneously and is considered weedy or "semi-natural" as opposed to cultivated. Examples from Florida may include the native species *Eupatorium capillifolium, Helianthemum carolinianum, Heterotheca subaxillaris, Lechea sessiliflora, Nuttallanthus canadensis, Oenothera laciniata*, and *Solidago odora var. chapmanii*, among others. In addition, *Juniperus virginiana var. silicicola, Prunus serotina, Quercus hemisphaerica*, and *Quercus virginiana*, may be present as a sparse tree layer, and a very sparse shrub layer may that include *Baccharis halimifolia, Ilex vomitoria, Persea borbonia, Prunus angustifolia, Rubus trivialis, Sabal palmetto*, and *Sideroxylon tenax*. Vines may include *Smilax auriculata* and *Vitis rotundifolia*. Stands in Oklahoma may contain *Ambrosia artemisiifolia, Amphiachyris dracunculoides*, and *Melilotus albus*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs in the Inner Canyon and Western Grand Canyon, primarily along the banks of the Colorado River. It mostly occurs in sand, often wet sand, near the river's edge, and often occurs in small openings among various riparian shrublands.
Global Environment: This vegetation is weedy or "semi-natural" and is found in pastures, where it maintains itself spontaneously, aided by grazing or mowing.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous vegetation type is characterized by thick, often carpetlike swathes of the non-native grass *Cynodon dactylon* (65%). Scattered shrubs (7%) often occur intermixed, or around the periphery, of these dense patches of grass. The tall shrub *Tamarix ramosissima* (4%) and the short shrub *Baccharis sarothroides* (4%) are fairly common associates. Other shrub species such as *Pluchea sericea, Baccharis emoryi, Baccharis salicifolia*, and *Salix exigua* are less common and may occur at 1-2% cover each in some stands. Perhaps due to the dense graminoid growth, forb cover is typically quite low (1%). *Sonchus asper* (1%) occasionally occurs; however, forb composition is quite variable among stands. *Equisetum X ferrissii* (5%) occurs in the majority of stands and inhabits the immediate river shoreline.
Global Vegetation: Vegetation is dominated by the introduced grass *Cynodon dactylon*, with various remnant native species. Although originally planted, *Cynodon dactylon* maintains itself spontaneously and is considered weedy or "semi-natural" as opposed to cultivated. Examples from Florida may include the native species *Eupatorium capillifolium, Helianthemum carolinianum, Heterotheca subaxillaris, Lechea sessiliflora, Nuttallanthus canadensis, Oenothera laciniata*, and *Solidago odora var. chapmanii*, among others. In addition, *Juniperus virginiana var. silicicola, Prunus serotina, Quercus hemisphaerica*, and *Quercus virginiana*, may be present as a sparse tree layer, and a very sparse shrub layer may that include *Baccharis halimifolia, Ilex vomitoria, Persea borbonia, Prunus angustifolia, Rubus trivialis, Sabal palmetto*, and *Sideroxylon tenax*. Vines may include *Smilax auriculata* and *Vitis rotundifolia*. Stands in Oklahoma may contain *Ambrosia artemisiifolia, Amphiachyris dracunculoides*, and *Melilotus albus* (Hoagland 2000).

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Herb (field)	Graminoid	*Cynodon dactylon*
Herb (field)	Fern or fern ally	*Equisetum x ferrissii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis sarothroides*, *Cynodon dactylon*, *Equisetum* x *ferrissii*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Sonchus asper* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (8-Aug-2000). This vegetation is weedy and "semi-natural," as opposed to cultivated; stands are dominated by the introduced grass *Cynodon dactylon*, with various remnant native species.

CLASSIFICATION

Status: Standard

Classification Confidence: 1 - Strong

Global Comments: *Cynodon dactylon* was introduced to North America from Africa in the late nineteenth century (Hoagland 2000). This type is reported from "central and western Oklahoma" by Hoagland (2000). At Fort Benning, Georgia, *Cynodon dactylon* is planted in agricultural outlease fields at Lawson Army Airfield, in cantonment areas, and for soil conservation projects (a non seed-producing hybrid, Tifton 44, is planted at the airfield).

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from various locations in the Inner Canyon and Western Grand Canyon, immediately along the Colorado River corridor.
Global Range: This type is reported from Florida, Georgia, and "central and western Oklahoma" (Hoagland 2000). It is probable across the southeastern United States Coastal Plain.
Nations: US
States/Provinces: AZ, FL, GA, OK, TX?
TNC Ecoregions: 19:C, 32:C, 33:C, 43:C, 53:C, 55:C, 56:C
USFS Ecoregions (1994/95): 231Bd:CCC, 232B:CC, 232Ce:CCC, 232D:CC, 232G:CC, 255A:CC, 311A:CC, 313A:CC
Federal Lands: DOD (Fort Benning, Fort Hood?); NPS (Grand Canyon, Lyndon B. Johnson, San Antonio Missions, Timucuan, Tuzigoot)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based nine (9) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: A.S. Weakley, mod. B. Hoagland and M.J. Russo
References: Barclay 1978, Cogan 2007c, Cogan 2007d, Heath et al. 1973, Hoagland 2000, Kelting 1948, Kelting and Penfound 1950, McDonald 1938, Penfound 1953, Petranka and Holland 1980, Reid and Hall 2010, Southeastern Ecology Working Group n.d., TNC 1995e

2.B.6. Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland
2.B.6.Nb. Western North American Freshwater Shrubland, Wet Meadow & Marsh

M075. Western North American Montane & Subalpine Wet Shrubland & Wet Meadow
G521. Vancouverian & Rocky Mountain Montane Wet Meadow

Juncus balticus Herbaceous Vegetation

Baltic Rush Herbaceous Vegetation
Baltic Rush Wet Meadow
Identifier: CEGL001838

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Montane & Subalpine Wet Shrubland & Wet Meadow (M075)
Group	Vancouverian & Rocky Mountain Montane Wet Meadow (G521)
Association	*Juncus balticus* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This Baltic rush community is found widely throughout the western United States and into western Canada. This herbaceous wet meadow occurs as small to extensive, open to typically dense patches on flat stream benches, along overflow channels, and near springs. Habitats are often alkaline meadows and may have long-term grazing disturbance. Soils are variable and range from poorly to well-drained, sandy clay loam to fine sand-textured and are usually mottled or gleyed. Stands are characterized by dense swards of *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis*, or *Carex utriculata*, is often present; other common species include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Phleum alpinum*, and *Sporobolus airoides*. The introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera* codominate some stands. Forb cover is generally low and includes wetland species such as *Caltha leptosepala, Rumex aquaticus*, and *Dodecatheon pulchellum*. *Iris missouriensis* can be common in heavily grazed stands. Shrubs are not common. This association is often considered to be a grazing-induced community since it increases with disturbance, though it can be a stable late-seral community.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs throughout Grand Canyon National Park along the Colorado River corridor. It occurs at approximately 375 to 950 m (1200-3100 feet) elevation, immediately along the riverbank, on sandbars, and in other riparian habitats. It can also be expected in larger perennially wet tributaries.

Global Environment: This broadly defined and widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 138 to 3500 m (454-11,475 feet). Far northern stands in the Boreal Plains are at about 800 m (2625 feet). Stands usually occur as small, dense patches on flat to gently sloping sites near seeps and streams. Stream channels are highly variable in size and type, ranging from narrow to moderately wide, and from deeply entrenched to very sinuous (Kittel et al. 1999b). In the boreal regions, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy well-drained to poorly drained silty clay loam or silty clay alluvium to organic muck; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). Sites with sandy soils are usually saturated for part of the growing season or have high water tables. Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999b).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous association typically occurs immediately adjacent to riparian shrublands, and scattered shrubs sometimes punctuate stands. *Salix exigua* (2%) is common, while *Baccharis salicifolia* and the somewhat more upland *Chloracantha spinosa* infrequently occur at low individual covers (1%). *Juncus balticus* (20-40%) dominates and characterizes this association. Other graminoids, including *Lolium arundinaceum* (up to 15%), *Elymus canadensis* (3%), *Juncus articulatus* (1%), and *Carex aquatilis* (1%), occur in some stands. *Conyza canadensis* (3%), *Artemisia ludoviciana* (1%), and *Plantago major* (1%) are frequent components of the sparse (1-3%) and variable forb layer. The fern ally *Equisetum x ferrissii* (1%) occasionally occurs as well.

Global Vegetation: This broadly defined association is characterized by a low (<50 cm), open to typically dense

graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. In montane zones and the Great Basin, minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex microptera, Carex nebrascensis*, or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum brachyantherum, Hordeum jubatum, Muhlenbergia andina, Muhlenbergia asperifolia, Pascopyrum smithii, Poa nemoralis ssp. interior, Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Achillea millefolium, Artemisia ludoviciana, Caltha leptosepala, Cirsium scariosum (= Cirsium tioganum), Dodecatheon pulchellum, Glaux maritima, Iris missouriensis, Maianthemum stellatum, Rumex aquaticus, Polygonum bistortoides, Potentilla plattensis*, and *Solidago canadensis*. Many other forb species may be present, given the wide elevational amplitude and broad geographic spread of this type. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia cana, Artemisia tridentata ssp. tridentata, Dasiphora fruticosa ssp. floribunda, Ericameria nauseosa, Populus* spp., *Rosa woodsii, Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis, Bromus inermis*, or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense, Cirsium vulgare, Erodium cicutarium, Iva axillaris, Lactuca serriola, Phleum pratense, Taraxacum officinale, Thinopyrum intermedium, Trifolium* spp., *Tragopogon dubius, Xanthium strumarium*, and others, may occur in disturbed stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Juncus balticus*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Juncus balticus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Juncus balticus*, *Salix exigua*
Global: *Juncus balticus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Lolium arundinaceum* (exotic, High/Medium), *Plantago major* (exotic), *Polypogon monspeliensis* (exotic, High/Low), *Sonchus asper* (exotic)
Global: Invasive/Exotic: *Agrostis stolonifera* (invasive, Medium/Low), *Bromus inermis* (invasive/exotic, High/Medium), *Cirsium arvense* (invasive/exotic, High/Medium), *Cirsium vulgare* (invasive/exotic, Medium/Low), *Erodium cicutarium* (invasive/exotic, Medium/Low), *Iva axillaris* (invasive), *Lactuca serriola* (invasive/exotic, Low/Insignificant), *Phleum pratense* (invasive/exotic, Medium), *Poa pratensis* (invasive, Medium), *Taraxacum officinale* (invasive/exotic), *Thinopyrum intermedium* (invasive/exotic, Medium/Insignificant), *Tragopogon dubius* (invasive/exotic, Medium/Low), *Xanthium strumarium* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This association is often considered to be a grazing-induced community since it increases with grazing disturbance. Based on the extensive geographic and environmental range (from alpine meadows to sagebrush-dominated landscapes), it verges on astonishing that any number of *Juncus balticus* associations have not been recognized.
Global Similar Associations:

- *Eleocharis palustris - Juncus balticus* Herbaceous Vegetation (CEGL001835)

- *Juncus balticus - (Juncus mexicanus)* Herbaceous Vegetation (CEGL003486)

Global Related Concepts:
- *Juncus arcticus* / *Carex* spp. Plant Association (Johnston 1987) =
- *Juncus balticus* / *Carex* spp. Habitat Subtype (Olson and Gerhart 1982) =
- *Juncus balticus* / *Carex* spp. Habitat Type (Wasser and Hess 1982) ?
- *Juncus balticus* (Crowe and Clausnitzer 1997) =
- *Juncus balticus* (Bourgeron and Engelking 1994) =
- *Juncus balticus* (Murray 2000) =
- *Juncus balticus* (McCain and Christy 2005) =
- *Juncus balticus* Association (Klein et al. 2007) =
- *Juncus balticus* Association (Christy 2004) =
- *Juncus balticus* Association (Crowe et al. 2004) =
- *Juncus balticus* Community Type (Hall and Hansen 1997) =
- *Juncus balticus* Community Type (Padgett et al. 1989) =
- *Juncus balticus* Community Type (Tuhy and Jensen 1982) ?
- *Juncus balticus* Community Type (Thompson and Hansen 2002) =
- *Juncus balticus* Community Type (Youngblood et al. 1985a) =
- *Juncus balticus* Community Type (Hansen et al. 1995) =
- *Juncus balticus* Plant Association (Jankovsky-Jones et al. 2001) =
- *Juncus balticus* Vegetation Type (Mutz and Graham 1982) =
- *Juncus balticus* Wetland Plant Association (Baker 1984a) =
- *Juncus balticus* community type (Kunze 1994) =
- *Juncus balticus* dominated (Zone 3) (Shupe et al. 1986) =
- *Juncus balticus* var. *montanus* Herbaceous Vegetation (Carsey et al. 2003b) =
- *Juncus balticus* var. *montanus* (Kittel et al. 1999b) =
- *Juncus balticus* var. *montanus* Herbaceous Vegetation (Carsey et al. 2003a) =
- Baltic Rush (*Juncus balticus)* Dominance Type (Jones and Walford 1995) =
- Baltic rush community type (Kovalchik 1987) =
- DRISCOLL FORMATION CODE: V.C.6.a. (Driscoll et al. 1984) >
- Mountain rush (*Juncus balticus* var. *montanus*) Plant Association (Kittel et al. 1999a) =
- Palustrine (Cowardin et al. 1979) >
- Saline Meadow (Brotherson and Barnes 1984) =
- Wiregrass (*Juncus balticus*) Plant Association (Kittel et al. 1997a) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and Western Grand Canyon, where it was sampled from along the Colorado River corridor. It can also be expected in larger perennially wet tributaries.

Global Range: This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Nebraska west to Washington, south to California, and east to New Mexico. It also occurs in western Canada.

Nations: CA, US

States/Provinces: AB, AZ, BC:S3, CA, CO:S5, ID:S5, MT:S5, NE:S2?, NM:S4, NV, OR:S5, SD, UT:S3S4, WA:S3S4, WY:S3

TNC Ecoregions: 1:C, 2:C, 4:C, 5:C, 6:C, 7:C, 8:C, 9:C, 10:C, 11:C, 12:C, 15:C, 17:C, 18:C, 19:C, 20:C, 25:C, 26:C, 27:C, 33:P, 68:C

USFS Ecoregions (1994/95): 242A:CC, 313A:CC, 331D:CC, 331F:CC, 331G:CC, 331H:CC, 331I:CC, 332C:CP, 341B:CC, 341C:CC, 342A:CC, 342B:CC, 342C:CC, 342D:CC, 342E:CC, 342F:CC, 342G:CC, 342I:C?, M261F:CC, M261G:CC, M262A:CC, M313B:CC, M331A:CC, M331B:CC, M331D:CC, M331E:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M332A:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M332F:CC, M332G:CC, M333A:CC, M333B:CC, M333C:CC, M333D:CC, M334A:CC, M341B:CC, M341C:CC

Federal Lands: NPS (Agate Fossil Beds, Bandelier, Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Colorado, Craters of the Moon, Curecanti, Dinosaur, Florissant Fossil Beds, Fossil Butte, Glacier, Grand Canyon, Grand Teton, Great Basin, Great Sand Dunes, Mesa Verde, Pinnacles, Rocky Mountain, Zion); USFS

(Arapaho-Roosevelt, Black Hills, Deschutes?, Fremont, Gunnison, Malheur, Ochoco, Pike-San Isabel, Rio Grande, Routt, San Juan, Umatilla, Uncompahgre, Valles Caldera, Wallowa-Whitman, Winema?); USFWS (Bosque del Apache, Lacreek, Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on two (2) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: J. Drake, mod. D. Faber-Langendoen, K.A. Schulz, L. Allen, G. Kittel
References: ANHIC n.d., Baker 1984a, Bell et al. 2009, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, Butler et al. 2002, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Carsey et al. 2003b, Christy 2004, Cogan et al. 2004, Cogan et al. 2005, Coles et al. 2008a, Coles et al. 2010, Cowardin et al. 1979, Crowe and Clausnitzer 1997, Crowe et al. 2004, Donnelly et al. 2006, Driscoll et al. 1984, Evans 1989b, Evenden 1990, Faber-Langendoen 2001, Flowers 1962, Friesen et al. 2010, Hall and Hansen 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hess 1981, Hop et al. 2007, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992b, Jones and Walford 1995, Kagan et al. 2004, Kartesz 1994a, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Kittel et al. 2009, Klein et al. 2007, Komarkova 1986, Kovalchik 1987, Kunze 1994, MTNHP 2002b, Manning 1988, Manning and Padgett 1991, Manning and Padgett 1992, McCain and Christy 2005, Muldavin et al. 2000a, Muldavin et al. 2003, Muldavin et al. 2006, Muldavin et al. 2011b, Murray 2000, Mutel 1973, Mutz and Graham 1982, NMNHP unpubl. data, Olson and Gerhart 1982, Owns et al. 2004, Padgett 1981, Padgett 1982, Padgett et al. 1989, Peterson 2008, Rector 1979, Reid and Hall 2010, Reid et al. 2004, Richard et al. 1996, Rolfsmeier and Steinauer 2010, Salas et al. 2005, Salas et al. 2010b, Schulz and Hall 2011, Shupe et al. 1986, Stewart 1940, TNC 1998d, Taylor 1980, Taylor and Teare 1979a, Tendick et al. 2010, Tendick et al. 2011b, Thomas et al. 2009b, Thompson and Hansen 2002, Titus and Christy 1996a, Tuhy and Jensen 1982, Volland 1976, Von Loh et al. 2002, Von Loh et al. 2007, WNHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a

Carex aquatilis Herbaceous Vegetation

Water Sedge Herbaceous Vegetation
Identifier: CEGL001802

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Montane & Subalpine Wet Shrubland & Wet Meadow (M075)
Group	Vancouverian & Rocky Mountain Montane Wet Meadow (G521)
Association	*Carex aquatilis* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This common, widespread herbaceous vegetation occurs as large, mesic meadows in high montane valleys or as narrow strips bordering ponds and streams at lower elevations throughout the western U.S. It occurs in a variety of environmental settings in the montane and subalpine zones. Some of the largest expanses occur in broad, low-gradient valleys where large snowmelt-fed swales and slopes dominate the landscape. It can also grow in fine sediments at the margins of lakes and beaver ponds. Presence of *Carex aquatilis* typically indicates wet soils with high organic matter or histic epipedons. This plant association is characterized by a dense rhizomatous meadow of *Carex aquatilis* (10-80% cover), usually accompanied by a few other graminoids species such as *Calamagrostis canadensis*, *Deschampsia caespitosa*, *Juncus balticus*, and *Poa palustris*. *Eleocharis quinqueflora* can be abundant on organic substrates at high elevations. Woody species rarely occur in these sites. A clear dominance by *Carex aquatilis* and low cover of *Carex utriculata* or *Pedicularis groenlandica* set this plant association apart from closely related types.

ENVIRONMENTAL DESCRIPTION

Global Environment: This plant association occurs in a variety of valley types, but the largest expanses occur in broad, low-gradient valleys where large snowmelt-fed swales and slopes dominate the landscape. It can also grow in fine sediments at the margins of lakes and beaver ponds. These palustrine wetlands have a range of hydrologic

regimes, though all stands are saturated for a significant enough period during the growing season to cause a build up of organic material in the soil. Soils are organic mucks and peats and are poorly to very poorly drained.

VEGETATION DESCRIPTION

Global Vegetation: This plant association is characterized by a dense rhizomatous meadow of *Carex aquatilis* (10-80% cover), usually accompanied by a few other graminoids species such as *Calamagrostis canadensis* (1-40%) or *Deschampsia caespitosa* (1-16%), *Juncus balticus*, and *Poa palustris*. *Eleocharis quinqueflora* can be abundant on organic substrates (1-49% cover) at high elevations. *Carex utriculata* (1-20% cover) may be present. When present, *Carex utriculata* is usually not more than one-third the cover of *Carex aquatilis* cover. If it is more than that, the stand may be classified as *Carex aquatilis - Carex utriculata* Herbaceous Vegetation (CEGL001803) or *Carex utriculata* Herbaceous Vegetation (CEGL001562). Forbs are often present, although sometimes inconspicuous (generally <10%, but can be as high as 40%). Species include *Epilobium* spp., *Pedicularis groenlandica, Caltha leptosepala, Menyanthes trifoliata, Cardamine cordifolia*, and *Mertensia ciliata*. Shrubs and trees have been observed invading the wetland from surrounding areas, including *Betula nana, Salix maccalliana*, and *Picea engelmannii*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex aquatilis*

CHARACTERISTIC SPECIES

Global: *Carex aquatilis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Salix arizonica* (G2G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This association (CEGL001802) is distinguished from *Carex aquatilis - Carex utriculata* Herbaceous Vegetation (CEGL001803) and *Carex aquatilis - Pedicularis groenlandica* Herbaceous Vegetation (CEGL001804) by the dominance of *Carex aquatilis*. If *Carex utriculata* is present, it is no more than one-third of the total cover.
Global Similar Associations:
- *Carex aquatilis - Carex utriculata* Herbaceous Vegetation (CEGL001803)
- *Carex aquatilis var. dives* Herbaceous Vegetation (CEGL001826)
- *Carex limosa* Herbaceous Vegetation (CEGL001811)

Global Related Concepts:
- *Carex aquatilis - Carex utriculata* Vegetation Type (Achuff et al. 2002a) ><
- *Carex aquatilis* (Kovalchik 1987) =
- *Carex aquatilis* (Bourgeron and Engelking 1994) =
- *Carex aquatilis* (Crowe and Clausnitzer 1997) =
- *Carex aquatilis* (Kittel et al. 1999b) =
- *Carex aquatilis* Association (Kovalchik 1993) =
- *Carex aquatilis* Community Type (Manning and Padgett 1995) =
- *Carex aquatilis* Community Type (Cooper and Cottrell 1990) =
- *Carex aquatilis* Community Type (Padgett et al. 1989) =
- *Carex aquatilis* Community Type (Youngblood et al. 1985a) =
- *Carex aquatilis* Community Type (Girard et al. 1997) =
- *Carex aquatilis* Habitat Type (Hansen et al. 1988b) =

- *Carex aquatilis* Habitat Type (Hansen et al. 1995) =
- *Carex aquatilis* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Carex aquatilis* Herbaceous Vegetation (Carsey et al. 2003b) =
- *Carex aquatilis* Plant Association (Sanderson and Kettler 1996) =
- *Carex aquatilis* var. *aquatilis* (McCain and Christy 2005) =
- *Carex aquatilis* var. *aquatilis* (*C. aquatilis*) Association (Crowe et al. 2004) =
- *Carex aquatilis* var. *aquatilis* Association (Christy 2004) =
- *Carex aquatilis-Carex aquatilis* Habitat Type (Mattson 1984) =
- DRISCOLL FORMATION CODE:V.C.6.a. (Driscoll et al. 1984) >
- Water sedge (*Carex aquatilis*) Plant Association (Kittel et al. 1999a) =
- Water sedge (*Carex aquatilis*) Plant Association (Kittel et al. 1997a) =

ELEMENT DISTRIBUTION

Global Range: This association is common and located in mountainous areas throughout the western U.S. and Canada.
Nations: CA, US
States/Provinces: AB, AZ?, CA:S3, CO:S4, ID:S4, MT:S4, NM:S4, NV, OR:S4, UT:S3?, WA:S3, WY:S3
TNC Ecoregions: 4:C, 5:C, 6:C, 7:C, 8:C, 9:C, 10:C, 11:C, 12:C, 18:C, 19:C, 20:C, 26:C, 68:C
USFS Ecoregions (1994/95): 313A:CC, 331D:CC, 331E:CC, 331F:CC, 341B:CC, 342A:CC, 342B:CC, 342C:CC, 342D:CC, 342F:CC, 342G:CC, M242C:CC, M261A:CC, M261D:CC, M261E:CC, M261G:CC, M331A:CC, M331B:CC, M331D:CC, M331F:CC, M331G:CC, M331H:CC, M331I:CC, M331J:CC, M332A:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M332F:CC, M332G:CC, M333A:CC, M333B:CC, M333C:CC, M333D:CC, M341A:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Cedar Breaks, Florissant Fossil Beds, Glacier, Grand Canyon, Grand Teton, Great Sand Dunes, Rocky Mountain); PC (Waterton Lakes); USFS (Arapaho-Roosevelt, Bighorn, Fremont, Gunnison, Malheur, Medicine Bow, Ochoco, Rio Grande, Routt, Shoshone, Umatilla, Wallowa-Whitman, White River NF)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: G. Kittel
References: Achuff et al. 2002a, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bierly 1972, Bourgeron and Engelking 1994, Briggs and MacMahon 1983, Bunin 1975c, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Carsey et al. 2003b, Christy 2004, Cogan et al. 2005, Cooper and Cottrell 1990, Cox 1933, Crowe and Clausnitzer 1997, Crowe et al. 2004, Driscoll et al. 1984, Giese 1975, Girard et al. 1997, Hall 1971, Hall 1973, Hansen et al. 1988b, Hansen et al. 1995, Hess and Wasser 1982, Hop et al. 2007, Hopkins 1979a, IDCDC 2005, Jankovsky-Jones et al. 1999, Johnson 1932a, Johnson 1932b, Johnson 1936, Johnson 1939, Johnson and Simon 1987, Jones 1992b, Jones and Ogle 2000, Kagan et al. 2004, Kauffman 1982, Kauffman et al. 1985, Kittel et al. 1997a, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova 1976, Kovalchik 1987, Kovalchik 1993, Kovalchik 2001, Kovalchik and Elmore 1992, Lewis 1970, MTNHP 2002b, Manning and Padgett 1991, Manning and Padgett 1992, Manning and Padgett 1995, Mattson 1984, McCain and Christy 2005, Muldavin et al. 2000a, NMNHP unpubl. data, Norton et al. 1981, Owns et al. 2004, Padgett and Manning 1988, Padgett et al. 1988b, Padgett et al. 1989, Ramaley 1919a, Ramaley 1920, Reid and Hall 2010, Reid et al. 2004, Robbins 1918, Salas et al. 2005, Salas et al. 2010b, Sanderson and Kettler 1996, Stuth 1975, Tendick et al. 2011a, Terwilliger et al. 1979a, Titus and Christy 1996a, Titus and Christy 1999, Tuhy 1981, Tuhy and Jensen 1982, Volland 1976, WNHP unpubl. data, Western Ecology Working Group n.d., Wilson 1969, Young 1982, Youngblood et al. 1985a, Youngblood et al. 1985b

Carex athrostachya Herbaceous Vegetation [Park Special]

Slender-beak Sedge Herbaceous Vegetation
Identifier: CEPS009535

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Montane & Subalpine Wet Shrubland & Wet Meadow (M075)
Group	Vancouverian & Rocky Mountain Montane Wet Meadow (G521)
Association	*Carex athrostachya* Herbaceous Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs on the plateau of the North Rim in small depressions and small sunken basins. It occurs at about 2325 m (7625 feet) elevation on completely flat slopes, in low-level sunken depressions which form seasonal wetlands or vernal pools. It occurs in very poorly-drained, silty clay soils which may be ephemerally inundated in the spring and early summer, and which can hold significant soil moisture well into the summer. Litter (55%) produced from the relatively thick herbaceous layer dominates the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This vegetation type completely lacks tree and shrub cover and is dominated purely by herbaceous species. *Carex athrostachya* dominates the herbaceous layer at approximately 70% cover, and total herbaceous cover can be as high as 90%. *Muhlenbergia wrightii* (15%) and *Poa pratensis* (5%) are common graminoid components, while *Mentha arvensis, Rumex salicifolius*, and *Polygonum douglasii* are characteristic forb species (all at trace covers). Based upon the single stand sampled, this association hosts well below-average species diversity for all communities in Grand Canyon, with only 10 species per 400-square-meter plot. However, this ephemeral wetland vegetation is extremely uncommon in Grand Canyon and is at risk to overgrazing by native and naturalized ungulates.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Forb	*Mentha arvensis*
Herb (field)	Graminoid	*Carex athrostachya*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Carex athrostachya*, *Mentha arvensis*, *Polygonum douglasii*, *Rumex salicifolius*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Nonstandard

Grand Canyon National Park Comments: *Carex vesicaria* Herbaceous Vegetation (CEGL002661) also occurs in similar habitats on the North Rim. *Carex vesicaria* requires more moisture than *Carex athrostachya*, and typically occupies areas within seasonal wetlands or vernal pools that display longer or more significant water inundation. Both *Carex vesicaria* and *Carex athrostachya* vegetation can occur in the same plant community or wetland, often forming concentric rings based upon soil moisture. *Carex vesicaria* inhabits the innermost/wettest zone of the wetlands, while *Carex athrostachya* occupies an outer/drier ring. While these two plant associations sometimes occur together as one, *Carex athrostachya* Herbaceous Vegetation (CEPS009535) frequently occurs exclusively of *Carex vesicaria* and is more abundant than *Carex vesicaria* Herbaceous Vegetation on the North Rim.

Global Similar Associations:

- *Carex vesicaria* Herbaceous Vegetation (CEGL002661) is dominated by *Carex vesicaria* and typically occupies areas within seasonal wetlands or vernal pools that display longer or more significant water inundation.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is restricted to seasonal wetlands and vernal pools on the Kaibab Plateau which are formed by small depressions or sinkholes on the plateau. It was sampled from Castle Lake on the North Rim.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02126.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

Carex vesicaria Herbaceous Vegetation

Inflated Sedge Herbaceous Vegetation
Identifier: CEGL002661

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Montane & Subalpine Wet Shrubland & Wet Meadow (M075)
Group	Vancouverian & Rocky Mountain Montane Wet Meadow (G521)
Association	*Carex vesicaria* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: Stands of this vegetation type are commonly found in wet meadows, around the edges of montane lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains throughout the western United States. Elevations range from 1075-2900 m (3525-9500 feet). These communities can occur in standing water or on sites that become relatively dry during the later part of the growing season. Many sites are located where beaver ponds have filled with sediment. A wide range of soils are associated with this association. Histosols are most common and often have organic accumulations greater than 1 meter thick. Mollisols and Entisols are also associated with this type. Soil texture varies widely from loamy clay to sandy loam. This association is characterized by the dominance of *Carex vesicaria*, with 20-98% cover. Other graminoids can be present and can be codominant. *Juncus balticus, Deschampsia caespitosa, Carex nebrascensis, Carex utriculata, Eleocharis palustris*, and *Glyceria* spp. are some of the more common associated species. Forbs can include *Epilobium* sp., *Galium trifidum, Camassia quamash, Symphyotrichum foliaceum (= Aster foliaceus), Equisetum arvense*, and *Mentha arvensis*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs on the plateau of the North Rim in small depressions, sunken basins, vernal pools, and ponds. It typically occurs at 2665 m (8750 feet) elevation on completely flat slopes, in low-level sunken depressions which form seasonal, yet semipermanent wetlands. It occurs in poorly-drained mucky soils which are inundated with water throughout the spring and much of the summer. Soils may become desiccated during the summer and fall, yet these sites still host obligate wetland species. Litter (80%) ubiquitously dominates the ground cover.
Global Environment: Stands of this vegetation type are commonly found in wet meadows, around the edges of montane lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains throughout the western United States. Elevations range from 1075-2900 m (3525-9500 feet). They can occur in standing water or on sites that become relatively dry during the later part of the growing season. Many sites are located where beaver ponds have filled with sediment. A wide range of soils are associated with this association. Histosols are most common and often have organic accumulations greater than 1 meter thick. Mollisols and Entisols are also associated with this type. Soil texture varies widely from loamy clay to sandy loam.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This vegetation type completely lacks tree and shrub cover and is dominated purely by herbaceous species. A uniform monoculture of *Carex vesicaria* dominates the herbaceous layer at

approximately 85% cover. *Eleocharis acicularis, Deschampsia elongata, Ranunculus flammula, Hypericum anagalloides*, and *Carex athrostachya* are characteristic components of the understory, yet all occur at 1% cover or less. Based upon the single stand sampled, this association hosts well below-average species diversity among all plant communities in Grand Canyon, with only 6 species per 400-square-meter plot. However, this ephemeral wetland vegetation type is extremely uncommon in Grand Canyon and is at risk to overgrazing by native and naturalized ungulates.
Global Vegetation: This association is characterized by the dominance of *Carex vesicaria*, with 20-98% cover. Other graminoids can be present and can be codominant. *Juncus balticus, Deschampsia caespitosa, Carex nebrascensis, Carex utriculata, Calamagrostis stricta, Eleocharis palustris*, and *Glyceria* spp. are some of the more common associated species. Forbs can include *Epilobium* sp., *Galium trifidum, Camassia quamash, Symphyotrichum foliaceum (= Aster foliaceus), Equisetum arvense*, and *Mentha arvensis*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex vesicaria*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Carex vesicaria*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Carex vesicaria*, *Deschampsia elongata*, *Eleocharis acicularis*, *Hypericum anagalloides*, *Ranunculus flammula*
Global: *Carex vesicaria*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Hypericum anagalloides* (state-imperiled, G4), *Ranunculus flammula* (state-vulnerable, G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4Q (2-Dec-1998).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Carex athrostachya* Herbaceous Vegetation (CEPS009535) also occurs in seasonal wetlands formed by sunken depressions and hosts a sedge-dominated understory. *Carex athrostachya* typically inhabits drier, less inundated sites than *Carex vesicaria*. *Carex athrostachya* can tolerate merely moist soil conditions found in swales, whereas *Carex vesicaria* tends to require truly inundated habitats. Sometimes these species and vegetation types occur together within a single vernal pool complex. In this case, *Carex vesicaria* inhabits the innermost, wettest portion of the site; while *Carex athrostachya* occupies an outer, drier concentric ring of vegetation.
Global Comments: The association needs crosswalking between stands in the Pacific Northwest states and Colorado to determine if this is the same type, thus the G4Q rank. This type appears to be a simple dominance type with *Carex vesicaria* and occasionally *Carex utriculata* as the only species of significance. Some authors have treated communities dominated by *Carex vesicaria* as being analogous to *Carex utriculata* (example Hansen et al. (1995) for Montana). Further work is needed to clarify the distribution of this type due to this treatment.
Global Similar Associations:
- *Carex athrostachya* Herbaceous Vegetation [Park Special] (CEPS009535) also occurs in seasonal wetlands formed by sunken depressions and hosts a sedge-dominated understory dominated by *Carex athrostachya*.

Global Related Concepts:
- *Carex rostrata* (*Deschampsia cespitosa* Phase) (Hansen et al. 1995) **><**
- *Carex vesicaria* (Kovalchik 1987) **=**

- *Carex vesicaria* (Bourgeron and Engelking 1994) =
- *Carex vesicaria* (Kittel et al. 1999b) =
- *Carex vesicaria* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Carex vesicaria* Miscellaneous Unclassified Herbaceous Community (Manning and Padgett 1991) =
- *Carex vesicaria* Plant Association (Potter 2005) =
- *Carex vesicaria* var. *vesicaria* (Crowe and Clausnitzer 1997) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is restricted to ephemeral and semi-permanent wetlands on the Kaibab Plateau which are formed by small depressions or sinkholes on the plateau. It was sampled from the North Rim between Kanabownits Canyon and Fawn Spring.
Global Range: This association is known from stands throughout the montane western United States.
Nations: US
States/Provinces: AZ, CA, CO:S1, ID:S3, MT:S4, NV?, OR:S4, WA, WY
TNC Ecoregions: 7:C, 8:P, 9:C, 11:P, 12:C, 19:C, 20:C, 26:P, 27:C
USFS Ecoregions (1994/95): 313A:CC, 331I:CC, M261E:CC, M331G:CC, M331H:CC, M333C:CC
Federal Lands: NPS (Glacier, Grand Canyon, Grand Teton, Yosemite); USFS (Deschutes?, Fremont, Malheur, Ochoco?, Umatilla, Wallowa-Whitman, Winema?)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02141.
Local Description Authors: K. Christie
Global Description Authors: T. Keeler-Wolf, mod. G. Kittel
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Christy and Cornelius 1980, Cogan et al. 2005, Cooper and Severn 1992, Crowe and Clausnitzer 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hop et al. 2007, IDCDC 2005, Kagan et al. 2004, Keeler-Wolf et al. 2003a, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1993, Manning and Padgett 1991, Potter 2005, Reid and Hall 2010, Reid et al. 2004, Sanderson and Kettler 1996, WNDD unpubl. data, WNHP unpubl. data, Western Ecology Working Group n.d.

M301. Western North American Ruderal Wet Shrubland, Meadow & Marsh
G524. Western North American Ruderal Wet Shrubland, Meadow & Marsh

Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation

Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation
Western Reed Marsh
Identifier: CEGL001475

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Ruderal Wet Shrubland, Meadow & Marsh (M301)
Group	Western North American Ruderal Wet Shrubland, Meadow & Marsh (G524)
Association	*Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This reed marsh type is found across the west-temperate regions of the United States and Canada. Stands occur in semipermanently flooded marshes, ditches, impoundments, etc. that have often been disturbed by human activity. The vegetation is often variable, as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis*, with few or no other vascular plants present. In Colorado, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage. Stands have a dense, 1- to 1.5-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis*. Minor cover of associates such as *Agrostis stolonifera*, *Carex* spp., *Conyza canadensis*, *Glycyrrhiza lepidota*, *Iva axillaris*, *Mentha arvensis*, *Schoenoplectus acutus*

(= Scirpus acutus), and *Typha latifolia* may be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This common reed association occurs in the Inner Canyon and Western Grand Canyon along the Colorado River corridor. It occurs at 950 to 375 m (3100-1200 feet) elevation, immediately along the riverbank, often in backwater coves and near slow-moving water. It occurs in inundated areas with sandy substrates.

Global Environment: This association is widespread in the western U.S. and Canada. Elevation ranges from 640-1980 m. Stands occur in temporarily to semipermanently flooded marshes, ditches, impoundments, pond and lake margins, swales, and wet meadows that often have been disturbed by human activity. Sites are usually saturated or flooded during the growing season, but the soil surface may dry out in late summer. Soils are often fine-textured silts and clays. In Colorado and Utah, this reed marsh often occurs in small wet patches in seeps and backwater areas of large floodplains in springs emerging from canyon walls, around the fringes of irrigation ponds, ditches, and along railroad embankments that have poor drainage.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characterized by dense stands of the reedlike grass *Phragmites australis* (65%). Scattered shrubs, including *Tamarix ramosissima* (5-10%), *Baccharis emoryi* (2-3%), and *Salix exigua* (up to 15%), infrequently punctuate some stands. Total shrub cover usually averages 6%. The non-native grass *Cynodon dactylon* only occurs in some stands, but can form a fairly dense understory (25%) when it does. Forbs (1%) such as *Melilotus officinalis*, *Artemisia ludoviciana, Conyza canadensis*, and *Pseudognaphalium stramineum* sporadically occur at very low individual covers (1% or less); however, overall forb composition is quite variable. *Equisetum X ferrissii* (10%) occurs occasionally, but can be quite dense in some stands (up to 40% cover).

Global Vegetation: The vegetation is often variable as *Phragmites australis* will often invade into existing natural or semi-natural communities present on the site. Once firmly established, this community is usually strongly dominated by *Phragmites australis* with few or no other vascular plants present. Stands have a dense, 1- to 3-m tall herbaceous layer dominated by the perennial graminoid *Phragmites australis* usually with at least 50% absolute cover. Associated graminoids include *Agrostis stolonifera, Carex* spp., *Typha latifolia, Juncus balticus, Agrostis gigantea, Elymus canadensis, Equisetum* spp., *Hordeum jubatum, Muhlenbergia asperifolia, Schoenoplectus acutus (= Scirpus acutus)*, and *Sporobolus contractus*. Forbs are diverse and provide low cover; those commonly present include *Ambrosia acanthicarpa, Conyza canadensis, Glycyrrhiza lepidota, Eurybia glauca (= Aster glaucodes), Iva acerosa (= Oxytenia acerosa), Iva axillaris, Mentha arvensis, Solidago canadensis*, and *Taraxacum officinale*. Introduced species such as *Lepidium latifolium* and *Cirsium arvense* may be present and compete well against *Phragmites australis* in disturbed sites.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Phragmites australis*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Phragmites australis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis emoryi*, *Equisetum* x *ferrissii*, *Phragmites australis*, *Tamarix ramosissima*
Global: *Phragmites australis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Alhagi maurorum* (exotic, Medium/Low), *Cynodon dactylon* (exotic, Medium/Low), *Lepidium latifolium* (exotic, High), *Melilotus officinalis* (exotic, Medium/Low), *Plantago lanceolata* (exotic, High/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Sonchus asper* (exotic), *Tamarix ramosissima* (exotic, High)

Global: Invasive/Exotic: *Agrostis gigantea* (invasive/exotic, Medium/Low), *Cirsium arvense* (invasive/exotic, High/Medium), *Lepidium latifolium* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (20-Sep-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This vegetation has variable hydrology and is often treated as part of other marshes and meadows. The geographic distribution of the type is arbitrarily limited to Bailey's Dry and Humid Temperate Domain in western North America (Bailey 1997, 1998). Compare with *Phragmites australis* Eastern North America Temperate Semi-natural Herbaceous Vegetation (CEGL004141). The two types need to be better distinguished, both conceptually and nomenclaturally.
Global Similar Associations:
- *Phragmites australis* Eastern North America Temperate Semi-natural Herbaceous Vegetation (CEGL004141)

Global Related Concepts:
- *Phragmites australis* (Bourgeron and Engelking 1994) =
- *Phragmites australis* (Kittel et al. 1999b) =
- *Phragmites australis* Habitat Type (Hansen et al. 1995) =
- *Phragmites australis* Habitat Type (Hall and Hansen 1997) =
- *Phragmites australis* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Phragmites australis* Wetland (Baker 1984a) =
- *Phragmites communis* / *Carex lacustris* Plant Association (Johnston 1987) =
- Bulrush - Reed Grass Association (Pool 1914) >
- DRISCOLL FORMATION CODE:V.A.4.a. (Driscoll et al. 1984) >
- Sandhills Freshwater Marsh (Steinauer and Rolfsmeier 2000) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and Western Grand Canyon, where it occurs along the banks of the Colorado River.
Global Range: This reed marsh type is found across the temperate regions of the western United States and Canada, ranging from western North Dakota and Saskatchewan to Oregon, south to California and Texas. Its distribution is somewhat incomplete as not all states have listed semi-natural types in their state.
Nations: CA, US
States/Provinces: AZ, CA:S3, CO:S3, ID, MB:S3?, MT:S2, ND, NE:S4, NM, NV, OK, ON:S4, OR:S1, SD, SK, TX, UT, WY:S2S3
TNC Ecoregions: 6:C, 7:C, 8:C, 9:C, 10:C, 11:C, 17:C, 19:C, 20:C, 26:C, 27:C, 28:C, 32:P, 33:P, 35:C, 47:P, 48:C
USFS Ecoregions (1994/95): 212Ja:PPP, 251Aa:CCC, 313A:CC, 315B:CC, 322A:CC, 331C:CC, 331D:CC, 331G:CC, 331I:CC, 341A:CC, 341B:CC, 341C:CC, 341E:CC, 342B:CC, 342C:CC, 342D:CC, 342E:CC, 342F:CC, 342G:CC, 342I:C?, M331D:CC, M331E:CC, M331F:CC, M331H:CC, M332A:CC, M332D:CC, M332E:CC, M332F:CC, M333B:CC, M333D:CC, M341A:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Dinosaur, Glen Canyon, Grand Canyon, Great Sand Dunes, Lake Meredith); USFWS (Lacreek, Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on ten (10) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: D. Faber-Langendoen, mod. K. Schulz and J. Coles
References: Bailey 1997, Bailey 1998, Baker 1982a, Baker 1984a, Bourgeron and Engelking 1994, Butler et al. 2002, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Greenall 1996, Hall and Hansen 1997, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, IDCDC 2005, Johnston 1987, Kagan et al. 2004, Kittel et al. 1995, Kittel et al. 1999b, MTNHP 2002b, NDNHI

unpubl. data, NMNHP unpubl. data, Pool 1914, Reid and Hall 2010, Rolfsmeier and Steinauer 2010, Romme et al. 1993, Salas et al. 2010b, Steinauer and Rolfsmeier 2000, TNHS unpubl. data, Von Loh 2000, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.

Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation

Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation
Identifier: CEGL003081

USNVC CLASSIFICATION

Division	Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.B.6.Nb)
Macrogroup	Western North American Ruderal Wet Shrubland, Meadow & Marsh (M301)
Group	Western North American Ruderal Wet Shrubland, Meadow & Marsh (G524)
Association	*Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural meadows and riparian areas. Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid region it is restricted to relatively mesic sites. Soils are highly variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content. It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought. The vegetation is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This semi-natural herbaceous association occurs on the North Rim in meadows and somewhat mesic forest openings in the mixed conifer zone. It occurs at 2400 to 2550 m (7900-8375 feet) elevation on flat to very gentle slopes (up to 6 degrees) with southwestern aspects in low-level valley bottoms. Soils tend to be moderately well-drained silts, sometimes with a clay component. These sites tend to be somewhat mesic and probably support a relatively high level of soil moisture, at least during the spring. Adjacent sites often support stands of *Populus tremuloides*. Litter (80%) ubiquitously dominates the ground cover.
Global Environment: This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural prairies, meadows and riparian areas. Elevation ranges from 1100-3200 m (3600-10,500 feet). Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid regions it is restricted to relatively mesic sites. Soils are variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content (Hansen et al. 1995). It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought (Hansen et al. 1995, Hall and Hansen 1997, Kovalchik 1987, Manning and Padgett 1995, Padgett et al. 1989).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees and shrubs are essentially absent from this herbaceous community; however, *Pinus ponderosa* and *Populus tremuloides* rarely encroach at 1-3% cover. Total graminoid cover averages 50%. *Poa pratensis* dominates this community and averages 25-30% cover, but can be as high as 50% on some sites. A rhizomatous *Carex* sp. (8%) is consistently present as well, sometimes at up to 20% cover. *Elymus elymoides* and *Bromus ciliatus* consistently occur, but only at 1-3% cover. *Muhlenbergia montana* may occur in this association; however, it is always less abundant than *Poa pratensis* when it occurs. Over 40 different forb species can occur, and total forb

cover averages 10% in this association. *Artemisia dracunculus* (3%) cover can be as high as 10% on some sites, while *Artemisia carruthii*, *Potentilla hippiana*, and *Eriogonum racemosum* are consistently present but only at 1-2% cover each. While overall forb diversity is fairly high, no other single species typically exists at more than 1% cover. The presence of trace amounts of *Equisetum laevigatum* is characteristic of this community, and perhaps evidences high levels of early-season soil moisture. This association often occurs in forest openings near extant *Populus tremuloides* stands, and can contain regenerating *Populus tremuloides* (1-2%) seedlings. Based upon the 5 stands sampled, this association hosts above-average species diversity for high-elevation communities in Grand Canyon, with 27 species per 400-square-meter plot.

Global Vegetation: This widespread, semi-natural plant association is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor-condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Forb	*Artemisia dracunculus*
Herb (field)	Graminoid	*Poa pratensis*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Poa pratensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Equisetum laevigatum*, *Poa pratensis*
Global: *Poa pratensis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Phleum pratense* (exotic, Medium), *Poa pratensis* (exotic, Medium), *Taraxacum officinale* (exotic), *Thinopyrum ponticum* (exotic, Low/Insignificant)
Global: Invasive/Exotic: *Achillea millefolium* (invasive native), *Agrostis stolonifera* (invasive, Medium/Low), *Bromus inermis* (invasive/exotic, High/Medium), *Cirsium arvense* (invasive/exotic, High/Medium), *Elymus repens* (invasive/exotic, High/Medium), *Linaria vulgaris* (invasive/exotic, High/Low), *Phleum pratense* (invasive/exotic, Medium), *Poa pratensis* (invasive/introduced, Medium), *Taraxacum officinale* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (1-Dec-1997).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) occurs in very similar (but perhaps slightly more xeric) habitats, and supports an extremely similar assemblage of forb species. *Poa pratensis* can be present at up to 10% cover; however *Muhlenbergia montana* is the dominant graminoid component in this community. It is difficult to determine what factors drive this floristic difference; potentially the native *Muhlenbergia montana* is outcompeted and eventually replaced by the non-native *Poa pratensis*. *Festuca (calligera, arizonica, brachyphylla)* Herbaceous Vegetation (CEGL005500) is another herbaceous/meadow community on the North Rim; however, it occurs at higher elevations (typically at 2666 m). *Festuca* sp. dominates the herbaceous

layer, and *Poa pratensis* is only occasionally present at 1-3% cover.

Global Similar Associations:

- *Festuca (calligera, arizonica, brachyphylla)* Herbaceous Vegetation (CEGL005500) is another herbaceous/meadow community; however, it occurs at higher elevations and *Festuca* sp. dominates.
- *Muhlenbergia montana* Herbaceous Vegetation (CEGL001646) occurs in very similar (but perhaps slightly more xeric) habitats, and supports an extremely similar assemblage of forb species; however *Muhlenbergia montana* is the dominant graminoid.
- *Phleum pratense - Poa pratensis - Bromus inermis* Semi-natural Herbaceous Vegetation (CEGL005874)
- *Poa pratensis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation (CEGL005265)

Global Related Concepts:

- *Poa pratensis - Agrostis* spp. Community (Franklin and Dyrness 1973) >
- *Poa pratensis - Phleum pratense* / Mixed Grass Community Type (Kauffman et al. 1985) >
- *Poa pratensis* / Mixed Forb Community Type (Kauffman et al. 1985) >
- *Poa pratensis* (Kovalchik 1987) =
- *Poa pratensis* Community Type (Tuhy and Jensen 1982) =
- *Poa pratensis* Community Type (Padgett et al. 1989) =
- *Poa pratensis* Community Type (Youngblood et al. 1985a) =
- *Poa pratensis* Community Type (Hall and Hansen 1997) =
- *Poa pratensis* Community Type (Hansen et al. 1995) =
- *Poa pratensis* Community Type (Manning and Padgett 1995) =
- Dry Meadow (Hall 1973) >
- Dry Meadows (Kauffman et al. 1983) >
- Kentucky Bluegrass Series (Sawyer and Keeler-Wolf 1995) >
- Moist Meadows (Kauffman et al. 1983) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the western portion of the North Rim, from Highway 67 west to the Shinumo Amphitheater. It was sampled from Kanabownits Canyon, near Kanabownits Spring, from the upper reaches of Crystal Creek, from the upper reaches of the Walla Valley drainage, and from Kanab Canyon near Crescent Ridge.

Global Range: This semi-natural grassland is widespread in the western U.S. and northern Great Plains.

Nations: US

States/Provinces: AZ, CA, ID, MT, OR, SD, UT, WA, WY

TNC Ecoregions: 7:C, 12:C, 13:C, 15:C, 18:C, 19:C, 25:C

USFS Ecoregions (1994/95): 261A:CC, 262A:CC, 313A:CC, 341:C, 342:C, M261E:CC, M262:C, M333C:CC, M334A:CC, M341C:CC

Federal Lands: NPS (Bryce Canyon, Cedar Breaks, Grand Canyon, Wind Cave, Yosemite, Zion); USFS (Deschutes, Fremont, Ochoco, Winema)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (5 plots): GRCA.02140, GRCA.02194, GRCA.02195, GRCA.03111, GRCA.03118.

Local Description Authors: K. Christie

Global Description Authors: D. Faber-Langendoen, mod. K.A. Schulz and G. Kittel

References: Cogan et al. 1999, Cogan et al. 2004, Franklin and Dyrness 1973, Hall 1973, Hall and Hansen 1997, Hansen et al. 1995, Kauffman et al. 1983, Kauffman et al. 1985, Keeler-Wolf et al. 2003a, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1995, Marriott pers. comm., Padgett et al. 1989, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Tendick et al. 2011a, Tendick et al. 2011b, Tuhy and Jensen 1982, Volland 1978, Volland and Dell 1981, WNDD unpubl. data, Western Ecology Working Group n.d., Youngblood et al. 1985a

2.B.6.Nc. Southwestern North American Warm Desert Freshwater Marsh

M076. Warm Desert Freshwater Shrubland, Meadow & Marsh
G531. Arid West Emergent Marsh

Aletes macdougalii Herbaceous Vegetation [Park Special]

MacDougal's Indian-parsley Herbaceous Vegetation
Identifier: CEPS009536

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	Arid West Emergent Marsh (G531)
Association	*Aletes macdougalii* Herbaceous Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs in the Inner Canyon on rocky slopes, on ledges and in crevices, and sometimes in dry margins of seeps. It is also often found in sandy soils. It occurs rocky habitats extending from mixed-conifers forests below the Kaibab Limestone down into pinyon-juniper woodlands and farther down to the Colorado River.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous vegetation type is characterized and dominated by a relatively dense layer of *Aletes macdougalii* (45%) in the understory. A sparse layer of scattered short shrubs (3%), including *Baccharis emoryi, Baccharis sarothroides, Encelia farinosa, Baccharis salicifolia, Ephedra* spp., and *Isocoma acradenia*, can occur when this association occurs near the Colorado River. *Gutierrezia sarothrae* (1%) consistently occurs in the sparse dwarf-shrub layer. Graminoids are somewhat uncommon; however, the exotic *Bromus rubens* (3%) occurs in some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Forb	*Aletes macdougalii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aletes macdougalii*, *Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Cynodon dactylon* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon; it was presumably sampled in close proximity to the Colorado River corridor.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on four (4) Grand Canyon

Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

Equisetum X ferrissii Herbaceous Vegetation

Ferriss' Horsetail Herbaceous Vegetation
Identifier: CEGL005394

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	Arid West Emergent Marsh (G531)
Association	*Equisetum X ferrissii* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This horsetail herbaceous association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs throughout Grand Canyon National Park along the Colorado River corridor at 375 to 950 m (1200-3100 feet) elevation, immediately along the riverbank, on sandbars, and in backwater coves. It occurs in saturated or inundated sand. This herbaceous association typically occurs immediately adjacent to riparian shrublands, and scattered shrubs occasionally punctuate some stands. *Baccharis emoryi, Salix exigua, Baccharis salicifolia*, and *Pluchea sericea* infrequently occur . The fern ally *Equisetum X ferrissii* characterizes and dominates this community and often forms small monocultural stands. Scattered graminoids occur intermixed in some stands, although graminoid composition varies considerably. *Cynodon dactylon, Andropogon gerardii*, and *Phragmites australis* can all occur. Other species such as *Polypogon monspeliensis, Juncus articulatus, Juncus torreyi*, and *Agrostis stolonifera* infrequently occur. *Typha domingensis* can also be codominant in some stands. Forb cover is usually fairly sparse, and species such as *Pseudognaphalium stramineum, Melilotus officinalis*, and *Conyza canadensis* are among the more frequent components of the forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs throughout Grand Canyon National Park along the Colorado River corridor. It occurs at 375 to 950 m (1200-3100 feet) elevation, immediately along the riverbank, on sandbars, and in backwater coves. It occurs in saturated or inundated sand.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous association typically occurs immediately adjacent to riparian shrublands, and scattered shrubs occasionally punctuate some stands. *Baccharis emoryi, Salix exigua, Baccharis salicifolia*, and *Pluchea sericea* infrequently occur at low individual covers (1-2%). The fern ally *Equisetum X ferrissii* (typically 30% cover, up to 85% cover in dense stands) characterizes and dominates this community and often forms small monocultural stands. Scattered graminoids (10%) occur intermixed in some stands, although graminoid composition varies considerably. *Cynodon dactylon, Andropogon gerardii*, and *Phragmites australis* can all occur at up to 15% cover. Other species such as *Polypogon monspeliensis, Juncus articulatus, Juncus torreyi*, and *Agrostis stolonifera* infrequently occur at low individual covers (1-2%). *Typha domingensis* can also be codominant in some stands (up to 15%). Forb cover is usually fairly sparse (3%), and species such as *Pseudognaphalium stramineum, Melilotus officinalis*, and *Conyza canadensis* are among the more frequent components of the forb layer.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Fern or fern ally	*Equisetum x ferrissii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Equisetum* x *ferrissii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Melilotus officinalis* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Sonchus asper* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard
Global Similar Associations:
- *Salix exigua* / *Equisetum X ferrissii* Shrubland [Park Special] (CEPS009538)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from throughout the Inner Canyon and Western Grand Canyon, where it was sampled from numerous locations along the Colorado River corridor.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on nine (9) Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Schoenoplectus americanus* Western Herbaceous Vegetation**

Chairmaker's Bulrush Western Herbaceous Vegetation
Identifier: CEGL001841

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	Arid West Emergent Marsh (G531)
Association	*Schoenoplectus americanus* Western Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This wetland herbaceous association ranges from California to Washington and east to Colorado and Wyoming. This description is based on information from Great Sand Dunes National Park and Preserve in Colorado. Additional global information will be added as it becomes available. This association is found within basin floor sabkhas, swales, or dunefields at elevations ranging from 2300 to 2340 m. This palustrine system can be seasonally flooded, temporarily flooded, or saturated. Soils are very poorly drained clays or very poorly to poorly drained loamy sands. Ground cover includes litter and duff (30-35%) and bare soil (10-40%). Herbaceous vegetation cover ranges from 55-95%, which is largely comprised of *Schoenoplectus americanus* with 20-70% cover. Additional species that occur in lesser amounts include *Cleome multicaulis, Distichlis spicata*, and *Juncus balticus*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Schoenoplectus americanus*

CHARACTERISTIC SPECIES

Global: *Cleome multicaulis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Cleome multicaulis* (G2G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3Q (9-Jul-1999). *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841) is rare due to narrow habitat requirements and habitat loss and degradation. Known stands are restricted to hot springs and alkaline basins. Few examples are known in Oregon and Idaho, but its distribution in California is unclear. It is suspected that stands may be present in Montana. Stands occurring near hot springs are threatened by recreational use and some stands may have been extirpated by development of springs. Livestock impact stands by creating trails, accelerating hummocking, and creating areas where weedy species such as *Argentina anserina* or *Plantago major* may become established. Draining of wetlands for agricultural use or expansion of open water habitat for waterfowl may also eliminate stands of this association. *Schoenoplectus americanus* is a weakly defined association with limited supporting data. The association is listed as occurring in Idaho, California, Oregon, and Washington. The plant association as treated here occurs in inland alkaline basins and at hot springs. Hansen et al. (1995) recognized a *Scirpus pungens* association in Montana that included all combinations of *Schoenoplectus pungens* and *Schoenoplectus americanus*. Stand tables indicate that four Montana stands are dominated by *Schoenoplectus americanus*. Regional analysis is needed to further define the inland *Schoenoplectus americanus* association. Two additional *Schoenoplectus americanus* associations occurring in coastal salt marshes and tidal freshwater systems may need to be recognized in California, Oregon, and Washington.

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Similar Associations:
- *Schoenoplectus pungens* Herbaceous Vegetation (CEGL001587)

Global Related Concepts:
- *Schoenoplectus americanus* (Keeler-Wolf 2007) **=**
- *Scirpus americanus* (Bourgeron and Engelking 1994) **=**
- *Scirpus americanus* Dominance Type (Evans 1989a) **=**
- DRISCOLL FORMATION CODE:V.C.6.a. (Driscoll et al. 1984) **>**
- Three-square Bulrush Tidal Herbaceous Vegetation (*Schoenoplectus americanus*) (Christy et al. 1998) **?**

ELEMENT DISTRIBUTION

Global Range: The association is a minor type in the Great Basin and southern Rocky Mountains. It ranges from California north to Washington and east to Colorado and Wyoming.
Nations: US
States/Provinces: AZ, CA:S3, CO, ID:S3, MT?, OR:S2S3, WA:S1?, WY
TNC Ecoregions: 4:C, 6:C, 8:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 342B:CC, 342C:CC, 342H:CC, M242C:CC, M331F:CC, M332F:CC, M332G:C?
Federal Lands: NPS (Grand Canyon, Great Sand Dunes); USFS (Oregon Dunes?, Siuslaw?)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.E. Sabo, mod. M.J. Russo
References: Bourgeron and Engelking 1994, Christy et al. 1998, Driscoll et al. 1984, Evans 1989a, Hansen et al. 1995, IDCDC 2005, Kagan et al. 2004, Keeler-Wolf 2007, Reid and Hall 2010, Salas et al. 2010b, Tuhy 1981, WNDD unpubl.

data, Western Ecology Working Group n.d.

Schoenoplectus pungens Herbaceous Vegetation

Common Threesquare Herbaceous Vegetation
Bulrush Wet Meadow
Identifier: CEGL001587

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	Arid West Emergent Marsh (G531)
Association	*Schoenoplectus pungens* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This bulrush wet meadow community is found in the western United States in the intermountain basins, as far north as southern British Columbia, as well as in western parts of the Great Plains north into Alberta, Canada. Stands are found along low-gradient, meandering, usually perennial streams and springs and around the margins of ponds and marshes. Substrates are generally dark, organic, fine-textured soils derived from alluvium. *Schoenoplectus pungens (= Scirpus pungens)* dominates the dense, 0.3- to 0.6-m tall herbaceous vegetation layer. Other species that often are present include *Schoenoplectus maritimus (= Scirpus maritimus), Spartina gracilis, Hordeum jubatum, Pascopyrum smithii, Juncus balticus, Eleocharis palustris, Lemna minor, Sagittaria latifolia*, and *Typha* spp. Stands of this association contain no tree or shrub layer, but a few scattered trees and shrubs may be present, most commonly *Populus deltoides*, *Populus fremontii, Salix amygdaloides, Salix exigua, Salix gooddingii, Symphoricarpos occidentalis*, or *Sarcobatus vermiculatus*.

ENVIRONMENTAL DESCRIPTION

Global Environment: Stands of this widespread association are found throughout much of the western U.S., north into British Columbia and east to Alberta, Canada, in appropriate wetland habitats. Elevations range from 1000-2400 m. Stands occur along low-gradient, meandering, usually perennial streams, along springs, around the margins of ponds and marshes, in low-lying swales, adjacent to perennial pools in intermittent washes, and abandoned or overflow channels where the soils remain saturated (Hansen et al. 1995, Jones and Walford 1995, Walford 1996, Kittel et al. 1999a). It also occurs on silt and sand bars within the active channel. Soils are generally derived from alluvium and are fine-textured or sandy, and often are black, alkaline, organic anoxic with gleying. Soils range from normal to saline with pH ranging from 7.4-9.1. Typical pH reported for Alberta stands is 8.5 (Thompson and Hansen 2002).

VEGETATION DESCRIPTION

Global Vegetation: This widespread wetland association is characterized by a dense, 0.3- to 0.6-m tall herbaceous vegetation layer that is dominated by *Schoenoplectus pungens (= Scirpus pungens)*. Associated species include *Schoenoplectus maritimus (= Scirpus maritimus), Equisetum* spp., *Spartina gracilis, Distichlis spicata, Hordeum jubatum, Muhlenbergia asperifolia, Pascopyrum smithii, Juncus balticus, Eleocharis palustris, Lemna minor, Sagittaria latifolia*, and *Typha* spp. Stands of this association contain no tree or shrub layer, but a few scattered trees and shrubs may be present, most commonly *Populus deltoides, Populus fremontii, Salix amygdaloides, Salix exigua, Salix gooddingii, Symphoricarpos occidentalis*, or *Sarcobatus vermiculatus*. The more northern stands are dominantly *Schoenoplectus pungens* with 50% cover or greater with no other constant or significant species.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Schoenoplectus pungens*

CHARACTERISTIC SPECIES

Global: *Schoenoplectus pungens*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Spiranthes diluvialis* (G2G3); **Invasive/Exotic**: *Agrostis stolonifera* (invasive, Medium/Low), *Melilotus officinalis* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (9-Apr-1998).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: Muldavin et al. (2000a) described five *Schoenoplectus pungens (= Scirpus pungens)* community types from New Mexico. Most are codominated with an associated species listed in the vegetation description, e.g., *Eleocharis palustris, Distichlis spicata, Paspalum distichum*, and *Equisetum laevigatum*, with one being a *Schoenoplectus pungens* Monotype Community Type reported from the Gila River basin. Muldavin et al.'s (2000a) concept of this community type states that it can be dominated by *Schoenoplectus pungens (= Scirpus pungens)* or *Schoenoplectus americanus (= Scirpus americanus, = Scirpus olneyi)*. Hansen et al. (1995) also include *Schoenoplectus americanus* in their *Scirpus pungens* Habitat Type. The range of *Schoenoplectus americanus*, however, does not extend into Alberta, so this may be less of an issue moving north. This association needs further review to clarify whether to include stands where *Schoenoplectus pungens* is not the dominant species.
Global Similar Associations:

- *Schoenoplectus americanus* Western Herbaceous Vegetation (CEGL001841) stands are dominated by *Schoenoplectus americanus* instead of *Schoenoplectus pungens*.
- *Spartina pectinata - Schoenoplectus pungens* Herbaceous Vegetation (CEGL001478) should probably be split into a *Spartina* type and a *Schoenoplectus pungens* type.

Global Related Concepts:

- *Schoenoplectus pungens* Herbaceous Vegetation (Carsey et al. 2003a) =
- *Scirpus pungens* (Kittel et al. 1999b) =
- *Scirpus pungens* (Bourgeron and Engelking 1994) =
- *Scirpus pungens* Association (Bundy et al. 1996) ?
- *Scirpus pungens* Community (Jones and Walford 1995) =
- *Scirpus pungens* Community (Walford 1996) =
- *Scirpus pungens* Habitat Type (Hansen et al. 1995) >
- *Scirpus pungens* Saline Marsh (Thompson and Hansen 2002) =
- *Scirpus pungens* Series (MTNHP 1988) >
- DRISCOLL FORMATION CODE:V.B.4.a. (Driscoll et al. 1984) >
- Sharp Bullrush Marsh Site Association (MacKenzie and Moran 2004) =

ELEMENT DISTRIBUTION

Global Range: This community is found in the western United States in the intermountain basins, as well as in western parts of the Great Plains, from east-central Alberta, Canada, and Montana south to Colorado, and west into Nevada, Utah, and Wyoming.
Nations: CA, US
States/Provinces: AB:S3S4, AZ, BC, CO:S3, ID, KS:SU, MT:S3, ND:S1, NM, NV, SD, UT:S2S4, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 19:C, 20:C, 26:C, 27:C, 33:P
USFS Ecoregions (1994/95): 313A:CC, 331F:CP, 331H:CC, 332C:CP, 341B:CC, 341C:CC, 341E:CC, 342G:CC, M331E:CC, M331H:CC
Federal Lands: NPS (Arches, Badlands?, Capitol Reef, Dinosaur, Grand Canyon, Sand Creek Massacre); USFWS (Lacreek, Ouray)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: G.P. Jones, mod. K. Schulz, J. Coles, L. Allen
References: Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bundy et al. 1996, Butler et al. 2002, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a,

Driscoll et al. 1984, Gleason and Cronquist 1991, Great Plains Flora Association 1986, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Jones 1992b, Jones and Walford 1995, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999b, Larson 1993, Lauver et al. 1999, MTNHP 1988, MTNHP 2002b, MacKenzie and Moran 2004, Muldavin et al. 2000a, NDNHI unpubl. data, Neid et al. 2007, Reid and Hall 2010, Romme et al. 1993, Thompson and Hansen 2002, Von Loh et al. 2002, WNDD unpubl. data, Walford 1996, Western Ecology Working Group n.d.

Typha domingensis Western Herbaceous Vegetation

Southern Cattail Western Herbaceous Vegetation
Identifier: CEGL001845

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	Arid West Emergent Marsh (G531)
Association	*Typha domingensis* Western Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This wetland association is widespread across the southwestern United States and Great Basin. These marshes occur in bottomlands along drainages, in river floodplain depressions, oxbow lakes, and below seeps. Substrates are variable but are generally fine-textured, alkaline, alluvial soil. Flood regimes range from seasonal inundation with the soils drying out and cracking in late summer to permanently flooded marshes. The vegetation is characterized by a dense, 2- to 4-m tall herbaceous layer of *Typha domingensis* that dominates the site as a monoculture or codominates with *Schoenoplectus acutus (= Scirpus acutus)* or species of *Carex*. Associated graminoids include *Carex nebrascensis, Eleocharis palustris, Eleocharis macrostachya, Juncus balticus, Schoenoplectus maritimus (= Scirpus maritimus), Schoenoplectus pungens*, and under drier conditions *Hordeum jubatum* and *Distichlis spicata* may be present. During extended inundation, aquatic plant such as *Stuckenia pectinata (= Potamogeton pectinatus)* may flourish. Other forbs such as *Euthamia occidentalis (= Solidago occidentalis), Polygonum lapathifolium (= Persicaria lapathifolium), Chenopodium* spp., and *Sagittaria* spp. may also be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This cattail herbaceous association occurs in the Inner Canyon and Western Grand Canyon, predominantly along the Colorado River corridor, but also in major perennial tributaries. It occurs at 375 to 950 m (1200-3100 feet) elevation, immediately along riverbanks or streambanks, in backwater coves, pools, and in other areas of slow-moving perennial water.
Global Environment: This wetland association is widespread across the southwestern United States and Great Basin. This community occurs in areas of standing water or subirrigation. Running water is uncommon, except during periods of extensive irrigation runoff or because of high precipitation (Haase 1972). Elevations range from 300-1450 m. These marshes occur in bottomlands along drainages, in river floodplain depressions, oxbow lakes, and below seeps. Substrates are variable but are generally fine-textured, alkaline, alluvial soil. Flood regimes range from seasonal inundation with the soils drying out and cracking in late summer to permanently flooded marshes. *Typha domingensis* is more alkaline-tolerant than *Typha latifolia*.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: *Typha domingensis* (50-60%) characterizes and dominates this herbaceous community type, although it typically also supports *Salix exigua* (8%) in the short-shrub layer. Herbaceous wetland obligates, including *Juncus torreyi, Carex aquatilis, Juncus articulatus*, and *Phragmites australis*, also occasionally occur at fairly low individual covers. The forbs *Centaurium calycosum* and *Pseudognaphalium stramineum* occasionally occur at about 1% cover each. A trace amount of *Equisetum X ferrissii* can be found in some stands.
Global Vegetation: The vegetation is characterized by a dense, 2- to 4-m tall herbaceous layer of *Typha domingensis* that dominates the site as a monoculture or codominates with *Schoenoplectus acutus (= Scirpus acutus)* or species of *Carex*. Associated graminoids include *Carex nebrascensis, Eleocharis palustris, Eleocharis macrostachya, Juncus balticus, Schoenoplectus maritimus (= Scirpus maritimus), Schoenoplectus pungens*, and under drier conditions *Hordeum jubatum* and *Polypogon monspeliensis*. During extended inundation aquatic plants like *Stuckenia pectinata (= Potamogeton pectinatus)* may flourish. Other forbs such as *Euthamia occidentalis (= Solidago occidentalis), Polygonum lapathi-*

folium (= Persicaria lapathifolium), Chenopodium spp., and *Sagittaria* spp. may be present. Introduced species such as *Bassia scoparia (= Kochia scoparia), Lepidium latifolium*, and *Polypogon monspeliensis* may be abundant on disturbed sites.

In Colorado, *Typha domingensis* dominated the sampled stands (60-75% cover), with *Carex nebrascensis* and *Schoenoplectus acutus* associated (5-20% cover). Other species present included *Cicuta douglasii, Eleocharis palustris, Hordeum jubatum*, and *Triglochin maritima*. The *Typha domingensis*-dominated community described in southern Arizona (Haase 1972) included other *Typha* spp., *Schoenoplectus americanus (= Scirpus olneyi)*, and *Phragmites australis (= Phragmites communis)*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*
Herb (field)	Graminoid	*Typha domingensis*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Schoenoplectus acutus, Typha domingensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Equisetum* x *ferrissii*, *Juncus torreyi*, *Salix exigua*, *Typha domingensis*
Global: *Schoenoplectus acutus*, *Typha domingensis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (20-Sep-2000).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: There are 6 *Typha domingensis* associations described from the southeastern U.S., and only one from the western U.S. It is likely that there are associations yet to be classified in the West. The concept of this association is broad and currently includes both *Typha domingensis* monoculture and mixed stands with seasonally or permanently flooded hydrological regimes. More classification work needs to be done to fully characterize this wetland in the West.
Global Similar Associations:

- *Typha (angustifolia, domingensis, latifolia) - Schoenoplectus americanus* Herbaceous Vegetation (CEGL002032) is only reported from the southeastern U.S.
- *Typha domingensis - Pontederia cordata* Herbaceous Vegetation (CEGL003988) is only reported from the southeastern U.S.
- *Typha domingensis - Setaria magna* Herbaceous Vegetation (CEGL004138) is only reported from the southeastern U.S.
- *Typha domingensis* Seasonally Flooded Gulf Coastal Plain Herbaceous Vegetation (CEGL004137) is only reported from the southeastern U.S.
- *Typha domingensis* Semipermanently Flooded Tropical Herbaceous Vegetation (CEGL003987) is only reported from the southeastern U.S.
- *Typha domingensis* Tidal Herbaceous Vegetation (CEGL008456) is only reported from the southeastern U.S.

Global Related Concepts:

- *Typha domingensis - Scirpus acutus* Association (Bundy et al. 1996) **<**
- *Typha domingensis* (Bourgeron and Engelking 1994) **=**

- *Typha domingensis* Association (Bundy et al. 1996) <
- *Typha domingensis* Riparian Wetland (Baker 1983b) =
- *Typha* community (Haase 1972) =
- DRISCOLL FORMATION CODE:V.C.6.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and Western Grand Canyon immediately along the Colorado River corridor; it also occurs along perennial streams in tributary canyons.
Global Range: This wetland association is widespread across the southwestern United States and Great Basin.
Nations: US
States/Provinces: AZ, CA, CO:S1, NV:S5?, UT, WY
TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C, 22:C, 23:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322B:CC, 341A:CC, 341C:CC, 341D:CC, 341E:CC, 341F:CC, 341G:CC, M331F:CC, M341B:CC
Federal Lands: NPS (Canyonlands, Grand Canyon, Great Sand Dunes); USFWS (Buenos Aires, Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on two (2) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: M.S. Reid, mod. K. Schulz
References: Baker 1982b, Baker 1983b, Bourgeron and Engelking 1994, Bundy et al. 1996, CONHP 2010, CONHP unpubl. data 2003, Driscoll et al. 1984, Haase 1972, Reid and Hall 2010, Salas et al. 2010b, Schulz 2004, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.

G533. North American Warm Desert Riparian Low Bosque & Shrubland

Baccharis emoryi - Salix exigua Shrubland

Emory's Seep-willow - Narrowleaf Willow Shrubland
Identifier: CEGL005947

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Baccharis emoryi - Salix exigua* Shrubland

ELEMENT CONCEPT

Global Summary: This riparian shrubland association is found in the Pecos Basin in southeastern New Mexico and may occur farther south in the Trans-Pecos region of Texas. It occurs along low-gradient rivers with sandy-bottomed channels of wide lowland valleys at elevations from 1080 to 1110 m (3550-3650 feet). Soils are reported as weakly developed Aquic Ustipsamments and Oxyaquic Torrifluvents that are comprised of deep sandy sediments that are well-drained. Occasionally, they may have a thin, clayey surface layer that retains greater moisture. Underlying layers have less than 35% cobbles or gravels. *Baccharis emoryi* forms dense shrub thickets in association with *Salix exigua*. Canopies can exceed 85% cover and reach up to 2.5 m (8 feet) in height. The herbaceous layer is low to moderate in cover and dominated by *Schoenoplectus pungens (= Scirpus pungens)*. Other wetland indicators that may be present include *Eleocharis palustris, Muhlenbergia asperifolia*, and *Equisetum laevigatum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs in the Inner Canyon and Western Grand Canyon throughout the length of the Colorado River corridor at 450 to 950 m (1500-3100 feet) elevation, and along perennial streams in the Inner Canyon at up to 1375 m (4500 feet). It occurs on essentially flat, low-level slopes, typically in poorly-drained sandy clay soils. Litter (30%), rocks (30%), gravel (15%), and flowing water (10%) are major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrubland association often occurs in linear swathes along riparian channels and can support very dense vegetation cover (50-90%). It is dominated by the short or tall shrub *Baccharis emoryi* (30-60%) and is characterized by a strong component of *Salix exigua* (8-15%) in the shrub strata. *Tamarix ramosissima* (15% cover or more) occurs intermixed in the majority of stands as a tall shrub or small tree. Other short or dwarf-shrubs are essentially lacking from this vegetation type. Graminoid cover is typically quite sparse (1-2%); however, the tall reedlike grass *Phragmites australis* rarely codominates some stands at 20% cover or more. *Bromus rubens* (1%) often occurs scattered in the understory. Forb cover is relatively low (2-3%), and forb composition varies between stands. *Artemisia ludoviciana, Pseudognaphalium* spp., and *Melilotus officinalis* occur fairly frequently. In many stands, *Equisetum X ferrissii* (10%) occurs in the saturated sand or soil along the channel bank. This association typically hosts average species diversity among plant communities in Grand Canyon.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Baccharis emoryi*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis emoryi*, *Equisetum* x *ferrissii*, *Salix exigua*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Alhagi maurorum* (exotic, Medium/Low), *Bromus catharticus* (exotic, Insignificant), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Dactylis glomerata* (exotic, Medium/Insignificant), *Lepidium latifolium* (exotic, High), *Lolium arundinaceum* (exotic, High/Medium), *Melilotus officinalis* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Sonchus asper* (exotic), *Tamarix ramosissima* (exotic, High), *Verbascum thapsus* (exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (28-Sep-2004). This riparian shrubland association of the Pecos basin has likely undergone significant declines as a result of impoundments and subsequent river regulation along with agricultural conversion and livestock use. It requires low-gradient floodplain habitats in which natural hydrological processes are operational to ensure reproduction and maintenance of *Baccharis emoryi* and other key wetland species. Conditions such as these are now rare in river basins of the Southwest. In addition, stands can be significantly impacted when minimum in-stream base flows are not maintained, and many occurrences have been invaded by alien species. The rank of G3 was assigned pending further documentation, but the expectation is that this rank will be upheld.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This association can be distinguished from other riparian *Baccharis* spp. shrublands by the strong presence of *Salix exigua* (8-15%) in the shrub layers.
Global Comments: This association is distinguished from others in the alliance by the codominance of *Salix exigua* and the relatively low herbaceous cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from riparian habitats in the Inner Canyon; it was sampled from Transept Canyon and Bright Angel Creek, as well as from numerous localities along the Colorado River corridor.
Global Range: This association is found in the Pecos Basin in southeastern New Mexico but may occur in Trans-Pecos Texas and westward.
Nations: US
States/Provinces: AZ, NM:S3, TX?

TNC Ecoregions: 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321:C
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.02607, GRCA.02609; and 38 Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: E. Muldavin et al.
References: Muldavin et al. 2000a, NMNHP unpubl. data, Reid and Hall 2010, Western Ecology Working Group n.d.

Baccharis emoryi / *Imperata brevifolia* Shrubland [Park Special]

Emory's Seep-willow / California Satintail Shrubland
Identifier: CEPS009679

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Baccharis emoryi* / *Imperata brevifolia* Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Baccharis salicifolia Riparian Shrubland

Mule-fat Riparian Shrubland
Identifier: CEGL003549

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Baccharis salicifolia* Riparian Shrubland

ELEMENT CONCEPT

Global Summary: This riparian shrubland is known from central and southern interior coastal mountains of California, the Anza-Borrego Desert, and south into Baja California, Mexico. It is often found along washes, springs and riparian corridors. It is usually a small stringer community. It can occur on steep slopes associated with springs. Soils are course to fine sandy loams, mostly derived from alluvium. Elevation ranges from 216 to over 914 m

(708-3000+ feet). The shrub layer is dominated by *Baccharis salicifolia*. Non-native *Tamarix* is often found but usually in relatively low cover. *Baccharis pilularis* may also be present in low cover. The herbaceous layer is dominated by a variety of non-native and native species such as *Ambrosia psilostachya, Bromus hordeaceus, Hirschfeldia incana, Lepidium latifolium, Artemisia douglasiana*, and *Urtica dioica*. *Salix gooddingii* or *Platanus racemosa* may be emergent in some stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This riparian shrubland association occurs in the Inner Canyon and Western Grand Canyon along the Colorado River corridor at 450 to 900 m (1500-3000 feet) elevation, and along perennial streams in the Inner Canyon at up to 900 m (3000 feet). It is chiefly distributed to the west of Marble Canyon. It occurs on essentially flat, low-level slopes, typically in saturated sandy soils. Bare soil or sand (40%), litter (30%), rocks (15%), and gravel (5%) are major components of the ground cover.

Global Environment: This shrubland is often found along washes, springs and riparian corridors. It is usually small, stringer community. It can occur on steep slopes associated with springs. Soils are course to fine sandy loams, mostly derived from alluvium. Elevation ranges from 216 m to over 915 m (708-3000+ feet). In the Anza-Borrego Desert, *Baccharis salicifolia* is found scattered as small stands associated with springs and riparian stringers above 915 m and is most extensive at Sentenac Cienega.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrubland association often occurs in linear swathes along riparian channels and typically supports 40-50% vegetation cover. The short shrub *Baccharis salicifolia* (20%) dominates and characterizes this community, while the non-native *Tamarix ramosissima* (12%) also occurs in the majority of stands. The cover of both *Baccharis salicifolia* (up to 40%) and *Tamarix ramosissima* (up to 50%) can be considerably higher in dense stands. In the rare cases when *Tamarix ramosissima* cover exceeds that of *Baccharis salicifolia, Baccharis salicifolia* acts as an indicator species. Various other shrub species including *Salix exigua, Pluchea sericea, Baccharis emoryi*, and *Baccharis sarothroides* sporadically occur intermixed with the dominant shrubs at low individual covers (typically less than 5%). Dwarf-shrubs are lacking in this community. A graminoid understory (6%) only occurs in the minority of stands; however, it is composed chiefly of non-native species, including *Cynodon dactylon* (5%), *Bromus rubens* (1%), *Polypogon monspeliensis* (1%), and *Agrostis stolonifera* (1%) when it exists. The forb stratum is poorly-developed (1%) and variable. *Equisetum X ferrissii* (3%) occurs in some stands along banks of the riparian channels.

Global Vegetation: *Baccharis salicifolia* is usually dominant. Non-native *Tamarix* is often found but usually in relatively low cover. *Baccharis pilularis* may also be present in low cover. *Salix gooddingii* may be emergent in some stands. The herbaceous layer is dominated by a variety of non-native and native species such as *Ambrosia psilostachya, Bromus hordeaceus, Hirschfeldia incana, Lepidium latifolium, Artemisia douglasiana*, and *Urtica dioica*. Other herbaceous species include forbs *Pseudognaphalium canescens ssp. beneolens (= Gnaphalium canescens ssp. beneolens), Lotus unifoliolatus var. unifoliolatus (= Lotus purshianus var. purshianus), Melilotus indicus*, and *Rumex salicifolius*, and graminoids *Aira caryophyllea, Bromus diandrus*, and *Vulpia myuros*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Baccharis salicifolia*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Baccharis salicifolia*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Melilotus officinalis* (exotic, Medium/Low), *Plantago lanceolata* (exotic, High/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Sonchus asper* (exotic)

Global: Vulnerable: *Juglans californica* (CA endemic, G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (14-Dec-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: This association can be distinguished from other *Baccharis*-dominated associations as it is dominated by *Baccharis salicifolia* and not *Baccharis emoryi* or *Baccharis sarothroides*.
Global Comments: A similar *Baccharis salicifolia - Sambucus mexicana* association has been described from western Riverside County (Klein and Evens 2006). Very similar stands occur at least as far north as Shasta County in the Sacramento Valley of California (T. Keeler-Wolf pers. obs. 2004). Due to the inherent variability of these riparian scrublands, it remains to be seen if these associations should stay separate.
Global Related Concepts:

- *Baccharis salicifolia* Riparian Shrubland (Evens and San 2006) =
- *Baccharis salicifolia* Riparian Shrubland (Klein and Evens 2006) =
- *Baccharis salicifolia* Riparian Shrubland (Keeler-Wolf et al. 1998) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from riparian areas in the Inner Canyon and Western Grand Canyon. It was sampled from Kanab Creek and numerous locations along the Colorado River corridor.
Global Range: This association is known from the Santa Monica Mountains region, interior Central Coast Ranges (Pinnacles National Monument), central San Diego County, and the Anza-Borrego Desert. In addition, *Baccharis salicifolia* stands range widely from the northern Sacramento Valley south into Baja California, Mexico.
Nations: MX, US
States/Provinces: AZ, CA:S5, MXBC, NM
TNC Ecoregions: 13:C, 15:C, 16:C, 19:C, 23:C
USFS Ecoregions (1994/95): 261B:CC, 262A:CC, 313A:CC, 322C:CC, M262A:CC, M262B:CC
Federal Lands: NPS (Grand Canyon, Pinnacles, Santa Monica Mountains); USFWS (Buenos Aires)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.01028, GRCA.01031; and 26 Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: T. Keeler-Wolf and J. Evens, mod. G. Kittel
References: Evens and San 2006, Keeler-Wolf and Evens 2006, Keeler-Wolf et al. 1998, Keeler-Wolf pers. comm., Kittel et al. 2009, Klein and Evens 2006, Muldavin et al. 2000a, Reid and Hall 2010, Schulz 2004, Western Ecology Working Group n.d.

***Baccharis sarothroides* Shrubland [Park Special]**

Rosinbush Shrubland
Identifier: CEPS009677

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Baccharis sarothroides* Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (1-Feb-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Pluchea sericea Seasonally Flooded Shrubland

Arrow-weed Seasonally Flooded Shrubland
Identifier: CEGL003080

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Pluchea sericea* Seasonally Flooded Shrubland

ELEMENT CONCEPT

Global Summary: This evergreen shrubland is found in wetlands from southern California to the Sonoran Desert, and extends north into the Colorado Plateau in southwestern Utah. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil. The vegetation is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis, Atriplex* spp., *Baccharis* spp., *Prosopis* spp., *Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. The typically sparse herbaceous layer, if present, is typically composed of *Distichlis spicata, Schoenoplectus americanus (= Scirpus americanus), Sporobolus airoides*, or *Typha angustifolia*. The presence of weedy species is common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs in the Inner Canyon and Western Grand Canyon primarily on sandy beaches along the Colorado River corridor, but also in low-level valley bottoms, drainage channels, and terraces in side canyons. It occurs at 375 to 900 m (1200-3000 feet) elevation, on gentle gradients (2-6 degrees), and across all aspects. Soils are well-drained and predominantly sandy. Sand strongly dominates the ground cover of stands along the Colorado River corridor, while litter (43%), gravel (20%), bare soil (18%), and rocks (12%) are all common in stands which occur in side canyons.
Global Environment: This evergreen shrubland is found in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southwestern Utah. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 50% or more in this association which is characterized by dense and fairly pure stands of *Pluchea sericea* (45% cover, up to 80% in very dense stands). The

tall shrub *Tamarix ramosissima* (10%) occurs scattered among *Pluchea sericea* in the majority of stands, while *Prosopis glandulosa* occurs infrequently at up to 15% cover. *Baccharis* spp. *Baccharis emoryi, Baccharis sarothroides*, or *Baccharis salicifolia*) and *Isocoma acradenia* rarely punctuate the short-shrub layer at up to 10% cover. A graminoid understory (6%) only occurs about half of the time, but consists chiefly of the non-native *Bromus rubens* (5%) when present. Forb cover is very low (1%), and composition is variable.

Global Vegetation: This plant association is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis, Atriplex canescens, Atriplex torreyi, Baccharis emoryi, Baccharis sergiloides, Prosopis glandulosa, Prosopis pubescens, Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. The typically sparse herbaceous layer, if present, is typically composed of *Distichlis spicata, Schoenoplectus americanus (= Scirpus americanus), Sporobolus airoides*, or *Typha angustifolia*. Weedy species such as *Erodium cicutarium, Lactuca* spp., *Melilotus officinalis* are common in disturbed stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Short shrub/sapling	Broad-leaved deciduous shrub	*Pluchea sericea*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Pluchea sericea*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Pluchea sericea*, *Tamarix ramosissima*
Global: *Pluchea sericea*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Lepidium latifolium* (exotic, High), *Melilotus officinalis* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Schismus barbatus* (exotic, High/Medium), *Sonchus asper* (exotic), *Tamarix ramosissima* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3? (1-Dec-1997).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Related Concepts:

- Arrow Weed Series (Sawyer and Keeler-Wolf 1995) >
- Arrowweed Scrub (63820) (Holland 1986b) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Stone Creek and numerous locations along the Colorado River corridor; and from the Western Grand Canyon, where it was sampled along the Colorado River corridor, in Separation Canyon, Burnt Canyon, and along the shores of Lake Mead to the east of Pearce Ferry.
Global Range: This wetland association occurs in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southwestern Utah.
Nations: US

States/Provinces: AZ, CA:S3, UT
TNC Ecoregions: 6:C, 13:C, 15:C, 16:C, 17:C, 19:C, 23:C
USFS Ecoregions (1994/95): 261B:CC, 262A:CC, 313A:CC, 322A:CC, 322B:CC, 322C:CC, 331A:CC, M262A:CC
Federal Lands: NPS (Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01558, GRCA.03502, GRCA.03675, GRCA.03702; and 33 Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Barbour and Major 1977, Beatley 1976, Cogan et al. 2004, Holland 1986b, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Western Ecology Working Group n.d.

Prosopis glandulosa var. *torreyana* Shrubland

Western Honey Mesquite Shrubland
Identifier: CEGL001381

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Prosopis glandulosa var. torreyana* Shrubland

ELEMENT CONCEPT

Global Summary: This mesquite shrubland association is currently described from Grand Canyon National Park in Arizona. It is also reported from Nevada and Texas and possibly New Mexico. More survey and classification work are needed to fully characterize this type. It occurs most commonly along the Colorado River corridor above the old high-water line, but also in large tributary canyons along drainage channels and on adjacent sideslopes. It typically occurs at 375 to 850 m (1225-2825 feet) elevation, but has been observed at up to 1050 m (3475 feet). It occurs on gentle to moderate gradients (up to 20 degrees), across all aspects other than south-facing. When found on sideslopes, it typically occurs on low slopes or toeslopes. Soils are well- to rapidly-drained sandy loams. Some stands support notable cryptogamic soil crust. This association is characterized by pure and fairly dense stands of tall-shrub or small-tree *Prosopis glandulosa var. torreyana*, which can reach 75% cover in dense stands. *Encelia farinosa* occasionally occurs in the short-shrub layer, while various other species, including *Baccharis sarothroides*, *Pluchea sericea*, *Isocoma acradenia*, *Atriplex canescens*, and *Ephedra* spp., occur less frequently. Dwarf-shrubs are essentially absent. Exotic *Bromus rubens* and the native annual *Vulpia octoflora* dominate the graminoid understory when it occurs, although it is not present in all stands. Forb composition is quite variable.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This mesquite shrubland association occurs in the Inner Canyon and Western Grand Canyon, most commonly along the Colorado River corridor above the old high-water line, but also in large tributary canyons along drainage channels and on adjacent sideslopes. It typically occurs at 375 to 850 m (1225-2825 feet) elevation, but has been observed at up to 1050 m (3475 feet). It occurs on gentle to moderate gradients (up to 20 degrees), across all aspects other than south-facing. When found on sideslopes, it typically occurs on low slopes or toeslopes. Soils are well- to rapidly-drained sandy loams. Litter (36%), gravel (21%), rocks (17%), and bare soil (12%) are major components of the ground cover; some stands support notable cryptogamic soil crust.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 50-60% in this association which is characterized by pure and fairly dense stands of tall-shrub or small-tree *Prosopis glandulosa var. torreyana* (45%), which can reach 75% cover in dense stands. *Encelia farinosa* (2%) occasionally occurs in the short-shrub layer (4-6%), while various other species, including *Baccharis sarothroides, Pluchea sericea, Isocoma acradenia, Atriplex canescens*, and *Ephedra* spp., occur less frequently. Dwarf-shrubs are essentially absent. Graminoid cover averages

4-5%, but can be significantly higher in some stands. *Bromus rubens* (4-5%) and the native annual *Vulpia octoflora* (1-2%) dominate the graminoid understory when it occurs, although it is not present in all stands. Forb (1%) composition is quite variable. Based upon the 12 Grand Canyon Vegetation Mapping program stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 13 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Prosopis glandulosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Encelia farinosa*, *Prosopis glandulosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus catharticus* (exotic, Insignificant), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Poa pratensis* (exotic, Medium), *Salsola tragus* (exotic), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium altissimum* (exotic), *Sonchus asper* (exotic), *Tamarix ramosissima* (exotic, High), *Taraxacum officinale* (exotic)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Prosopis glandulosa var. torreyana* Sand Dune Shrubland (CEPS009526) is also dominated by *Prosopis glandulosa var. torreyana*; however, it occurs on sand dunes as opposed to on sideslopes and drainage channels, and *Prosopis glandulosa var. torreyana* usually also occurs at lower cover (8-10%) than in *Prosopis glandulosa var. torreyana* Shrubland (CEGL001381).
Global Similar Associations:
- *Prosopis glandulosa var. torreyana* Sand Dune Shrubland [Park Special] (CEPS009526) has less cover and occurs on sand dunes.

Global Related Concepts:
- *Prosopis glandulosa* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.2.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Royal Arches near Buck Farm Canyon, Lava (Chuar) Canyon, Unkar Creek, Kwagunt rapids, the mouth of Palisades Creek, Tanner rapids, and numerous locations along the Colorado River corridor, particularly near the old high-water line; and from the Western Grand Canyon, where it was sampled from near Lava Falls, Burnt Canyon, Surprise Canyon, and to the East of Pearce Ferry.
Global Range: This association is currently described from Grand Canyon National Park in Arizona. It is also reported from Nevada and Texas and possibly New Mexico. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, NM?, NV:S3, TX
TNC Ecoregions: 11:C, 17:C, 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322:?, 341A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.01534, GRCA.01543, GRCA.01545, GRCA.01668, GRCA.02540, GRCA.02541, GRCA.02547, GRCA.02562, GRCA.03504, GRCA.03584, GRCA.03703, GRCA.04559; and 68 Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Beatley 1976, Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Western Ecology Working Group n.d.

Salix exigua / *Equisetum* X *ferrissii* Shrubland [Park Special]

Narrowleaf Willow / Ferriss' Horsetail Shrubland
Identifier: CEPS009538

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Salix exigua* / *Equisetum X ferrissii* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This willow shrubland association occurs throughout Grand Canyon National Park along the Colorado River corridor. It occurs at 375 to 950 m (1200-3100 feet) elevation immediately along the riverbank, in moist or saturated sandy soil.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub typically averages 60-70% in this association. *Tamarix ramosissima* (15% cover or less) comprises a distinct tall-shrub layer; however, the short shrub *Salix exigua* (60%) dominates this association and can occur at up to 90% cover in dense stands. *Brickellia longifolia* (2%) and *Baccharis emoryi* (2%) frequently occur scattered among the dense *Salix exigua*. This association supports a very strong understory (40%) of graminoids and *Equisetum X ferrissii* (20%). The graminoid layer (20-25%) is dominated by *Carex aquatilis* (15%), while *Agrostis exarata* (2%), *Elymus glaucus* (2%), and *Bromus catharticus* (2%) also occur in the majority of stands. Forb cover is low (2%), and the non-natives *Plantago major* and *Sonchus asper* occur in the majority of stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*
Herb (field)	Forb	*Plantago major*
Herb (field)	Graminoid	*Carex aquatilis*
Herb (field)	Fern or fern ally	*Equisetum x ferrissii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agrostis exarata*, *Brickellia longifolia*, *Carex aquatilis*, *Elymus canadensis*, *Equisetum* x *ferrissii*, *Plantago major*, *Salix exigua*, *Sonchus asper*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus catharticus* (exotic, Insignificant), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Lolium arundinaceum* (exotic (= Schedonorus phoenix), High/Medium), *Plantago major* (exotic), *Sonchus asper* (exotic), *Tamarix ramosissima* (exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Nonstandard

Grand Canyon National Park Comments: *Equisetum X ferrissii* Herbaceous Vegetation (CEGL005394) also supports a strong component of *Equisetum X ferrissii* in the understory; however, it lacks *Salix exigua* or any shrub layer. *Salix exigua* / Barren Shrubland (CEGL001200) also supports *Salix exigua* in the shrub strata; however, *Equisetum X ferrissii* is essentially absent from the understory.

Global Similar Associations:

- *Equisetum X ferrissii* Herbaceous Vegetation (CEGL005394) also supports a strong component of *Equisetum X ferrissii* but lacks *Salix exigua* or any shrub layer.
- *Salix exigua* / Barren Shrubland (CEGL001200) also supports *Salix exigua* in the shrub strata, but *Equisetum X ferrissii* is essentially absent from the understory.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and Western Grand Canyon, where it occurs in riparian habitats along the Colorado River corridor.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on three (3) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.

Local Description Authors: K. Christie

Global Description Authors:

References: Western Ecology Working Group n.d.

***Salix exigua* / Barren Shrubland**

Narrowleaf Willow / Barren Shrubland

Identifier: CEGL001200

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Salix exigua* / Barren Shrubland

ELEMENT CONCEPT

Global Summary: This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and Great Basin. It is composed of nearly pure stands of *Salix exigua*, with few other species. Exposed gravel, cobbles or sand characterize the ground cover, but an undergrowth of a few, scattered forbs and grasses is usually present. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and streambanks.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs throughout Grand Canyon National Park along the Colorado River corridor. It occurs at approximately 375 to 950 m (1200-3100 feet) elevation, immediately along the riverbank, typically in saturated sand substrates. It also occurs in similar riparian habitats along larger, perennially wet tributary canyons.

Global Environment: This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and Great

Basin. Elevation ranges from 780-2600 m. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and on streambanks occurring along a wide variety of stream reaches, from moderately sinuous and moderate-gradient reaches. It can form large, wide stands on mid-channel islands in larger rivers or narrow stringer bands on small, rocky tributaries. Substrates are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified vertically from flooding scour and deposition, often consisting of alternating layers of finer textured soil with organic material over coarser alluvium. Occasionally, this association occurs on deep pockets of sand. The lack of soil development and high ground cover of coarse alluvial material are key indicators for this association.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characterized by a relatively pure short-shrub layer of *Salix exigua* (20-40%), although the exotic tall shrub *Tamarix ramosissima* (15%, sometimes up to 60%) also occurs in some stands. *Baccharis emoryi* (2-15%) sometimes occurs as an associate in the short-shrub stratum. Additional shrub components, as well as graminoids and forbs, are poorly represented or absent from this association. Scattered grasses, such as the exotic *Bromus tectorum* (1-3%), and *Bromus rubens* (1-3%) occasionally occur in the understory. Rarely the tall reed grass *Phragmites australis* codominates with *Salix exigua* at 15-40% cover. *Artemisia ludoviciana* and *Euthamia occidentalis* are the most frequent components of a sparse (1% or less) and inconsistent forb layer.
Global Vegetation: This riparian association is characterized by a sparse to dense, tall-shrub (1.5-3 m) canopy composed of *Salix exigua*, with ground cover of exposed gravel, cobbles or sand. *Salix exigua* may be the only shrub in the community, or other shrubs and trees may be present with relatively low cover, including *Alnus incana, Ericameria nauseosa, Rhus trilobata, Salix monticola, Salix ligulifolia (= Salix eriocephala var. ligulifolia), Salix irrorata, Salix lucida, Abies lasiocarpa, Acer negundo, Populus angustifolia, Populus deltoides, Populus fremontii*, and *Salix gooddingii*. A sparse herbaceous layer may be present among the bare soil, gravel, cobbles, or boulders, consisting of a wide variety of forbs and graminoids. *Mentha arvensis* and species of *Carex, Eleocharis, Juncus, Schoenoplectus*, and *Equisetum* are often present. Introduced species, such as *Elaeagnus angustifolia, Tamarix* spp., *Bromus tectorum, Bromus inermis, Elymus repens (= Elytrigia repens), Poa pratensis, Agrostis stolonifera* (and other exotic forage species), *Taraxacum officinale, Conyza canadensis*, and *Lepidium latifolium*, have been reported from some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Salix exigua*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous tree	*Salix exigua*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Salix exigua*
Global: *Salix exigua*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Conyza canadensis* (exotic), *Lolium arundinaceum* (exotic, High/Medium), *Melilotus officinalis* (exotic, Medium/Low), *Salsola tragus* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Elaeagnus angustifolia* (invasive/exotic, High), *Elymus repens* (invasive/exotic, High/Medium), *Lepidium latifolium* (invasive/exotic, High), *Melilotus officinalis* (invasive/exotic, Medium/Low), *Tamarix chinensis* (invasive/exotic), *Taraxacum officinale* (invasive/exotic), *Xanthium strumarium* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (15-Jun-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Salix exigua* also dominates the shrub strata in *Salix exigua* / *Equisetum X ferrissii* Shrubland [Park Special] (CEPS009538); however *Equisetum X ferrissii* (20%) is strongly represented in the understory.
Global Comments: In the western Great Plains this association includes stands composed of intermediates between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* (Dorn 1997, G. Kittel pers. comm. 2001). Until recently these taxa were combined at the species level (Kartesz 1999). More information on the distribution of introgression between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* is needed to fully understand the ranges of these two species.
Global Similar Associations:
- *Salix exigua* / *Equisetum X ferrissii* Shrubland [Park Special] (CEPS009538)
- *Salix exigua* / Mesic Forbs Shrubland (CEGL001202)
- *Salix exigua* / Mesic Graminoids Shrubland (CEGL001203)

Global Related Concepts:
- *Salix exigua* - *Salix* spp. / *Poa* spp. Plant Association (Johnston 1987) >
- *Salix exigua* / Barren Ground Plant Association (Kittel et al. 1994) =
- *Salix exigua* / Barren Ground Plant Association (Kittel et al. 1995) =
- *Salix exigua* / Barren Ground Plant Association (Culver et al. 1996) =
- *Salix exigua* / Scour (Durkin et al. 1995b) <
- *Salix exigua* / Sparse (Durkin et al. 1995b) <
- *Salix exigua ssp. exigua* Communities (Tuhy and Jensen 1982) >
- *Salix exigua* / Barren Community Type (Padgett et al. 1989) =
- *Salix exigua* / Barren Ground Shrubland (Carsey et al. 2003a) =
- *Salix exigua* / Bench Community Type (Manning and Padgett 1995) =
- *Salix exigua* Community Type (Hall and Hansen 1997) =
- *Salix exigua* Community Type (Hansen et al. 1995) =
- *Salix exigua* Plant Association (Richard et al. 1996) =
- *Salix exigua*/Barren (Bourgeron and Engelking 1994) =
- Coyote willow association (Kovalchik 1987) ?
- Coyote willow/bare ground (*Salix exigua*/bare ground) Plant Association (Kittel et al. 1999a) =
- DRISCOLL FORMATION CODE:III.B.3.c. (Driscoll et al. 1984) >
- Palustrine (Cowardin et al. 1979) >
- unclassified stands of *Salix exigua* (Jones and Walford 1995) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from throughout the Inner Canyon and Western Grand Canyon, where it was sampled along the Colorado River corridor. A single plot was also sampled in "Slimy Tick Canyon," a short tributary to the Colorado River just upstream from Havasu Canyon on river right.
Global Range: This riparian shrubland association is common along waterways of all sizes at lower to middle elevations in the Great Basin, Colorado Plateau and Rocky Mountains extending out into the western Great Plains along major rivers.
Nations: US
States/Provinces: AZ, CO:S5, ID?, MT:S5, NM:S4, NV, OR:SU, UT:S3?, WA:S2, WY
TNC Ecoregions: 6:C, 8:C, 9:C, 10:C, 18:C, 19:C, 20:C, 24:C, 27:C
USFS Ecoregions (1994/95): 311:C, 313A:CC, 313B:CC, 313D:CC, 321A:CC, 331C:CC, 331H:CC, 331I:CC, 341B:CC, 341C:CC, 342B:CC, 342D:CC, 342E:CC, 342G:CC, M331D:CC, M331E:CC, M331G:CC, M331H:CC, M331I:CC, M332A:CC, M332E:CC, M341B:CC, M341C:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Dinosaur, Grand Canyon, John Day Fossil Beds, Petrified Forest, Wupatki, Zion); USFS (Comanche, Deschutes, Fremont, Malheur, Ochoco, San Juan, Winema); USFWS (Bosque del Apache, Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (1 plot): GRCA.04583; and 14 Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Christy 1973, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Culver et al. 1996, Donnelly et al. 2006, Dorn 1997, Driscoll et al. 1984, Durkin et al. 1995b, Hall and Hansen 1997, Hansen et al. 1995, Hansen et al. 2004b, IDCDC 2005, Johnston 1987, Jones and Walford 1995, Kagan et al. 2004, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999a, Kovalchik 1987, MTNHP 2002b, Manning and Padgett 1995, Muldavin et al. 2000a, NMNHP unpubl. data, Padgett 1981, Padgett et al. 1988b, Padgett et al. 1989, Peterson 2008, Reid and Hall 2010, Richard et al. 1996, Romme et al. 1993, Thomas et al. 2009a, Tuhy and Jensen 1982, Von Loh et al. 2002, WNDD unpubl. data, Western Ecology Working Group n.d.

Vitis arizonica Shrubland [Park Special]
Canyon Grape Shrubland
Identifier: CEPS009693

USNVC CLASSIFICATION

Division	Southwestern North American Warm Desert Freshwater Marsh (2.B.6.Nc)
Macrogroup	Warm Desert Freshwater Shrubland, Meadow & Marsh (M076)
Group	North American Warm Desert Riparian Low Bosque & Shrubland (G533)
Association	*Vitis arizonica* Shrubland [Park Special]

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION
Status: Nonstandard

ELEMENT DISTRIBUTION
Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES
Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

2.B.7. Salt Marsh
2.B.7.Nd. North American Western Interior Brackish Marsh

M082. Cool Semi-Desert Alkali-Saline Wetland
G538. Intermountain Basins Alkaline-Saline Herb Wet Flat

Atriplex hymenelytra Shrubland
Desert-holly Shrubland
Identifier: CEGL001317

USNVC CLASSIFICATION

Division	North American Western Interior Brackish Marsh (2.B.7.Nd)
Macrogroup	Cool Semi-Desert Alkali-Saline Wetland (M082)
Group	Intermountain Basins Alkaline-Saline Herb Wet Flat (G538)

Association *Atriplex hymenelytra* Shrubland

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Related Concepts:

- *Atriplex hymenelytra* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ, CA:S3, NV:S5
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322:?
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Annable 1985, Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Schramm 1982, Western Ecology Working Group n.d.

***Muhlenbergia asperifolia* Herbaceous Vegetation**

Alkali Muhly Herbaceous Vegetation
Identifier: CEGL001779

USNVC CLASSIFICATION

Division	North American Western Interior Brackish Marsh (2.B.7.Nd)
Macrogroup	Cool Semi-Desert Alkali-Saline Wetland (M082)
Group	Intermountain Basins Alkaline-Saline Herb Wet Flat (G538)
Association	*Muhlenbergia asperifolia* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: In Colorado, these alkaline meadows are restricted to poorly drained low lands and alkaline soils. Stands are characterized by sparse cover of *Muhlenbergia asperifolia* and *Spartina gracilis*. Information on stands that occur outside Colorado will be added later.

CONSERVATION STATUS RANK

Global Rank & Reasons: GU (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Related Concepts:

- *Muhlenbergia asperifolia* (Kittel et al. 1999b) =
- *Muhlenbergia asperifolia* (Bourgeron and Engelking 1994) =
- *Muhlenbergia asperifolia* Herbaceous Vegetation (Carsey et al. 2003a) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Nations: US

States/Provinces: AZ, CO:S3, NM, NV, WY
TNC Ecoregions: 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:C?, 342G:CC, M331F:CC, M331H:CC, M341B:CC
Federal Lands: NPS (Grand Canyon, Great Sand Dunes); USFWS (Bosque del Apache)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: Western Ecology Group
References: Bolen 1964, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Carsey et al. 2003a, Donnelly et al. 2006, Driscoll et al. 1984, Kittel and Lederer 1993, Kittel et al. 1999b, Reid and Hall 2010, Salas et al. 2010b, U.S. Bureau of Reclamation 1976, WNDD unpubl. data, Western Ecology Working Group n.d.

***Suaeda moquinii* Shrubland**

Shrubby Seepweed Shrubland
Identifier: CEGL001991

USNVC CLASSIFICATION

Division	North American Western Interior Brackish Marsh (2.B.7.Nd)
Macrogroup	Cool Semi-Desert Alkali-Saline Wetland (M082)
Group	Intermountain Basins Alkaline-Saline Herb Wet Flat (G538)
Association	*Suaeda moquinii* Shrubland

ELEMENT CONCEPT

Global Summary: These shrublands occur in desert basins or playas in Nevada, Arizona, and southern and eastern California. Sites are generally flat to gently sloping saline valley bottoms, floodplains and playas, saline seeps, and along intermittent washes at elevations ranging from sea level to 1640 m (5381 feet). Soils are deep, saline, alkaline clay loams. The vegetation has a generally sparse shrub layer that is less than 1.5 m tall and strongly dominated by *Suaeda moquinii* with scattered *Atriplex polycarpa, Atriplex canescens, Allenrolfea occidentalis*, or *Sarcobatus vermiculatus* in some stands. The sparse herbaceous layer may include the forbs *Bassia hyssopifolia* and *Salicornia maritima (= Salicornia europaea)*. Graminoids are not abundant except for *Distichlis spicata* and occasional *Sporobolus airoides* or *Sporobolus cryptandrus*. The adjacent shrublands are dominated by *Sarcobatus vermiculatus* or *Atriplex* spp.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs in wide, flat, low-level drainage channels (particularly those which support alkaline substrates) in the Inner Canyon and Western Grand Canyon. It has been observed at 375 to 850 m (1250-2800 feet) elevation, but may occur within a broader elevational range. Soils are poorly- to moderately well-drained sandy or silty loams. Bare soil (30%), cryptogamic soil crust (28%), gravel (15%), and rocks (13%) are the major components of the ground cover.
Global Environment: These shrublands occur in desert basins or playas in Nevada, Arizona, and southern and eastern California. Sites are generally flat to gently sloping saline valley bottoms, floodplains and playas, saline seeps, and along intermittent washes at elevations ranging from sea level to 1640 m (5381 feet). Soils are deep, saline, alkaline clay loams derived from alluvium.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is dominated by the short shrub *Suaeda moquinii* (5-10%). *Larrea tridentata* (2%), *Fouquieria splendens* (1%), and *Prosopis glandulosa* (1%) occasionally occur in a fairly sparse tall-shrub layer (2%). Along with *Suaeda moquinii*, the short-shrub layer also occasionally includes *Atriplex canescens* (1%), *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%), and *Psorothamnus* sp. (1%). *Ambrosia dumosa* (2%) sporadically occurs in a very weak dwarf-shrub layer. The graminoid understory (1%) is similarly sparse but may include the exotic annuals *Bromus tectorum* and *Schismus barbatus*, as well as the natives *Sporobolus contractus* and *Dasyochloa pulchella*. Some stands may contain significant cover of the exotic forb *Erodium cicutarium* (25%). When *Erodium cicutarium* is not present, the forb layer is typically sparse and supports low diversity. Based upon the 2 stands sampled, this association hosts slightly

below-average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a sparse to open shrub layer less than 1.5 m tall that is strongly dominated by *Suaeda moquinii* sometimes with scattered *Atriplex polycarpa*, *Atriplex canescens*, *Allenrolfea occidentalis*, or *Sarcobatus vermiculatus*. The sparse herbaceous layer may include the forbs *Bassia hyssopifolia* and *Salicornia maritima (= Salicornia europaea)*. Graminoids are not abundant except for *Distichlis spicata* and occasional *Sporobolus airoides* or *Sporobolus cryptandrus*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Broad-leaved evergreen shrub	*Suaeda moquinii*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Forb	*Erodium cicutarium*
Herb (field)	Graminoid	*Bromus rubens*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Suaeda moquinii*
Herb (field)	Graminoid	*Distichlis spicata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Atriplex canescens*, *Bromus rubens*, *Descurainia pinnata*, *Erodium cicutarium*, *Larrea tridentata*, *Prosopis glandulosa*, *Psorothamnus fremontii*, *Schismus barbatus*, *Suaeda moquinii*
Global: *Sarcobatus vermiculatus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Other: *Sporobolus cryptandrus* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Similar Associations:

- *Atriplex obovata* / *Tidestromia carnosa* Dwarf-shrubland (CEGL004575)
- *Atriplex obovata* Badland Sparse Vegetation (CEGL002928)
- *Sarcobatus vermiculatus* / *Atriplex confertifolia - (Picrothamnus desertorum*, *Suaeda moquinii)* Shrubland (CEGL001371)
- *Sarcobatus vermiculatus* / *Suaeda moquinii* Shrubland (CEGL001370)

Global Related Concepts:

- *Suaeda fruticosa* Community (Faden 1977) **=**
- *Suaeda moquinii* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:V.D.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from widely disjunct locations in Grand Canyon and may occur in additional locations. It was sampled in the Inner Canyon from along the Colorado River corridor

near Kwagunt Rapids and from the Western Grand Canyon to the east of Pearce Ferry.
Global Range: This broadly defined shrubland association occurs in saline overflow areas in bottomlands in the Great Basin, Mojave, Colorado, and Sonoran deserts, and in the southern part of the Great Central Valley of California. The species occurs throughout the western U.S., so this type may be more widespread.
Nations: US
States/Provinces: AZ, CA:S3?, CO:S2, NM, NV:S5, UT
TNC Ecoregions: 6:C, 11:C, 13:C, 17:C, 19:C, 20:C, 23:C, 24:C
USFS Ecoregions (1994/95): 262A:CC, 313A:CC, 313D:CC, 321A:CC, 322A:CC, 322B:CC, 322C:CC, 341E:CC, 342B:CC, M331F:CC
Federal Lands: NPS (Canyonlands, Grand Canyon, Great Sand Dunes, Petrified Forest); USFWS (Bosque del Apache)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01539, GRCA.02505.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, CONHP 2010, Donnelly et al. 2006, Driscoll et al. 1984, Faden 1977, Peterson 2008, Reid and Hall 2010, Salas et al. 2010b, Thomas et al. 2009a, Western Ecology Working Group n.d.

3. Desert & Semi-Desert

3.A.2. Warm Desert & Semi-Desert Scrub & Grassland
3.A.2.Na. North American Warm Desert Scrub & Grassland

M087. Chihuahuan Semi-Desert Grassland
G490. Apacherian-Chihuahuan Semi-Desert Grassland & Steppe

Gutierrezia sarothrae / Pleuraphis rigida Shrub Herbaceous Vegetation
Broom Snakeweed / Big Galleta Shrub Herbaceous Vegetation
Identifier: CEGL001543

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Chihuahuan Semi-Desert Grassland (M087)
Group	Apacherian-Chihuahuan Semi-Desert Grassland & Steppe (G490)
Association	*Gutierrezia sarothrae / Pleuraphis rigida* Shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This association reportedly occurs extensively in Grand Canyon National Park in northwestern Arizona from 1160-1430 m elevation. However, it may be determined that this vegetation represents more than one association and may warrant being split. As currently defined, it is found on flat to gently rolling sites of all aspects in Toroweep Valley and Tuckup Canyon. The substrate is derived from basalt lava flows or consolidated alluvium, and the soils are shallow and cobbly. This association is dominated by graminoids with sparse sclerophyllous evergreen and deciduous shrubs and dwarf-shrubs, all less than 1 m in height. Total vegetation canopy cover is less than 50%. The graminoid layer is a mixture of perennial and annual grasses codominated by the native perennial grass *Pleuraphis rigida (= Hilaria rigida)* and the annual exotic grass *Bromus tectorum*. Other characteristic grasses include *Achnatherum hymenoides (= Oryzopsis hymenoides)* and species of *Aristida*, *Bouteloua*, *Muhlenbergia* and *Stipa*. The dwarf-shrub, *Gutierrezia sarothrae*, dominates the woody layer. Other characteristic shrubs and dwarf-shrubs include *Atriplex canescens, Lycium pallidum, Krascheninnikovia lanata* and *Ephedra viridis*. Succulents may include the cacti, *Opuntia whipplei, Opuntia phaeacantha, Opuntia erinacea, Coryphantha* spp. and the rosette, *Yucca baccata*. Other common annual forbs are *Plantago ovata (= Plantago insularis), Eriogonum inflatum, Cleome lutea*, and the exotic *Salsola kali*.

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Salsola kali* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2Q (28-Dec-1998). This association reportedly occurs extensively in Grand Canyon National Park in northwestern Arizona from 1160 to 1430 m elevation, in Toroweep Valley and Tuckup Canyon. The substrate is derived from basalt lava flows or consolidated alluvium, and the soils are shallow and cobbly. While it is extensive in the Park, it appears to be restricted to this area, being unreported by other studies elsewhere in the southwest. This grassland type needs to be re-evaluated and possibly reclassified as an anthropogenic type. These stands have been heavily disturbed by livestock grazing in the past and the co-dominance of *Gutierrezia sarothrae* and *Bromus tectorum* is undoubtedly a result of this grazing. What is unclear is whether the sampled vegetation represents what is left of a presettlement association of *Hilaria* and *Gutierrezia*, or is a truly unrecognizable anthropogenic type.

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: This grassland association needs to be re-evaluated and possibly reclassified as an anthropogenic type. These stands have been heavily disturbed by livestock grazing in the past, and the codominance of *Gutierrezia sarothrae* and *Bromus tectorum* is undoubtedly a result of this grazing. What is unclear is whether the sampled vegetation represents what is left of a presettlement association of *Hilaria* and *Gutierrezia*, or is a truly unrecognizable anthropogenic type. In addition, it may be determined that this vegetation represents more than one association and may warrant being split.
Global Similar Associations:

- *Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland (CEGL002690)

Global Related Concepts:

- 142.2511 *Hilaria rigida - Bromus tectorum - Gutierrezia sarothrae* Association (Warren et al. 1982) **=**
- *Gutierrezia sarothrae/Hilaria rigida-Bromus tectorum* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:V.B.2.f. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Global Range: This association reportedly occurs extensively in Grand Canyon National Park in northwestern Arizona from 1160 to 1430 m elevation.
Nations: US
States/Provinces: AZ:S2, CA?
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:??
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: M.S. Reid
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

M088. Mojave-Sonoran Semi-Desert Scrub
G296. Mojave Mid-Elevation Mixed Desert Scrub

Acacia greggii Shrubland

Catclaw Acacia Shrubland
Identifier: CEGL005053

USNVC CLASSIFICATION

Division North American Warm Desert Scrub & Grassland (3.A.2.Na)

Macrogroup Mojave-Sonoran Semi-Desert Scrub (M088)
Group Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association *Acacia greggii* Shrubland

ELEMENT CONCEPT

Global Summary: This catclaw acacia shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It predominantly occurs on sideslopes at 700 to 1325 m (2250-4325 feet) elevation, but can be found as low as 400 m (1275 feet). It is primarily found on moderate to steep slopes (20-50 degrees), but also occurs on more gentle gradients (3-8 degrees) as well. Soils are well- to rapidly-drained sandy loams or loamy sands, which lie above limestone or rarely shale, sandstone, or schist. Vegetation is characterized and dominated by *Acacia greggii* which typically occurs as a tall shrub but is also occasionally found as a short shrub. *Ephedra fasciculata* occurs quite frequently in the short-shrub layer, while *Ferocactus cylindraceus* and *Aloysia wrightii* also occur occasionally. *Agave utahensis, Gutierrezia* spp., *Opuntia basilaris, Brickellia atractyloides*, and *Janusia gracilis* occur sporadically in the sparse dwarf-shrub layer. *Bromus rubens* consistently occurs in a relatively well-developed graminoid layer. The perennial grasses *Aristida purpurea* and *Achnatherum speciosum* are also sporadically present. A fairly weak forb layer is common, in which *Porophyllum gracile, Acourtia wrightii, Cryptantha* spp., and *Sphaeralcea grossulariifolia* occur.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association predominantly occurs on sideslopes in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. It usually occurs at 700 to 1325 m (2250-4325 feet) elevation, but can be found as low as 400 m (1275 feet). It is primarily found on moderate to steep slopes (20-50 degrees), but also occurs on more gentle gradients (3-8 degrees) as well. Soils are well- to rapidly-drained sandy loams or loamy sands, which lie above limestone or rarely shale, sandstone, or schist. Ground cover tends to be dominated by rocks (32%), gravel (19%), bedrock (14%), and litter (16%), with some bare soil or sand (8%), and a relatively dense covering of cryptogamic soil crust (7%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized and dominated by *Acacia greggii* (6%). *Acacia greggii* typically occurs as a tall shrub but is also occasionally found as a short shrub. *Ephedra fasciculata* (2%) occurs quite frequently in the short-shrub layer, while *Ferocactus cylindraceus* (1%) and *Aloysia wrightii* (1%) also occur occasionally. A sparse dwarf-shrub layer (2%) exists in which *Agave utahensis*, *Gutierrezia* spp., *Opuntia basilaris*, *Brickellia atractyloides*, and *Janusia gracilis* occur sporadically at low individual covers. *Bromus rubens* (2%) consistently occurs in a relatively well-developed graminoid layer (4%). The perennial grasses *Aristida purpurea* (1%) and *Achnatherum speciosum* (3%) are also sporadically present. A fairly weak forb layer (2%) is common, in which *Porophyllum gracile, Acourtia wrightii, Cryptantha* spp., and *Sphaeralcea grossulariifolia* occur most often at up to 1% cover each. Based upon the 10 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Acacia greggii*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra fasciculata*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Achnatherum speciosum*, *Acourtia wrightii*, *Agave utahensis*, *Aloysia wrightii*, *Aristida purpurea*, *Bromus rubens*, *Ephedra fasciculata*, *Ferocactus cylindraceus*, *Sphaeralcea grossulariifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/

Low), *Schismus arabicus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Acacia greggii* Wash Shrubland (CEGL005390) is also dominated by *Acacia greggii* and supports a similar assemblage of species. It chiefly occurs in drainages and washes, while *Acacia greggii* Shrubland (CEGL005053) usually occurs on sideslopes.
Global Similar Associations:

- *Acacia greggii* Wash Shrubland (CEGL005390) supports a similar assemblage of species but chiefly occurs in drainages and washes.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled from lower Bright Angel Canyon and Phantom Creek; in the Western Grand Canyon, it was sampled from Kanab Creek, 204-Mile Canyon, Gneiss Canyon, Separation Canyon, Surprise Canyon, and Burnt Canyon; and in Grand Canyon-Parashant National Monument, it was sampled from near Grand Wash Bay.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (10 plots): GRCA.01030, GRCA.01522, GRCA.01602, GRCA.01605, GRCA.01666, GRCA.01681, GRCA.02653, GRCA.02657, GRCA.03608, GRCA.04593.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Canotia holacantha Grand Canyon Shrubland

Crucifixion-thorn Grand Canyon Shrubland
Identifier: CEGL005296

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Canotia holacantha* Grand Canyon Shrubland

ELEMENT CONCEPT

Global Summary: This crucifixion-thorn shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes of canyons typically from 575 to 975 m (1875-3625 feet) elevation, but it has been found as high as 1275 m (4150 feet). It usually occurs on north-facing, moderately-sloping gradients (15 to 25 degrees), but occasionally occurs on very steep slopes (40-50 degrees) as well. Soils are rapidly-drained sandy loams; the underlying geology is usually limestone. This community often occurs in protected areas with a relatively high cover of moss. This

community is characterized by a tall-shrub layer dominated by *Canotia holacantha*, which is invariably accompanied by the short shrub *Ephedra fasciculata* and occasionally by *Acacia greggii*. A variety of dwarf-shrubs also occur, including *Gutierrezia microcephala, Echinocereus* sp., *Agave utahensis*, and *Encelia farinosa*. A sparse graminoid layer is usually present, in which *Bromus rubens* occurs most frequently. The perennial grasses *Muhlenbergia porteri* and *Tridens muticus* also occur from time to time. *Sphaeralcea grossulariifolia* and *Xylorhiza tortifolia* are the most common forbs in a relatively sparse forb layer. Moss occurs sporadically, but when present has significant cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This crucifixion-thorn shrubland association occurs on sideslopes of canyons in the Western Grand Canyon, typically from 575 to 975 m (1875-3625 feet) elevation, but it has been found as high as 1275 m (4150 feet). It usually occurs on north-facing, moderately-sloping gradients (15 to 25 degrees), but occasionally occurs on very steep slopes (40-50 degrees) as well. Soils are rapidly-drained sandy loams that typically obscure the underlying geology; however, when unobscured, the underlying geology is usually limestone. The ground cover tends to be dominated by rocks (30%), gravel (35%) and litter (11%), with lesser amounts of bare soil (6%) and bedrock (6%). This community often occurs in protected areas with a relatively high cover of moss (5%). A single stand was also sampled from a similar environment in the Inner Canyon.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This community is characterized by a tall-shrub layer dominated by *Canotia holacantha* (10-15%), which is invariably accompanied by the short shrub *Ephedra fasciculata* (1%) and occasionally by *Acacia greggii* (2%). A variety of dwarf-shrubs also occur, including *Gutierrezia microcephala* (1%), *Echinocereus* sp. (up to 1%), *Agave utahensis* (1%), and *Encelia farinosa* (1%). A sparse graminoid layer is usually present, in which *Bromus rubens* (1%) occurs most frequently. The perennial grasses *Muhlenbergia porteri* (1%) and *Tridens muticus* (up to 1%) also occur from time to time. *Sphaeralcea grossulariifolia* (1%) and *Xylorhiza tortifolia* (up to 1%) are the most common forbs in a relatively sparse forb layer. Moss occurs sporadically, but when present has significant cover (15%). Based upon the 8 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 26 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Canotia holacantha*
Herb (field)	Forb	*Sphaeralcea grossulariifolia*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Agave utahensis*, *Bromus rubens*, *Canotia holacantha*, *Encelia farinosa*, *Ephedra fasciculata*, *Gutierrezia microcephala*, *Muhlenbergia porteri*, *Sphaeralcea grossulariifolia*, *Xylorhiza tortifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Agave utahensis* (state-vulnerable, G4); **Invasive/Exotic**: *Bromus rubens* (exotic)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (1-Jul-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: This association is unique within the park. No other association has a strong *Canotia holacantha* component.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is predominantly known from the Western Grand Canyon, where it was sampled from Indian Canyon, Two Hundred and Twentymile Canyon, in unnamed canyons on the Sanup Plateau across from Diamond Peak, "Gneiss" Canyon (north of the river), and in the East Fork of Separation Canyon. A single stand was also sampled in the Inner Canyon from an unnamed canyon to the east of Forster Canyon. This occurrence is disjunct roughly 100 kilometers from the main distribution of this community in the Western Grand Canyon. This community may occur in similar sheltered canyon environments of the Inner Canyon.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (8 plots): GRCA.01570, GRCA.01638, GRCA.01651, GRCA.01654, GRCA.01659, GRCA.02572, GRCA.02654, GRCA.03513.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland

Blackbrush - Joint-fir species Warm Desert Shrubland
Identifier: CEGL005297

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland

ELEMENT CONCEPT

Global Summary: This blackbrush shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs primarily on sideslopes but can be seen on a variety of landforms, including plateaus, ridges, terraces, and valley bottoms. It generally occurs from approximately 850 to 1575 m (2750-5150 feet) elevation. While predominantly found on flat or low-gradient settings (0-15 degrees), this association occasionally occurs on moderate to steep slopes (30-40 degrees) as well. Soils are predominantly rapidly-drained sandy loams that rarely contain silt and clay. The underlying geology is usually limestone, shale, or less frequently sandstone. When it occurs, this vegetation type often forms vast expanses across these environments. Trees and tall shrubs are essentially absent. A short-shrub layer dominated by *Coleogyne ramosissima* with *Ephedra* spp. as an associate characterizes this association. Three species of *Ephedra* are common, with *Ephedra fasciculata* and *Ephedra torreyana* occurring most frequently. *Ephedra viridis* also occurs, but its presence is sporadic. Additionally, the short-shrub stratum often includes *Yucca baccata*. A dwarf-shrub layer typically occurs and is dominated by *Opuntia polyacantha*. Occasionally *Agave utahensis* also occurs here. The desert grasses *Dasyochloa pulchella, Tridens muticus*, and *Vulpia octoflora* are all common in a fairly sparse graminoid layer, as well as the exotic *Bromus rubens*. A variety of species, including *Sphaeralcea grossulariifolia* and *Erodium cicutarium*, occur in the relatively sparse forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This blackbrush shrubland association is one of the most common and widespread community types in the Grand Canyon, and it occurs throughout much of the Inner Canyon and Western Grand Canyon. It occurs primarily on sideslopes but can be seen on a variety of landforms, including plateaus, ridges, terraces, and valley bottoms. It generally occurs below the rims on both sides of the Colorado River

from approximately 850 to 1575 m (2750-5150 feet) elevation. While predominantly found on flat or low-gradient settings (0-15 degrees), this association occasionally occurs on moderate to steep slopes (30-40 degrees) as well. Soils are predominantly rapidly-drained sandy loams that rarely contain silt and clay. The underlying geology is usually limestone, shale, or less frequently sandstone. Gravel (50%), rocks (20%), bare soil (11%), litter (9%) and bedrock (2%) are common components of the ground cover. When it occurs, this vegetation type often forms vast expanses across these environments.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 25-30% in this association, while trees and tall shrubs are essentially absent. A short-shrub layer dominated by *Coleogyne ramosissima* (15-20%), with *Ephedra* spp. (5%) as an associate characterizes this association. Three species of *Ephedra* are common, with *Ephedra fasciculata* (2%) and *Ephedra torreyana* (2%) occurring most frequently. *Ephedra viridis* (1%) also occurs, but its presence is sporadic. Additionally, the short-shrub stratum often includes *Yucca baccata* (1%). A dwarf-shrub layer typically occurs and is dominated by *Opuntia polyacantha* (4%). Occasionally *Agave utahensis* (1%) also occurs here. The desert grasses *Dasyochloa pulchella* (up to 2%), *Tridens muticus* (1%), and *Vulpia octoflora* (up to 1%) are all common in a fairly sparse graminoid layer, as well as the exotic *Bromus rubens* (1%). A variety of species, including *Sphaeralcea grossulariifolia* (1%) and *Erodium cicutarium* (up to 1%), occur in the relatively sparse forb understory. Based upon the 47 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra fasciculata*
Herb (field)	Dwarf-shurb	*Opuntia polyacantha*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Bromus rubens*, *Coleogyne ramosissima*, *Dasyochloa pulchella*, *Ephedra torreyana*, *Ephedra viridis*, *Opuntia polyacantha*, *Sphaeralcea grossulariifolia*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Agave utahensis* (state-vulnerable, G4); **Invasive/Exotic**: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Vulnerable: *Ephedra fasciculata* (G3?); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic), *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Coleogyne ramosissima* Shrubland (CEGL001332) contains a similar suite of shrub species and is dominated by *Coleogyne ramosissima*; however, *Ephedra* spp. are not common associates. It also typically occurs at higher elevations than *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland (CEGL005297).
Global Similar Associations:

- *Coleogyne ramosissima* Shrubland (CEGL001332) contains a similar suite of shrub species and is dominated by *Coleogyne ramosissima*, but *Ephedra* spp. are not common associates.

Global Related Concepts:

- Black Brush Series (Sawyer and Keeler-Wolf 2005) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from numerous localities in the Inner Canyon and Western Grand Canyon and covers an expansive area in the park. The best developed extent of its distribution stretches from Bright Angel Canyon west to Kanab Creek; however, it has been documented as far upstream as Nankoweap Creek and as far downstream as the Grand Wash Cliffs. Several stands were sampled from Grand Canyon-Parashant National Monument in the vicinity of Whitmore Canyon.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (47 plots): GRCA.01005, GRCA.01108, GRCA.01110, GRCA.01536, GRCA.01554, GRCA.01607, GRCA.01608, GRCA.01618, GRCA.01627, GRCA.01639, GRCA.01645, GRCA.01649, GRCA.02008, GRCA.02016, GRCA.02017, GRCA.02022, GRCA.02023, GRCA.02024, GRCA.02026, GRCA.02028, GRCA.02082, GRCA.02400, GRCA.02401, GRCA.02403, GRCA.02629, GRCA.02663, GRCA.03004, GRCA.03009, GRCA.03010, GRCA.03015, GRCA.03544, GRCA.03545, GRCA.03554, GRCA.03556, GRCA.03563, GRCA.03628, GRCA.04561, GRCA.04572, GRCA.04582, GRCA.04626, GRCA.04628, GRCA.04636, GRCA.04639, GRCA.04640, GRCA.04650, GRCA.04652, GRCA.04681.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Sawyer and Keeler-Wolf 2005, Western Ecology Working Group n.d.

***Coleogyne ramosissima - Purshia stansburiana* Shrubland**

Blackbrush - Stansbury's Cliffrose Shrubland
Identifier: CEGL002720

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Coleogyne ramosissima - Purshia stansburiana* Shrubland

ELEMENT CONCEPT

Global Summary: This blackbrush - cliffrose shrubland association is currently described from Grand Canyon National Park in Arizona. It is also reported from California and Nevada. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes and has been observed at 1425 to 1450 m (4650-4775 feet) elevation, but presumably occurs within a wider elevational range. It is primarily found on moderately steep slopes (14-26 degrees), on somewhat protected northwest- to east-facing aspects. Soils are rapidly-drained sandy loams over limestone bedrock. This association is codominated by the short shrubs *Coleogyne ramosissima* and *Purshia stansburiana*. Tall shrubs are absent. The short-shrub layer also includes *Encelia resinifera* and *Ephedra viridis*. *Thamnosma montana* is frequently present in a weak dwarf-shrub layer. The non-native *Bromus tectorum* strongly dominates the graminoid understory, while the native bunchgrass *Tridens muticus* also occurs in most stands. *Sphaeralcea ambigua, Dichelostemma capitatum*, and *Glandularia gooddingii* all consistently occur in a fairly sparse forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on sideslopes in the far Western Grand Canyon. It has been observed at 1425 to 1450 m (4650-4775 feet) elevation, but presumably occurs within a wider elevational range. It is primarily found on moderately steep slopes (14-26 degrees), on somewhat protected

northwest- to east-facing aspects. Soils are rapidly-drained sandy loams that lie on top of limestone bedrock. Rocks (40%) and gravel (20%) are the major components of the ground cover, while some litter (7%), bedrock (5%), and bare soil or sand (4%) also occur.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 25-35% in this association which is codominated by the short shrubs *Coleogyne ramosissima* (14%) and *Purshia stansburiana* (6%). Tall shrubs are absent from this association. Along with *Coleogyne ramosissima* and *Purshia stansburiana*, the short-shrub layer invariably includes *Encelia resinifera* (1%) and *Ephedra viridis* (1%). *Thamnosma montana* (1%) is frequently present in a weak dwarf-shrub layer. The non-native *Bromus tectorum* (11%) strongly dominates the graminoid understory, while the native bunchgrass *Tridens muticus* (up to 1%) also occurs in most stands. *Sphaeralcea ambigua* (1%), *Dichelostemma capitatum* (up to 1%), and *Glandularia gooddingii* (up to 1%) all consistently occur in a fairly sparse forb layer. Based upon the 2 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 23 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Short shrub/sapling	Thorn shrub	*Coleogyne ramosissima*
Herb (field)	Dwarf-shurb	*Thamnosma montana*
Herb (field)	Graminoid	*Bromus tectorum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus tectorum*, *Coleogyne ramosissima*, *Dichelostemma capitatum*, *Encelia resinifera*, *Ephedra viridis*, *Glandularia gooddingii*, *Purshia stansburiana*, *Sphaeralcea ambigua*, *Thamnosma montana*, *Tridens muticus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (26-Jun-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Coleogyne ramosissima* Shrubland (CEGL001332) is also dominated by *Coleogyne ramosissima* and supports *Ephedra viridis* and *Purshia stansburiana*; however, *Purshia stansburiana* occurs at much lower cover here than in *Coleogyne ramosissima - Purshia stansburiana* Shrubland (CEGL002720) where it is a dominant component of the vegetation.
Global Similar Associations:

- *Coleogyne ramosissima* Shrubland (CEGL001332) is also dominated by *Coleogyne ramosissima* and supports *Ephedra viridis* and *Purshia stansburiana*, but the latter occurs at much lower cover.

Global Related Concepts:

- *Coleogyne ramosissima - Purshia mexicana-stansburiana* Series (Nachlinger and Reese 1996) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the far Western Grand Canyon, where it was sampled from the "Hook" near the Grand Wash Cliffs.
Global Range: This association is currently described from Grand Canyon National Park in Arizona. It is also re-

ported from California and Nevada. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA, NV
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.01003, GRCA.03011.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Nachlinger and Reese 1996, Reid and Hall 2010, Western Ecology Working Group n.d.

Ephedra fasciculata / Mixed Semi-desert Grasses Shrubland

Arizona Joint-fir / Mixed Semi-desert Grasses Shrubland
Identifier: CEGL005084

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes or rarely in drainages and valley bottoms at 675 to 950 m (2250-3075 feet) elevation, but can be found as high as 1350 m (5500 feet). It is primarily found on moderate gradients (15-25 degrees), but is occasionally found on steeper slopes (25-35 degrees). Soils are rapidly-drained sandy loams that typically obscure various underlying bedrock types. Vegetation is characterized by the dominance of *Ephedra fasciculata* in the short-shrub stratum, together with a strong mixed-species graminoid understory. Tall shrubs are rare and sparse. The short-shrub layer also includes *Encelia farinosa* and sometimes *Ferocactus cylindraceus*. *Gutierrezia sarothrae* is the most common component of a relatively sparse dwarf-shrub layer. *Muhlenbergia porteri* and *Pleuraphis jamesii* dominate the well-developed graminoid understory. Other common graminoids include *Achnatherum speciosum*, *Dasyochloa pulchella*, *Aristida purpurea*, and *Vulpia octoflora*. The non-native *Bromus rubens* occurs in almost all stands. *Artemisia ludoviciana, Machaeranthera pinnatifida*, and *Erodium cicutarium* are the most common forbs. A relatively high cover of moss occurs in some stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes or rarely in drainages and valley bottoms in the Inner Canyon and Western Grand Canyon. It usually occurs at 675 to 950 m (2250-3075 feet) elevation, but can be found as high as 1350 m (5500 feet). It is primarily found on moderate gradients (15-25 degrees), but is occasionally found on steeper slopes (25-35 degrees) as well. Soils are rapidly-drained sandy loams that typically obscure various underlying bedrock types. Rocks (33%), gravel (26%), and litter (19%) dominate the ground cover, while relatively high amounts of cryptogamic soil crust (5%) and moss (3%) are also present.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the dominance of *Ephedra fasciculata* (8-12%) in the short-shrub stratum, together with a strong mixed-species graminoid understory (15%). Tall shrubs are rare and sparse, but *Acacia greggii* (2%) is occasionally present as either a tall or short shrub. Along with *Ephedra fasciculata*, the short-shrub layer also includes *Encelia farinosa* (1%), and sometimes *Ferocactus cylindraceus* (2%). *Gutierrezia sarothrae* (2%) is the most common

component of a relatively sparse dwarf-shrub layer (4%). A mixed-species graminoid understory is extremely well-developed in this association. *Muhlenbergia porteri* and *Pleuraphis jamesii* commonly occur at up to 10% cover each. Other common graminoids include *Achnatherum speciosum* (3%), and *Dasyochloa pulchella, Aristida purpurea*, and *Vulpia octoflora* at low covers. The non-native *Bromus rubens* (1-8%) occurs in almost all stands. *Artemisia ludoviciana* (1%), *Machaeranthera pinnatifida* (1%), and *Erodium cicutarium* (1%) are the most common forbs (3%). A relatively high cover of moss (3-5%) occurs in some stands. Based upon the 12 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra fasciculata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Artemisia ludoviciana*, *Bromus rubens*, *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Gutierrezia sarothrae*, *Machaeranthera pinnatifida*, *Muhlenbergia porteri*, *Pleuraphis jamesii*, *Vulpia octoflora*
Global: *Ephedra fasciculata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Thinopyrum ponticum* (exotic, Low/Insignificant)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Ephedra (torreyana, viridis)* / Mixed Semi-desert Grasses Shrubland (CEGL005113) supports similar species and is found in similar environments; however, it typically occurs at higher elevations and is dominated by either *Ephedra torreyana* or *Ephedra viridis* (and not *Ephedra fasciculata*). *Ephedra fasciculata* Shrubland (CEGL005090) is also dominated by *Ephedra fasciculata* and supports a similar assemblage of graminoid species; however, the graminoid component is much less well-developed in this community than in *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland (CEGL005084).
Global Similar Associations:

- *Ephedra (torreyana, viridis)* / Mixed Semi-desert Grasses Shrubland (CEGL005113) supports similar species and is found in similar environments; however, it typically occurs at higher elevations and is dominated by either *Ephedra torreyana* or *Ephedra viridis* rather than *Ephedra fasciculata*.
- *Ephedra fasciculata* Shrubland (CEGL005090) is also dominated by *Ephedra fasciculata* and supports a similar assemblage of graminoid species; however, the graminoid component is much less well-developed.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Unkar Creek, Haunted Canyon, Ruby Canyon, Bass Canyon, near Fiske Butte, Galloway Canyon, Stone Creek, near Forster Canyon, and Tapeats Creek; and from the Western Grand Canyon, where it was sampled from Tuckup Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US

States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.01107, GRCA.01577, GRCA.01595, GRCA.02025, GRCA.02027, GRCA.02509, GRCA.02554, GRCA.02555, GRCA.03611, GRCA.03614, GRCA.04576, GRCA.04599.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Ephedra fasciculata Shrubland

Arizona Joint-fir Shrubland
Identifier: CEGL005090

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Ephedra fasciculata* Shrubland

ELEMENT CONCEPT

Global Summary: This joint-fir shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes at 750 to 1100 m (2425-3225 feet) elevation, but can be found as high as 1650 m (5350 feet). It is primarily found on moderate to steep (20-40 degrees), north- to east-facing slopes, but also occasionally occurs on gentler slopes (8-15 degrees). Soils are well- to rapidly-drained silty or sandy loams that occasionally contain clay. Vegetation is characterized by the dominance of *Ephedra fasciculata* in the short-shrub stratum. Tall shrubs are rare and sparse, but *Acacia greggii* is occasionally present as either a tall or short shrub. The short-shrub layer also includes *Bernardia myricifolia*. *Gutierrezia sarothrae* is a common dwarf-shrub. *Muhlenbergia porteri, Vulpia octoflora*, and *Aristida purpurea* are fairly common in the graminoid understory. The non-native *Bromus rubens* also occurs in most stands. *Acourtia wrightii, Galium stellatum, Sphaeralcea grossulariifolia*, and *Erodium cicutarium* (exotic) are common components of the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This joint-fir shrubland association typically occurs on sideslopes in the Inner Canyon and Western Grand Canyon. It usually occurs at 750 to 1100 m (2425-3225 feet) elevation, but can be found as high as 1650 m (5350 feet). It is primarily found on moderate to steep (20-40 degrees), north- to east-facing slopes, but also occasionally occurs on gentler slopes (8-15 degrees). Soils are well- to rapidly-drained silty or sandy loams that occasionally contain clay. Rocks (41%), gravel (36%), and litter (11%) are the most common components of the ground cover, but a relatively high amount of moss (5%) also exists.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized by the dominance of *Ephedra fasciculata* (8-12%) in the short-shrub stratum. Tall shrubs are rare and sparse, but *Acacia greggii* (2%) is occasionally present as either a tall or short shrub. Along with *Ephedra fasciculata*, the short-shrub layer also includes *Bernardia myricifolia* (4%), and sometimes *Aloysia wrightii* (4%). *Gutierrezia sarothrae* (1%) and less frequently *Thamnosma montana* (1%) are common members of a relatively sparse dwarf-shrub layer (2%). A variety of species, including *Muhlenbergia porteri* (1%), *Vulpia octoflora* (up to 1%), and *Aristida purpurea* (1%), are fairly common in the graminoid understory (4%). The non-native *Bromus rubens* (2%) occurs in most stands as well. *Acourtia wrightii* (1%), *Galium stellatum* (1%), *Sphaeralcea grossulariifolia* (1%), and *Erodium cicutarium* (1%) are common components of the forb understory (5%). Based upon the 9 stands sampled,

this association hosts above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra fasciculata*
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Acourtia wrightii*, *Aloysia wrightii*, *Aristida purpurea*, *Bernardia myricifolia*, *Bromus rubens*, *Ephedra fasciculata*, *Galium stellatum*, *Gutierrezia sarothrae*, *Muhlenbergia porteri*, *Sphaeralcea grossulariifolia*, *Thamnosma montana*
Global: *Ephedra fasciculata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Chenopodium album* (exotic), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Ephedra fasciculata* (G3?); **Invasive/Exotic**: *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Ephedra fasciculata* is also the dominant shrub species in *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland (CEGL005084). However, a codominant, mixed-species graminoid understory (15%) also occurs here. The graminoid layer is much less well-developed in *Ephedra fasciculata* Shrubland (CEGL005090).
Global Similar Associations:

- *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland (CEGL005084) is also dominated by *Ephedra fasciculata*, but a codominant, mixed-species graminoid understory also occurs.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from near Ruby Canyon, Hotauta Canyon, Matkatamiba Canyon, and White Creek; and from the Western Grand Canyon, where it was sampled from Vulcans Throne and Tincanebits Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.01555, GRCA.01562, GRCA.01620, GRCA.02029, GRCA.02552, GRCA.02553, GRCA.02584, GRCA.02626, GRCA.02641.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros

References: Reid and Hall 2010, Western Ecology Working Group n.d.

Ephedra nevadensis - Yucca baccata Basalt Shrubland

Nevada Joint-fir - Banana Yucca Basalt Shrubland
Identifier: CEGL005486

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Ephedra nevadensis - Yucca baccata* Basalt Shrubland

ELEMENT CONCEPT

Global Summary: This association has only been described from Grand Canyon National Park. Until further inventory is completed, there is no global information.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This *Ephedra nevadensis* association is described from three NPS classification plots and five KGA calibration plots in the Whitmore Canyon area in the western end of Grand Canyon National Park. It occurs below the rim on arid west and southwest aspects of sideslopes and low slopes. It is found primarily on eroded basalt flows between 1100 and 1550 m (3600-5100 feet) elevation. Most of these areas have moderate slopes (1-15 degrees), although some have up to 20-degree slopes. The soil texture varies but generally includes clay (sandy clays, clays and clay loams) and are derived from basalts. There may be contributions from eroding limestones in the area. Basalt rocks and gravel make up 60-95% of the ground surface.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover varies between 7 and 12% (average = 10%) in this association. The shrub layer, dominated by *Ephedra nevadensis* (2-6%; average = 4.5%) with a consistent presence of *Yucca baccata* (2-6%; average = 3.5%), characterizes this association. The dwarf-shrub layer consists of either *Gutierrezia microcephala* (0-4%) or *Gutierrezia sarothrae* (0-3%). Cacti, including *Opuntia polyacantha, Ferocactus cylindraceus*, and Echinocereus engelmannii are present in some plots. A graminoid layer is typically present (6%), characterized by *Pleuraphis rigida* (3-4%) and *Bouteloua eriopoda* (1-2%). Introduced *Bromus rubens* can have relatively high cover (8%) but is usually rare. There are no trees or tall shrubs in this association, although they may be present in neighboring blackbrush-dominated vegetation.

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (9-Jul-2012).

CLASSIFICATION

Status: Provisional

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors: M.E. Hall
Global Description Authors:
References: Western Ecology Working Group n.d.

Ephedra viridis / Pleuraphis rigida Shrubland

Mormon-tea / Big Galleta Shrubland
Identifier: CEGL001257

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Ephedra viridis* / *Pleuraphis rigida* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association has been described from the inner gorge of Grand Canyon National Park in northwestern Arizona. Elevations range from 580-980 m. Sites are moderate to steep, north-facing colluvial slopes below cliffs often with talus and rock outcrops. Substrate is a shallow and rocky soil that is derived from limestone, sandstone, igneous rocks. Stands have an open, short woody canopy (less than 1 m tall) that is codominated by the xeromorphic evergreen and deciduous shrubs, *Ephedra viridis* and *Acacia greggii*, with an herbaceous layer dominated by *Pleuraphis rigida (= Hilaria rigida)*. Total vegetation cover ranges from 15-20%. Other common species may include shrubs and dwarf-shrubs such as *Gutierrezia sarothrae, Sphaeralcea ambigua, Encelia farinosa* or *Lycium andersonii*, and scattered forbs such as *Galium stellatum, Machaeranthera pinnatifida* or *Eriogonum inflatum*. Succulents are common and include *Ferocactus cylindraceus (= Ferocactus acanthodes), Echinocereus engelmannii, Opuntia phaeacantha, Opuntia erinacea, Opuntia basilaris, Echinocactus polycephalus*, and *Agave utahensis*. Extent of the association outside the park is not known. This shrubland appears restricted to these inner-canyon habitats in the Grand Canyon. Disturbance from rockslides may be important in maintaining this successional type. Shrublands with similar species composition have been reported from California, but survey and classification work is needed to determine if they represent the same association as this type.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (16-Nov-1999). These shrublands occur extensively in the inner gorge of Grand Canyon National Park, Arizona. Stands are found predominately on colluvial slopes with northern aspects and may be endemic to the Park. Disturbance from rockslides may be important in maintaining this successional type. Within the Park, stands are protected. The extent and status of this association outside the Park is not known. More survey work is needed, especially on colluvial slopes in mountainous areas in the Mojave Desert, which may have similar vegetation.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This type needs to be reviewed against new Grand Canyon associations. It should probably be archived with 2 or more successors.
Global Related Concepts:

- 153.11016 *Ephedra viridis - Hilaria rigida - Sphaeralcea ambigua* Association (Warren et al. 1982) **=**
- *Ephedra viridis/Hilaria rigida* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.C.1.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Global Range: This sparse shrubland occurs extensively on northern aspects in the inner gorge of Grand Canyon National Park. Occurrence of stands outside the Park in unknown.
Nations: US
States/Provinces: AZ:S3, CA:S1?
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon?)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

Gutierrezia (*sarothrae, microcephala*) - *Ephedra spp. - Agave utahensis* Dwarf-shrubland

(Broom Snakeweed, Threadleaf Snakeweed) - Joint-fir species - Utah Agave Dwarf-shrubland
Identifier: CEGL005130

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Gutierrezia (sarothrae, microcephala) - Ephedra* spp. - *Agave utahensis* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This dwarf-shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes, but also sometimes occurs in valley bottoms, plateaus, and on ridges, at 750 to 1450 m (2475-4700 feet) elevation, but can be found as high as 1850 m (6075 feet). It is primarily found on moderate to steep gradients (20-40 degrees), but also occasionally occurs on gentler slopes (1-9 degrees), across all aspects, other than north-facing. Soils are well- to rapidly-drained and range from silty or sandy loams to clays. The underlying geology is typically limestone. Trees are essentially lacking in this shrubland association; however, scattered *Juniperus osteosperma* infrequently occurs in both the canopy and subcanopy layers, and *Acacia greggii* sporadically occurs in a sparse tall-shrub layer. Vegetation is characterized by the codominance of one of *Ephedra viridis, Ephedra fasciculata*, or *Ephedra torreyana*, along with *Gutierrezia sarothrae* and *Agave utahensis*. In rare stands in which *Gutierrezia sarothrae* is not present (typically at lower elevations), *Gutierrezia microcephala* occurs in its place. The short-shrub layer also sometimes supports *Yucca baccata, Encelia farinosa*, and *Ferocactus cylindraceus*. The native bunch grasses *Muhlenbergia porteri* and *Achnatherum speciosum* occasionally occur in the graminoid understory. The exotic *Bromus rubens* frequently occurs as well. *Sphaeralcea grossulariifolia, Artemisia ludoviciana*, and *Galium stellatum* are frequent components of the forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes, but also sometimes occurs in valley bottoms, plateaus, and on ridges in the Inner Canyon and Western Grand Canyon. It usually occurs at 750 to 1450 m (2475-4700 feet) elevation, but can be found as high as 1850 m (6075 feet). It is primarily found on moderate to steep gradients (20-40 degrees), but also occasionally occurs on gentler slopes (1-9 degrees). It occurs across all aspects, other than north-facing. Soils are well- to rapidly-drained and range from silty or sandy loams to clays. When unobscured, the underlying geology is typically limestone. The ground cover tends to be dominated by rocks (38%) and gravel (32%), with relatively low amounts of bare soil (10%) litter (7%), and bedrock (7%). A single stand was sampled from a similar environment in Grand Canyon-Parashant National Monument.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees are essentially lacking in this shrubland association; however, scattered *Juniperus osteosperma* (1%) infrequently occurs in both the canopy and subcanopy layers. *Acacia greggii* (2%) sporadically occurs in a sparse tall-shrub layer. Total shrub cover averages 10-15% in this association which is characterized by the codominance of three different shrub species: one of *Ephedra viridis, Ephedra fasciculata*, or *Ephedra torreyana* (2-4%), along with *Gutierrezia sarothrae* (3-5%) and *Agave utahensis* (2-3%). In rare stands in which *Gutierrezia sarothrae* is not present (typically at lower elevations), *Gutierrezia microcephala* (2%) occurs in its place. Along with *Ephedra* spp., the short-shrub layer also sometimes supports *Yucca baccata* (1%), *Encelia farinosa* (1%), and *Ferocactus cylindraceus* (1%). The native bunch grasses *Muhlenbergia porteri* (3%) and *Achnatherum speciosum* (3%) occasionally occur in the graminoid understory (6%), and can each occur at up to 10-15% cover in some cases. The exotic *Bromus rubens* (1%) frequently occurs as well. *Sphaeralcea grossulariifolia* (up to 1%), *Artemisia ludoviciana* (up to 1%), and *Galium stellatum* (up to 4%) are frequent components of the forb layer (3%). Based upon the 20 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 25 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Herb (field)	Dwarf-shurb	*Agave utahensis, Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Agave utahensis*, *Artemisia ludoviciana*, *Bromus rubens*, *Ephedra fasciculata*, *Ephedra torreyana*, *Ephedra viridis*, *Ferocactus cylindraceus*, *Galium stellatum*, *Gutierrezia sarothrae*, *Muhlenbergia porteri*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Vulnerable: *Ephedra fasciculata* (G3?); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Gutierrezia (microcephala, sarothrae)* Dwarf-shrubland (CEPS009523) is also dominated by *Gutierrezia sarothrae*; however, it does not support any *Agave utahensis*, and *Ephedra* spp. are much less abundant.
Global Similar Associations:

- *Gutierrezia (microcephala, sarothrae)* Dwarf-shrubland [Park Special] (CEPS009523) is also dominated by *Gutierrezia sarothrae* but does not contain any *Agave utahensis*, and *Ephedra* spp. are much less abundant.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from much of the Grand Canyon and was sampled from the "corridor area" in the Inner Canyon, west to the extreme western edge of the park at the Grand Wash Cliffs. It was sampled in the Inner Canyon from Clear Creek, near Horseshoe Mesa, Bright Angel Canyon, Crystal Creek, Dragon Creek, Galloway Canyon, Matkatamiba Canyon, and Indian Hollow; in the Western Grand Canyon, it was sampled from Kanab Creek, 150-Mile Canyon, Whitmore Canyon, Andrus Canyon, Separation Canyon, Surprise Canyon, and from the "Hook"; and in Grand Canyon-Parashant National Monument, it was sampled from Twin Point.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (20 plots): GRCA.01027, GRCA.01566, GRCA.01658, GRCA.01660, GRCA.02083, GRCA.02549, GRCA.02618, GRCA.02662, GRCA.03006, GRCA.03558, GRCA.03562, GRCA.03602, GRCA.03641, GRCA.03643, GRCA.03652, GRCA.03653, GRCA.04110, GRCA.04571, GRCA.04666, GRCA.04677.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Lycium andersonii - Ephedra (*torreyana, viridis*) Shrubland

Water Jacket - (Torrey's Joint-fir, Mormon-tea) Shrubland
Identifier: CEGL005150

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Lycium andersonii - Ephedra (torreyana, viridis)* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes at 925 to 1250 m (3075-4125 feet) elevation, but can be found as low as 750 m (2450 feet). It is primarily found on moderately steep gradients (20-32 degrees), but is also occasionally found on gentler slopes (7-16 degrees). It shows some preference for north- and east-facing slopes, but can also occur on west-facing aspects. Soils are rapidly-drained sandy loams, and the underlying geology is typically sandstone or less frequently limestone or shale. Vegetation is characterized by the codominance of the short shrubs *Lycium andersonii* and *Ephedra torreyana*. In rare stands in which *Ephedra torreyana* is not present, *Ephedra viridis* occurs in its place. Tall shrubs are absent. The short-shrub layer also commonly includes *Encelia farinosa*; however, at least 20 different short-shrub associates can occur at low individual covers. A sparse dwarf-shrub layer of *Gutierrezia* spp. and *Opuntia polyacantha* occasionally occurs. The graminoid understory is well-developed and can be particularly dense in some stands. *Pleuraphis jamesii*, Bromus rubens (exotic), *Muhlenbergia porteri, Dasyochloa pulchella*, and *Aristida purpurea* are the most common. *Bouteloua eriopoda* does not occur frequently, but can be dominant in some stands. A somewhat sparse forb understory occasionally includes *Porophyllum gracile, Erodium cicutarium* (exotic), *Sphaeralcea grossulariifolia, Eriogonum inflatum*, and *Cryptantha* spp.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes in the Inner Canyon, from Marble Canyon to the beginning of the Granite Gorge. It usually occurs at 925 to 1250 m (3075-4125 feet) elevation, but can be found as low as 750 m (2450 feet). It is primarily found on moderately steep gradients (20-32 degrees), but is also occasionally found on gentler slopes (7-16 degrees) as well. It shows some preference for north- and east-facing slopes, but can also occur on west-facing aspects. Soils are rapidly-drained sandy loams, and when unobscured, the underlying geology is typically sandstone or less frequently limestone or shale. Gravel (40%) and rocks (38%) dominate the ground cover, while a relatively high cover of moss (2%) occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the codominance of the short shrubs *Lycium andersonii* (3-5%) and *Ephedra torreyana* (3-5%). In rare stands in which *Ephedra torreyana* is not present, *Ephedra viridis* (3%) occurs in its place. Tall shrubs are non-existent in this association. Along with *Lycium andersonii* and *Ephedra torreyana*, the short-shrub layer also commonly includes *Encelia farinosa* (1%); however, at least 20 different short-shrub associates can occur at low individual covers. A sparse dwarf-shrub layer (3%) exists in which *Gutierrezia* spp. (3%) and *Opuntia polyacantha* (2%) occasionally occur. The graminoid understory is well-developed in this association (10%) and can be particularly dense in some stands (up to 45% cover). *Pleuraphis jamesii* (3%, up to 10%), the exotic *Bromus rubens* (4%, up to 15%), *Muhlenbergia porteri* (up to 3%), *Dasyochloa pulchella* (1%), and *Aristida purpurea* (up to 1%) are the most common components of this stratum. *Bouteloua eriopoda* does not occur frequently, but can be dominant in some stands and occupy up to 40% cover. A somewhat sparse forb understory (3%) occasionally includes *Porophyllum gracile* (1%), *Erodium cicutarium* (1%), *Sphaeralcea grossulariifolia* (up to 1%), *Eriogonum inflatum* (up to 1%), and *Cryptantha* spp. (1%). Based upon the 17 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 22 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Thorn shrub	*Lycium andersonii*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua eriopoda*, *Bromus rubens*, *Dasyochloa pulchella*, *Ephedra torreyana*, *Lycium andersonii*, *Muhlenbergia porteri*, *Opuntia polyacantha*, *Pleuraphis jamesii*, *Porophyllum gracile*, *Sphaeralcea grossulariifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic), *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Ephedra (torreyana, viridis)* / Mixed Semi-desert Grasses Shrubland (CEGL005113) is also codominated by *Ephedra torreyana* and supports *Lycium andersonii*; however, *Lycium andersonii* occurs much less frequently and at lower cover than in *Lycium andersonii - Ephedra (torreyana, viridis)* Shrubland (CEGL005150).
Global Similar Associations:

- *Ephedra (torreyana, viridis)* / Mixed Semi-desert Grasses Shrubland (CEGL005113) is also codominated by *Ephedra torreyana*, but *Lycium andersonii* occurs much less frequently and at lower cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it primarily occurs between Rider Canyon and the beginning of the Granite Gorge near Hance Rapids. A single stand was sampled to the west from Galloway Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (17 plots): GRCA.01015, GRCA.01017, GRCA.01018, GRCA.01019, GRCA.01020, GRCA.01022, GRCA.01023, GRCA.01544, GRCA.02548, GRCA.03023, GRCA.03024, GRCA.03030, GRCA.03041, GRCA.03534. GRCA.03559, GRCA.04553, GRCA.04562.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Nolina microcarpa* Shrubland [Park Special]**

Sacahuista Shrubland
Identifier: CEPS009689

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Nolina microcarpa* Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

***Opuntia bigelovii* Shrubland**

Teddy-bear Cholla Shrubland
Identifier: CEGL003065

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Opuntia bigelovii* Shrubland

ELEMENT CONCEPT

Global Summary: This cholla shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on xeric sideslopes at 600 to 675 m (2000-2200 feet) elevation, on moderate (10-30 degrees), south- or southeast-facing slopes. Soils are rapidly-drained sandy loams or clays that usually lie on top of shale or quartzite. Vegetation is characterized by the dominance of the short shrub *Opuntia bigelovii*. Tall shrubs such as *Fouquieria splendens* do occur but are sparse and infrequent. *Opuntia bigelovii* is invariably accompanied by *Encelia farinosa* in the short-shrub layer. Scattered *Krameria erecta*, *Opuntia acanthocarpa*, *Ferocactus cylindraceus*, and *Ephedra fasciculata* also occur fairly frequently. *Opuntia basilaris* consistently occurs in a very sparse dwarf-shrub stratum. Graminoids are virtually non-existent in this association. Forbs are similarly sparse; however, species such as *Plantago ovata*, *Phacelia* sp., *Amsinckia menziesii*, and *Eriogonum inflatum* occur sporadically at very low individual covers.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on xeric sideslopes in the far Western Grand Canyon. It occurs at 600 to 675 m (2000-2200 feet) elevation, on moderate (10-30 degrees), south- or southeast-facing slopes. Soils are rapidly-drained sandy loams or clays that usually lie on top of shale or quartzite. Gravel (65%) and rocks (24%) strongly dominate the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-25% in this association which is characterized by the dominance of the short shrub *Opuntia bigelovii* (8-12%). Tall shrubs such as *Fouquieria splendens* (1%) do occur but are sparse and infrequent. *Opuntia bigelovii* is invariably accompanied by *Encelia*

farinosa (5-8%) in the short-shrub layer. Scattered *Krameria erecta* (1%), *Opuntia acanthocarpa* (1%), *Ferocactus cylindraceus* (1%), and *Ephedra fasciculata* (2%) also occur fairly frequently. *Opuntia basilaris* (1%) consistently occurs in a very sparse dwarf-shrub stratum. Graminoids are virtually non-existent in this association. Forbs are similarly sparse; however, species such as *Plantago ovata, Phacelia* sp., *Amsinckia menziesii*, and *Eriogonum inflatum* occur sporadically at very low individual covers. Based upon the 9 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 10 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Opuntia bigelovii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Encelia farinosa*, *Ephedra fasciculata*, *Ferocactus cylindraceus*, *Fouquieria splendens*, *Krameria erecta*, *Mammillaria grahamii*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Opuntia bigelovii*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Ephedra fasciculata* (G3?), *Opuntia bigelovii* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (1-Dec-1997).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Related Concepts:

- *Larrea tridentata - Opuntia bigelovii* / *Ambrosia* spp. Association (Malusa 2003) **=**
- *Opuntia bigelovii* Shrubland Alliance (Sawyer and Keeler-Wolf 1995) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from "Gneiss" Canyon (north of the River and from near Bridge Canyon Rapids.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. It is also reported from California. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA:S4
TNC Ecoregions: 17:C, 19:C, 23:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 322B:C?, 322C:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (6 plots): GRCA.01656, GRCA.03664, GRCA.03668, GRCA.04596, GRCA.04692, GRCA.04694.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Malusa 2003, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Western Ecology Working Group n.d.

***Parthenium incanum* - (*Ephedra fasciculata*) Shrubland [Park Special]**

Mariola - (Arizona Joint-fir) Shrubland
Identifier: CEPS009524

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Parthenium incanum - (Ephedra fasciculata)* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on mid-level and high-level sideslopes in the Western Grand Canyon and Inner Canyon. It usually occurs at 1250 to 1300 m (4100-4275 feet) elevation, but can be found as low as 900 m (2875 feet). It is primarily found on moderate to steep gradients (20-35 degrees), but is also occasionally found on gentler slopes (8 degrees), and occurs across all aspects. Soils are well-drained loamy sands or silty loams which typically lie above limestone or quartzite. Gravel (55%) and rocks (22%) dominate the ground cover, and moss (2%) is also found in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is dominated by the short shrubs *Parthenium incanum* (8-10%) and *Ephedra fasciculata* (3-4%). Tall shrubs are sparse and rare, but *Fouquieria splendens* (1%) sporadically punctuates some stands. Along with *Parthenium incanum* and *Ephedra fasciculata*, the short-shrub layer (15%) also typically supports *Yucca baccata* (2%), *Aloysia wrightii* (1%), and sometimes *Encelia resinifera* (1%). *Gutierrezia sarothrae* (1%) and sometimes *Agave utahensis* (up to 1%) are frequent components of the dwarf-shrub stratum (2%). *Bromus rubens* (1%) and *Tridens muticus* (trace cover) are common in a weak graminoid layer. *Cryptantha* spp. (trace cover), *Thymophylla pentachaeta* (up to 1%), and *Sphaeralcea grossulariifolia* (1%) regularly occur in a poorly-developed forb understory (1%). Based upon the 4 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 22 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Parthenium incanum*
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Aloysia wrightii*, *Encelia resinifera*, *Ephedra fasciculata*, *Gutierrezia sarothrae*, *Parthenium incanum*, *Thymophylla pentachaeta*, *Tridens muticus*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from Tuckup Canyon and near 220-Mile Canyon; and from the Inner Canyon, where it was sampled from near Dox Castle.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (4 plots): GRCA.01619, GRCA.01637, GRCA.01652, GRCA.04616.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Pleuraphis rigida Herbaceous Vegetation

Big Galleta Herbaceous Vegetation
Identifier: CEGL003051

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Pleuraphis rigida* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This grassland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It predominantly occurs on sideslopes, but also sometimes occurs in drainage channels and on valley bottoms, mesas, and plateaus from approximately 1050 to 1600 m (3420-5250 feet) elevation, but has been found as low as 470 m (1540 feet). It is typically found on flat to gently sloping gradients (0-5 degrees), but also occurs on moderately steep slopes (15-30 degrees) as well. Soils are well- to rapidly-drained sandy clays or loams that occasionally contain silt. The underlying geology is usually limestone. Tree and tall shrubs are essentially absent from this graminoid-dominated community type. A relatively sparse short-shrub layer occurs, in which *Coleogyne ramosissima* and *Ephedra fasciculata* occur most frequently. *Opuntia polyacantha* and *Gutierrezia* spp. are commonly seen in a sparse dwarf-shrub stratum. A well-developed graminoid layer dominated by *Pleuraphis rigida* characterizes this association. The invasive grass *Bromus rubens* also occurs on a regular basis, while the native perennials *Bouteloua eriopoda* and *Aristida purpurea* occur sporadically. Species such as *Sphaeralcea grossulariifolia* and *Erodium cicutarium* are common in the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association is known from the Inner Canyon (to the west of Phantom Ranch), the Western Grand Canyon, and from Grand Canyon-Parashant National Monument. It predominantly occurs on sideslopes, but also sometimes occurs in drainage channels and on valley bottoms, mesas, and plateaus. It occurs from approximately 1050 to 1600 m (3420-5250 feet) elevation, but has been found as low as 470 m (1540 feet). It is typically found on flat to gently sloping gradients (0-5 degrees), but also occurs on moderately steep slopes (15-30 degrees) as well. Soils are well- to rapidly-drained sandy clays or loams that occasionally contain silt. When unobscured, the underlying geology is usually limestone. The ground cover tends to be dominated by gravel (43%), bare soil (15%) and rocks (15%), with lesser amounts of litter (9%) and cryptogamic soil crust (3%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree and tall shrubs are essentially absent from this graminoid-dominated community type. A relatively sparse short-shrub layer occurs, in which *Coleogyne ramosissima* (2%) and *Ephedra fasciculata* (2%) occur most frequently. *Opuntia polyacantha* (1%) and *Gutierrezia* spp. (1%) are commonly seen in a sparse dwarf-shrub stratum. A well-developed graminoid layer, dominated by *Pleuraphis rigida* (25-30%), characterizes this association. The invasive grass *Bromus rubens* (1%) also occurs on a regular basis, while the native perennials *Bouteloua eriopoda* (5%) and *Aristida purpurea* (up to 1%) occur sporadically. Species such as *Sphaeralcea grossulariifolia* (1%) and *Erodium cicutarium* (1%) are common in the forb understory (2-3%). Based upon the 16 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 11 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis rigida*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aristida purpurea*, *Bouteloua eriopoda*, *Bromus rubens*, *Erodium cicutarium*, *Opuntia polyacantha*, *Pleuraphis rigida*, *Sphaeralcea grossulariifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cirsium vulgare* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (1-Dec-1997).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777) is found on similar landforms (although typically at higher elevations) and hosts a similar set of common species; however, *Pleuraphis jamesii*, and not *Pleuraphis rigida*, is the dominant graminoid species.
Global Similar Associations:

- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777) is found on similar landforms (although typically at higher elevations) and hosts a similar set of common species; however, *Pleuraphis jamesii* rather than *Pleuraphis rigida* is dominant.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, the Western Grand Canyon, and Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled from Cogswell Butte and near Dear Spring; in the Western Grand Canyon, it was sampled from the Hook near Grand Wash Cliffs, near Pearce Ferry, and from Surprise Canyon; and in Grand Canyon-Parashant, it was sampled from the Whitmore Canyon area.
Global Range: This association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from California. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA:S3S4, NV
TNC Ecoregions: 17:C, 19:C, 23:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 322B:CC, 322C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (15 plots): GRCA.01009, GRCA.01502, GRCA.01674, GRCA.02000, GRCA.03016, GRCA.03018, GRCA.03625, GRCA.03634, GRCA.03642, GRCA.04637, GRCA.04644, GRCA.04651, GRCA.04662, GRCA.04672, GRCA.04673.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Peterson 2008, Reid and Hall 2010, Western Ecology Working Group n.d.

Yucca baccata Shrubland [Park Special]

Banana Yucca Shrubland
Identifier: CEPS009530

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Yucca baccata* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This yucca shrubland association can occur on a variety of landforms, including valley bottoms, sideslopes, plateaus, and ridges in the Western Grand Canyon and Inner Canyon. It typically occurs at 1225 to 1400 m (4025-4550 feet) elevation, but may occur as high as 1550 m (5050 feet). It is primarily found on gentle gradients (1-7 degrees), but is also occasionally found on steeper slopes (20 degrees). It seems to predominantly occur on either east- or west-facing slopes. Soils are well- to rapidly-drained silty or sandy loams or clays. When unobscured, the underlying geology is typically limestone. Ground cover tends to be dominated by gravel (36%), bare soil (28%), and rocks (21%), with relatively low amounts of litter (10%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association. It is characterized by a varied assemblage of different shrub species and is dominated by the short shrub *Yucca baccata* (5%). Along with *Yucca baccata*, the short-shrub layer also occasionally includes *Ephedra fasciculata* (2%), *Encelia resinifera* (1%), and *Ephedra nevadensis* (3%). *Opuntia polyacantha* (up to 1%) and either *Gutierrezia sarothrae* or *Gutierrezia microcephala* (2%) are frequent components of the dwarf-shrub layer (3%). At least 20 different shrub species can occur as associates in the community. *Aristida purpurea* (1%), *Bromus rubens* (1%), *Dasyochloa pulchella* (1%), and *Vulpia octoflora* (up to 1%) occasionally occur in the fairly well-developed graminoid layer (7%). *Erodium cicutarium* (up to 1%) and *Calochortus flexuosus* (trace cover) are sporadically present in a weak forb layer. Based upon the 9 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Yucca baccata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aristida purpurea*, *Calochortus flexuosus*, *Dasyochloa pulchella*, *Encelia resinifera*, *Ephedra fasciculata*, *Ephedra nevadensis*, *Gutierrezia microcephala*, *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Vulpia octoflora*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard

Grand Canyon National Park Comments: *Yucca baccata* occurs in many different associations within Grand Canyon National Park; however, this is the only community in which it is dominant.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from the Toroweap Valley, Whitmore Canyon, Tuckup Canyon, and the "Hook" near the Grand Wash Cliffs;

and from the Inner Canyon, where it was sampled in Bright Angel Canyon.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.02013, GRCA.02575, GRCA.02614, GRCA.03588, GRCA.03633, GRCA.03644, GRCA.03645, GRCA.04610, GRCA.04649.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Yucca brevifolia / *Coleogyne ramosissima* Wooded Shrubland

Joshua Tree / Blackbrush Wooded Shrubland
Identifier: CEGL005294

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Yucca brevifolia* / *Coleogyne ramosissima* Wooded Shrubland

ELEMENT CONCEPT

Global Summary: This Joshua tree shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It is restricted to low-level sideslopes and valley bottoms at 1475 to 1500 m (4875-4900 feet) elevation, but can occur as high as 1600 m (5275 feet). It is typically found on very gentle slopes (2-4 degrees), but occasionally occurs on more moderate gradients (6-8 degrees). It seems to occur across all aspects other than south-facing. Soils are rapidly-drained sandy loams that usually lie on top of limestone or basalt. Vegetation is characterized by the codominance of the tall shrub *Yucca brevifolia* and the short shrub *Coleogyne ramosissima*. *Yucca baccata*, *Ephedra viridis, Atriplex canescens*, and *Purshia stansburiana* also commonly occur in the short-shrub layer. *Opuntia basilaris* regularly occurs in the dwarf-shrub stratum, while *Agave utahensis* and *Gutierrezia microcephala* can be found sporadically. Native bunch grasses, including *Bouteloua eriopoda, Muhlenbergia porteri, Bouteloua gracilis, Dasyochloa pulchella*, and *Tridens muticus*, occur in most stands at relatively low individual covers. The exotic *Bromus tectorum* is a frequent graminoid, and *Cymopterus purpurascens* and *Erodium cicutarium* occur most frequently in a poorly-developed forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This wooded shrubland association is restricted to low-level sideslopes and valley bottoms in the extreme Western Grand Canyon near the Grand Wash Cliffs. It typically occurs at 1475 to 1500 m (4875-4900 feet) elevation, but can occur as high as 1600 m (5275 feet). It is typically found on very gentle slopes (2-4 degrees), but occasionally occurs on more moderate gradients (6-8 degrees). It seems to occur across all aspects other than south-facing. Soils are rapidly-drained sandy loams that usually lie on top of limestone or basalt. The ground cover tends to be dominated by gravel (60%), with relatively low amounts of bare soil (13%), rocks (10%), and litter (10%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 30-40% in this association which is characterized by the codominance of the tall shrub *Yucca brevifolia* (5-10%) and the short shrub *Coleogyne ramosissima* (20-30%). *Yucca baccata* (2%) frequently accompanies *Coleogyne ramosissima* in the short-shrub layer. *Ephedra viridis* (1%), *Atriplex canescens* (1%), and *Purshia stansburiana* (2%) also commonly occur. *Opuntia basilaris* (1%) regularly occurs in the dwarf-shrub stratum (3%), while *Agave utahensis* and *Gutierrezia microcephala*

can be found sporadically. Native bunch grasses, including *Bouteloua eriopoda, Muhlenbergia porteri, Bouteloua gracilis, Dasyochloa pulchella*, and *Tridens muticus*, occur in most stands at relatively low individual covers. The exotic *Bromus tectorum* (1%) is a frequent member of the graminoid layer (3%). *Cymopterus purpurascens* (up to 1%) and *Erodium cicutarium* (up to 1%) occur most frequently in a poorly-developed forb layer (1%). Based upon the 6 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 14 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Succulent shrub	*Yucca brevifolia*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus tectorum*, *Coleogyne ramosissima*, *Cymopterus purpurascens*, *Ephedra viridis*, *Opuntia basilaris*, *Yucca baccata*, *Yucca brevifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: This association is unique in Grand Canyon National Park; no other association supports significant *Yucca brevifolia* cover.
Global Related Concepts:
- Joshua Tree Series (Sawyer and Keeler-Wolf 2005) **>**

ELEMENT DISTRIBUTION

Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (6 plots): GRCA.01013, GRCA.02004, GRCA.02007, GRCA.02018, GRCA.03005, GRCA.03007.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Sawyer and Keeler-Wolf 2005, Western Ecology Working Group n.d.

***Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland**

Mojave Yucca - Creosotebush - White Bursage Shrubland
Identifier: CEGL005295

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Mojave Mid-Elevation Mixed Desert Scrub (G296)
Association	*Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland

ELEMENT CONCEPT

Global Summary: This yucca shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes, but can occur on ridges, plateaus, and in drainage channels, at 550 to 600 m (1825-1975 feet) elevation, but can be found as high as 650 m (2175 feet). It is typically found on low gradients (2-10 degrees), but occasionally occurs on steeper slopes (up to 20 degrees), and seems to favor south- or east-facing aspects. Soils are well- to rapidly-drained silty or sandy clays or loams. Vegetation is characterized by the dominance of *Larrea tridentata* in the tall-shrub stratum, *Yucca schidigera* in the short-shrub stratum, and *Ambrosia dumosa* in the dwarf-shrub stratum. No other tall shrubs occur regularly. Tthe short-shrub layer usually includes *Krameria grayi* and occasionally *Psorothamnus fremontii*. The cactus *Opuntia basilaris* occurs sporadically in the dwarf shrub-layer. *Vulpia octoflora, Bromus rubens*, and *Schismus barbatus* are common in a very sparse graminoid understory. *Cryptantha* spp., *Plantago ovata*, *Antheropeas lanosum*, *Phacelia crenulata*, and *Erodium cicutarium* are all frequently present in a well-developed forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes but can occur on ridges, plateaus, and in drainage channels in Grand Canyon-Parashant National Monument. It usually occurs at 550 to 600 m (1825-1975 feet) elevation, but can be found as high as 650 m (2175 feet). It is typically found on low gradients (2-10 degrees), but occasionally occurs on steeper slopes (up to 20 degrees), and seems to favor south- or east-facing aspects. Soils are well- to rapidly-drained silty or sandy clays or loams. Ground cover tends to be dominated by gravel (65%), with some rocks (16%), bare soil (9%), and a notable amount of cryptogamic soil crust (3%). A single stand was sampled from a similar environment in Grand Canyon National Park near Pearce Ferry.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-20% in this association which is characterized by the dominance of *Larrea tridentata* (2-4%) in the tall-shrub stratum, *Yucca schidigera* (3-5%) in the short-shrub stratum, and *Ambrosia dumosa* (5-10%) in the dwarf-shrub stratum. Besides *Larrea tridentata*, no other tall shrubs occur regularly. Along with *Yucca schidigera*, the short-shrub layer usually includes *Krameria grayi* (2%) and occasionally *Psorothamnus fremontii* (1%). The cactus *Opuntia basilaris* (up to 1%) occurs sporadically in the dwarf shrub-layer. *Vulpia octoflora* (1%), *Bromus rubens* (up to 1%), and *Schismus barbatus* (1%) are common in a weak graminoid understory (2%). *Cryptantha* spp. (1%), *Plantago ovata* (1%), *Antheropeas lanosum* (3%), *Phacelia crenulata* (1%), and *Erodium cicutarium* (2%) are all frequently present in a well-developed forb component (8-10%). Based upon the 12 stands sampled, this association hosts significantly above-average species diversity among plant communities in Grand Canyon, with 26 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Succulent shrub	*Yucca schidigera*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Forb	*Antheropeas lanosum*
Herb (field)	Graminoid	*Vulpia octoflora*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Antheropeas lanosum*, *Bromus rubens*, *Camissonia brevipes*,

Eriogonum inflatum, *Krameria grayi*, *Larrea tridentata*, *Opuntia basilaris*, *Pectocarya recurvata*, *Phacelia crenulata*, *Plantago ovata*, *Rafinesquia neomexicana*, *Schismus barbatus*, *Vulpia octoflora*, *Yucca schidigera*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus arabicus* (exotic, High/Medium), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland (CEGL005137) is also codominated by *Larrea tridentata* and *Ambrosia dumosa* and supports *Krameria* spp.; however, *Yucca schidigera* is very infrequent. *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also codominated by *Larrea tridentata* and *Ambrosia dumosa*; however, *Yucca schidigera* is absent.

Global Similar Associations:

- *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland (CEGL005137) is also codominated by *Larrea tridentata* and *Ambrosia dumosa* and supports *Krameria* spp., but *Yucca schidigera* is very infrequent.
- *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also codominated by *Larrea tridentata* and *Ambrosia dumosa*, but *Yucca schidigera* is absent.

Global Related Concepts:

- Mojave Yucca Series (Sawyer and Keeler-Wolf 2005) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument where it was sampled to the east of Grand Wash Bay from Snap Canyon, Tassi Wash, Pigeon Wash, and Gyp Wash. A single stand was sampled from the extreme Western Grand Canyon to the southeast of Pearce Ferry.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (12 plots): GRCA.01501, GRCA.02517, GRCA.02524, GRCA.03519, GRCA.03521, GRCA.03523, GRCA.03524, GRCA.03525, GRCA.03528, GRCA.04512, GRCA.04516, GRCA.04519.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Reid and Hall 2010, Sawyer and Keeler-Wolf 2005, Western Ecology Working Group n.d.

G295. Sonoran-Mojave Creosotebush - White Bursage Desert Scrub

Ambrosia dumosa - Encelia farinosa Dwarf-shrubland

White Bursage - Brittlebush Dwarf-shrubland

Identifier: CEGL005061

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)

Group Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association *Ambrosia dumosa - Encelia farinosa* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This white bursage shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. This association primarily occurs on sideslopes at approximately 425 to 850 m (1375-2800 feet) elevation; it uncommonly occurs as high as 1050 m (3425 feet). It is typically found on moderately sloping gradients (10-20 degrees), but occasionally occurs on much steeper slopes (30-40 degrees) as well. Soils are well- to rapidly-drained silty or sandy loams that rarely contain clay. The underlying geology is usually limestone, shale, or infrequently basalt or quartzite. Vegetation is characterized by the codominance of the dwarf-shrub *Ambrosia dumosa* and the short shrub *Encelia farinosa*. Tall shrubs are rare, but some stands sporadically contain *Larrea tridentata*. The short-shrub layer frequently includes *Ephedra fasciculata* and *Ferocactus cylindraceus*. The cacti *Opuntia polyacantha* and *Opuntia basilaris* sporadically occur in the dwarf-shrub stratum. *Bromus rubens* and *Dasyochloa pulchella* commonly occur in a very weakly-developed graminoid layer. *Eriogonum inflatum* and *Sphaeralcea grossulariifolia* occasionally occur in a relatively sparse forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association primarily occurs on sideslopes in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument from approximately 425 to 850 m (1375-2800 feet) elevation; it uncommonly occurs as high as 1050 m (3425 feet). It is typically found on moderately sloping gradients (10-20 degrees), but occasionally occurs on much steeper slopes (30-40 degrees) as well. Soils are well- to rapidly-drained silty or sandy loams that rarely contain clay. When unobscured, the underlying geology is usually limestone, shale, or infrequently basalt or quartzite. Ground cover is strongly dominated by rocks (48%) and gravel (40%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-25% in this association which is characterized by the codominance of the dwarf-shrub *Ambrosia dumosa* (5-15%) and the short shrub *Encelia farinosa* (5-10%). Tall shrubs are rare, but some stands are sporadically punctuated by *Larrea tridentata* (up to 1%). Along with *Encelia farinosa*, the short-shrub layer frequently includes *Ephedra fasciculata* (2%) and *Ferocactus cylindraceus* (1%). The cacti *Opuntia polyacantha* (3%) and *Opuntia basilaris* (1%) sporadically occur in the dwarf-shrub stratum. *Bromus rubens* (up to 1%) and *Dasyochloa pulchella* (up to 1%) commonly occur in a very weakly-developed graminoid layer. *Eriogonum inflatum* (up to 1%) and *Sphaeralcea grossulariifolia* (up to 1%) occasionally occur in a relatively sparse forb understory. Based upon the 9 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*
Herb (field)	Dwarf-shrub	*Ambrosia dumosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Eriogonum inflatum*, *Ferocactus cylindraceus*, *Sphaeralcea grossulariifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)

Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Ambrosia dumosa* Shrubland (CEGL005074) supports similar cover of *Ambrosia dumosa*, has a similar floristic composition, and also typically occurs on sideslopes in the Inner Canyon. However, *Encelia farinosa* occurs less frequently and with lower cover in this association.

Global Similar Associations:

- *Ambrosia dumosa - Ephedra (fasciculata, nevadensis)* Dwarf-shrubland (CEGL000954)
- *Ambrosia dumosa* Dwarf-shrubland (CEGL005074) supports similar cover of *Ambrosia dumosa*, has a similar floristic composition, and also typically occurs on sideslopes, but *Encelia farinosa* occurs less frequently and with lower cover.

Global Related Concepts:

- *Ambrosia dumosa - Encelia farinosa* Dwarf-shrubland (Keeler-Wolf et al. 1998) **=**
- *Ambrosia dumosa* (White bursage scrub) Alliance (Sawyer et al. 2009) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Stone Creek, in and around Tapeats Creek, and near Cogswell Butte; from the Western Grand Canyon, where it was sampled along the Colorado River near Burnt Canyon; and from Grand Canyon-Parashant National Monument, where it was sampled in vicinity of Grand Wash Bay.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.01513, GRCA.02673, GRCA.03695, GRCA.04052, GRCA.04577, GRCA.04579, GRCA.04630, GRCA.04633, GRCA.04643.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Keeler-Wolf et al. 1998, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

***Ambrosia dumosa - Ephedra* (*fasciculata, nevadensis*) Dwarf-shrubland**

White Bursage - (Arizona Joint-fir, Nevada Joint-fir) Dwarf-shrubland

Identifier: CEGL000954

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Ambrosia dumosa - Ephedra (fasciculata, nevadensis)* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This white bursage shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs primarily on sideslopes and ridgetops at 650 to 750 m (2150-2500 feet) elevation, but may occur throughout a broader elevational range than was documented by the classification plots. It is typically found on moderately sloping gradients (10-15 degrees), but has also been seen on nearly flat surfaces.

Soils are well- to rapidly-drained sandy clays that occasionally obscure the bedrock below. The underlying geology is usually sandstone. Vegetation is characterized and codominated by the dwarf-shrub *Ambrosia dumosa* and the short shrub *Ephedra fasciculata*. In some stands, *Ephedra fasciculata* is absent and *Ephedra nevadensis* takes its place as a codominant. Tall shrubs are rare, but some stands are occasionally contain *Acacia greggii*. The short-shrub layer also frequently includes *Ferocactus cylindraceus*. The only other dwarf-shrub that appears with significant cover is *Gutierrezia sarothrae*. *Vulpia octoflora* and *Pleuraphis jamesii* are frequently present in a sparse graminoid layer. *Erodium cicutarium, Lepidium densiflorum*, and *Machaeranthera pinnatifida* occur with some regularity in a relatively poorly-developed forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This dwarf-shrubland association occurs primarily on sideslopes and ridgetops in the Inner Canyon and Grand Canyon-Parashant National Monument. It occurs at 650 to 750 m (2150-2500 feet) elevation but may occur throughout a broader elevational range than was documented by the classification plots. It is typically found on moderately sloping gradients (10-15 degrees) but has also been seen on nearly flat surfaces. Soils are well- to rapidly-drained sandy clays that occasionally obscure the bedrock below. When unobscured, the underlying geology is usually sandstone. Ground cover tends to be dominated by gravel (53%), rocks (16%), and bare soil (20%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized and codominated by the dwarf-shrub *Ambrosia dumosa* (5-7%) and the short shrub *Ephedra fasciculata* (5%). In some stands, *Ephedra fasciculata* is absent and *Ephedra nevadensis* (2%) takes its place as a codominant. Tall shrubs are rare, but some stands are occasionally punctuated with *Acacia greggii* (1%). Along with *Ephedra* spp., the short-shrub layer frequently includes *Ferocactus cylindraceus* (up to 1%). Other than *Ambrosia dumosa*, the only other dwarf-shrub that appears with significant cover is *Gutierrezia sarothrae* (2%). *Vulpia octoflora* (trace cover) and *Pleuraphis jamesii* (3%) are frequently present in a sparse graminoid layer (3%). *Erodium cicutarium* (2%), *Lepidium densiflorum* (1%), and *Machaeranthera pinnatifida* (1%) occur with some regularity in a relatively poorly-developed forb layer (2%). Based upon the 2 stands sampled, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Acacia greggii*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Graminoid	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Ambrosia dumosa*, *Ephedra fasciculata*, *Ephedra nevadensis*, *Ferocactus cylindraceus*, *Gutierrezia sarothrae*, *Machaeranthera pinnatifida*, *Pleuraphis jamesii*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)

Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak

Grand Canyon National Park Comments: *Ambrosia dumosa - Encelia farinosa* Shrubland (CEGL005061) supports a similar cover of *Ambrosia dumosa* and also contains *Ephedra fasciculata*, *Ephedra nevadensis*, and *Encelia farinosa*. *Encelia farinosa* occurs more frequently and with higher cover here, than in *Ambrosia dumosa - (Ephedra fasciculata, nevadensis)* Dwarf-shrubland (CEGL000954).

Global Similar Associations:

- *Ambrosia dumosa - Encelia farinosa* Dwarf-shrubland (CEGL005061) supports a similar cover of *Ambrosia dumosa* and also contains *Ephedra fasciculata*, *Ephedra nevadensis*, and *Encelia farinosa* (which occurs more frequently and with higher cover).

Global Related Concepts:

- 153.11013 *Ambrosia dumosa - Ephedra nevadensis - Ferocactus acanthodes* Association (Warren et al. 1982) **=**
- *Ambrosia dumosa-Ephedra nevadensis* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.A.1.d. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon where it was sampled from near Tapeats Rapids, and from Grand Canyon-Parashant National Monument where it was sampled from near Grand Wash Bay.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from New Mexico. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ, NM

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC, 313B:C?

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (2 plots): GRCA.03561, GRCA.04034.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

***Ambrosia dumosa* Dwarf-shrubland**

White Bursage Dwarf-shrubland

Identifier: CEGL005074

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Ambrosia dumosa* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This white bursage shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It primarily occurs on sideslopes and plateaus at 475 to 575 m (1600 to 1875 feet) elevation; it rarely occurs as high as 625 m (2025 feet). This association is typically found on moderately sloping gradients (10 to 15 degrees), but occasionally occurs on much flatter slopes (0 to 4 degrees). Soils are rapidly-drained sands or sandy loams that lie on top of limestone or sandstone. *Ambrosia dumosa* dominates the dwarf-shrub layer and characterizes this vegetation type. Tall shrubs such as *Larrea tridentata* occasionally occur in a poorly-defined stratum. *Opuntia acanthocarpa, Ephedra torreyana*, and *Encelia farinosa* regularly occur in a sparse short-shrub layer. The cactus *Opuntia basilaris* is commonly found in the dwarf-shrub layer. *Bromus rubens* and *Vulpia octoflora*

occur occasionally in the sparse graminoid layer. *Eriogonum inflatum, Gilia* sp., *Cryptantha* spp., *Pectocarya* sp., and *Descurainia pinnata* are common forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This burrobush shrubland association primarily occurs on sideslopes and plateaus in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument at 475 to 575 m (1600 to 1875 feet) elevation; it rarely occurs as high as 625 m (2025 feet). It is typically found on moderately sloping gradients (10 to 15 degrees), but occasionally occurs on much flatter slopes (0 to 4 degrees). Soils are rapidly-drained sands or sandy loams that lie on top of limestone or sandstone. Gravel (57%) and sand or bare soil (19%) dominate the ground cover, while cryptogamic soil crust (8%) also occurs with relatively high cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association. *Ambrosia dumosa* (5-15%) dominates the dwarf-shrub layer and characterizes this vegetation type. Tall shrubs such as *Larrea tridentata* (1%) occasionally occur in a poorly-defined stratum. *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%), *Ephedra torreyana* (1%), and *Encelia farinosa* (1%) regularly occur in a sparse short-shrub layer. The cactus *Opuntia basilaris* (up to 1%) commonly accompanies *Ambrosia dumosa* in the dwarf-shrub layer. *Bromus rubens* (1%) and *Vulpia octoflora* (up to 1%) occur occasionally in the sparse graminoid layer (1%). *Eriogonum inflatum* (up to 1%), *Gilia* sp. (1%), *Cryptantha* spp. (2%), *Pectocarya* sp. (1%), and *Descurainia pinnata* (1%) are common forbs (4%). Based upon the 4 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Short shrub/sapling	Succulent shrub	*Opuntia acanthocarpa*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Dasyochloa pulchella*, *Descurainia pinnata*, *Encelia farinosa*, *Ephedra torreyana*, *Eriogonum inflatum*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Ambrosia dumosa - Encelia farinosa* Shrubland (CEGL005061) is also dominated by *Ambrosia dumosa*, has a similar floristic composition, and is typically found on sideslopes in the Inner Canyon. However, *Encelia farinosa* occurs more frequently and with higher cover in this association.

Global Similar Associations:

- *Ambrosia dumosa - Encelia farinosa* Dwarf-shrubland (CEGL005061) is also dominated by *Ambrosia dumosa*, has a similar floristic composition, and is typically found on sideslopes, but *Encelia farinosa* occurs more frequently and with higher cover.

Global Related Concepts:

- *Ambrosia dumosa* (White bursage scrub) Alliance (Sawyer et al. 2009) >

- *Ambrosia dumosa* Dwarf-shrubland (Evens and Hartman 2007) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from near Tapeats Rapids; from the Western Grand Canyon, where it was sampled near Salt Creek; and from Grand Canyon-Parashant National Monument, where it was sampled from near Grand Wash Bay.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01514, GRCA.01515, GRCA.01677, GRCA.03560.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Evens and Hartman 2007, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

***Ambrosia eriocentra* - (*Coleogyne ramosissima*) Dwarf-shrubland**

Woolly-fruit Bur-ragweed - (Blackbrush) Dwarf-shrubland
Identifier: CEGL005080

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Ambrosia eriocentra - (Coleogyne ramosissima)* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on sideslopes from 1400 to 1500 m (4575-5000 feet) elevation, but has been found as high as 1600 m (5250 feet). It is typically found on east- to south-facing, moderately sloping gradients (10-20 degrees), but also occasionally occurs on steeper slopes (30 degrees). Soils are rapidly-drained sandy loams that lie on top of limestone. *Ambrosia eriocentra* dominates the short-shrub layer and characterizes this association. *Purshia stansburiana, Coleogyne ramosissima*, and *Yucca baccata* occur in the short-shrub stratum of almost all stands as well, while *Encelia resinifera* and *Ephedra viridis* occur occasionally. The fairly sparse dwarf-shrub layer typically includes *Agave utahensis* and *Gutierrezia microcephala*, and sometimes also includes *Opuntia basilaris* and *Echinocereus triglochidiatus*. The graminoid understory is relatively well-developed and frequently supports *Tridens muticus* and the exotic *Bromus tectorum. Erodium cicutarium, Sphaeralcea ambigua, Chaetopappa ericoides, Castilleja applegatei ssp. martinii (= Castilleja angustifolia var. dubia)*, and *Mirabilis multiflora* are the most common forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on sideslopes in the "Hook" region of the Western Grand Canyon. It mostly occurs from 1400 to 1500 m (4575-5000 feet) elevation, but has been found as high as 1600 m (5250 feet). It is typically found on east- to south-facing, moderately sloping gradients (10-20 degrees), but also occasionally occurs on steeper slopes (30 degrees). Soils are rapidly-drained sandy loams that lie on top of limestone. Gravel (36%), rocks (23%), litter (11%), bedrock (10%), and bare soil (9%) are common components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 20-25% in this association. *Ambrosia*

eriocentra (10-20%) dominates the short-shrub layer and characterizes this association. *Purshia stansburiana* (2%), *Coleogyne ramosissima* (2%), and *Yucca baccata* (2%) occur in the short-shrub stratum of almost all stands as well, while *Encelia resinifera* (1%) and *Ephedra viridis* (1%) occur occasionally. The fairly sparse dwarf-shrub layer (3%) typically includes *Agave utahensis* (1%) and *Gutierrezia microcephala* (1%), and sometimes includes *Opuntia basilaris* (up to 1%) and *Echinocereus triglochidiatus* (1%) as well. The graminoid understory is relatively well-developed (6%) and frequently supports *Tridens muticus* (2%) and the exotic *Bromus tectorum* (1%). *Erodium cicutarium* (1%), *Sphaeralcea ambigua* (1%), *Chaetopappa ericoides* (up to 1%), *Castilleja applegatei ssp. martinii (= Castilleja angustifolia var. dubia)* (up to 1%), and *Mirabilis multiflora* (up to 1%) are the most common forbs (2%). Based upon the 8 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ambrosia eriocentra*
Herb (field)	Forb	*Sphaeralcea ambigua*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Ambrosia eriocentra*, *Castilleja applegatei* ssp. *martinii*, *Chaetopappa ericoides*, *Coleogyne ramosissima*, *Echinocereus triglochidiatus*, *Encelia resinifera*, *Ephedra viridis*, *Gutierrezia microcephala*, *Mirabilis multiflora*, *Opuntia basilaris*, *Purshia stansburiana*, *Sphaeralcea ambigua*, *Tridens muticus*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the extreme Western Grand Canyon; it was sampled from the "Hook" near the Grand Cliffs.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (8 plots): GRCA.01010, GRCA.01012, GRCA.02006, GRCA.02010, GRCA.02011, GRCA.02014, GRCA.03008, GRCA.03014.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Encelia farinosa - Ephedra (*fasciculata, nevadensis*) Shrubland

Brittlebush - (Arizona Joint-fir, Nevada Joint-fir) Shrubland
Identifier: CEGL001252

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Encelia farinosa - Ephedra (fasciculata, nevadensis)* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association has been described from the inner gorge of Grand Canyon National Park in northwestern Arizona. Elevation ranges from 610-1340 m. Stands occur on south-facing colluvial slopes below cliffs. Sites are predominately steep to moderate slopes, often talus with frequent rock outcrops. Substrate is shallow, rocky soil derived from limestone, sandstone, shale or igneous parent materials. Stands have a sparse (less than 20% cover), short woody canopy (less than 1 m tall) that is dominated by the xeromorphic evergreen shrubs *Encelia farinosa, Ephedra nevadensis*, and *Ephedra viridis*. Other common shrubs and dwarf-shrubs may include *Acacia greggii, Gutierrezia sarothrae*, or *Lycium andersonii*. The sparse herbaceous layer is composed of scattered forbs such as *Galium stellatum, Machaeranthera pinnatifida, Eriogonum inflatum*, and the introduced annual grass *Bromus rubens*. Succulents are common and include *Opuntia basilaris, Opuntia erinacea, Opuntia phaeacantha, Echinocereus engelmannii, Echinocactus polycephalus, Ferocactus cylindraceus (= Ferocactus acanthodes)*, and *Agave utahensis*. Extent outside the park is not known. This association appears to be restricted to these inner-canyon habitats in the Grand Canyon. Disturbance from rockslides may be important in maintaining this successional type. Shrublands with similar species composition have been reported from California, but survey and classification work are needed to determine if they represent the same association as this.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This brittlebush shrubland is one of the most common and widespread community types in Grand Canyon National Park. It often occurs on xeric sideslopes but can occur on a variety of other landforms, including drainage bottoms, ridges, and terraces in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. It is particularly well-developed along the Colorado River corridor and usually occurs at 400 to 1000 m (1350-3300 feet) elevation, but can be found as high as 1175 m (3850 feet). It favors moderate slopes (10-30 degrees) but can occur across a wide range of gradients (flat to 55 degrees). Soils are well- to rapidly-drained sandy loams that occasionally contain silt or clay, and may be derived from numerous parent materials. Gravel (41%) and rocks (37%) strongly dominate the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized by the dominance of *Encelia farinosa* in the short-shrub stratum. *Encelia farinosa* averages 8-12% cover but can occupy as much as 40% cover in dense stands. A sparse tall-shrub layer that includes *Larrea tridentata* (1%) and *Fouquieria splendens* (up to 1%) is infrequently present. Along with *Encelia farinosa, Ephedra fasciculata* (2%) and *Ferocactus cylindraceus* (1%) occasionally occur in the short-shrub stratum. A very sparse dwarf-shrub layer exists in which *Mammillaria grahamii* and *Opuntia basilaris* occasionally occur at low individual covers. *Dasyochloa pulchella* (1%) is fairly common, while *Aristida purpurea* (1%) and *Vulpia octoflora* (up to 2%) sporadically occur in the graminoid understory (2%). Over 100 different forb species can occur in this community type at low individual covers. *Cryptantha* spp., *Gilia* sp., and *Eriogonum inflatum* are the most frequent members of the forb layer (2%). Based upon the 88 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aristida purpurea*, *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Eriogonum inflatum*, *Ferocactus cylindraceus*, *Mammillaria grahamii*, *Opuntia basilaris*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Brassica tournefortii* (exotic, High/Low), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Schismus arabicus* (exotic, High/Medium), *Schismus barbatus* (exotic, High/Medium), *Sonchus oleraceus* (exotic)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (30-Jan-2007). This shrubland association occurs extensively in the inner gorge of Grand Canyon National Park, Arizona. Stands are found predominately on colluvial slopes with southern aspects and may be endemic to the park. Disturbance from rockslides may be important in maintaining this successional type. Within the park, stands are protected, however, condition has declined in some stands because of the abundance of *Bromus rubens*, an introduced annual grass. The extent and status of this vegetation outside the park is not known. More survey work is needed, especially on colluvial slopes in mountainous areas in the Mojave Desert, which may have similar vegetation.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Larrea tridentata - Encelia farinosa* Shrubland (CEGL002955) also supports a strong *Encelia farinosa* component; however, *Larrea tridentata* is codominant here, whereas it is only present at low relative cover in *Encelia farinosa* Shrubland (CEGL001251).
Global Related Concepts:

- *Encelia farinosa - Ephedra* spp. - *Acacia greggii* Association (Warren et al. 1982) =
- *Encelia farinosa-Ephedra nevadensis-Ephedra viridis* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is ubiquitous on xeric desert slopes along the Colorado River corridor. It occurs throughout much of the length of the Colorado River in Grand Canyon National Park, from Buck Farm Canyon in Marble Canyon to Quartermaster Canyon in the Western Grand Canyon. This association is particularly well-developed and prevalent from the Little Colorado River to Hance Rapids near the start of the Granite Gorge, and also from the Bass/White Creek area. Several stands were also sampled from Grand Wash Bay in Grand Canyon-Parashant National Monument.
Global Range: Assuming this association is restricted to the Grand Canyon, then its range is less than 5000 square km. Occurrence of stands outside the inner gorge of Grand Canyon National Park is unknown.
Nations: US
States/Provinces: AZ:S3, CA?
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (88 plots): GRCA.00500, GRCA.01016, GRCA.01021, GRCA.01111, GRCA.01505, GRCA.01525, GRCA.01546, GRCA.01547, GRCA.01550, GRCA.01551, GRCA.01552, GRCA.01556, GRCA.01563, GRCA.01572, GRCA.01614, GRCA.01617, GRCA.01653, GRCA.01667, GRCA.01678, GRCA.02019, GRCA.02020, GRCA.02021, GRCA.02508, GRCA.02535, GRCA.02536, GRCA.02538, GRCA.02539, GRCA.02542, GRCA.02544, GRCA.02551, GRCA.02556, GRCA.02564, GRCA.02570, GRCA.02574, GRCA.02622, GRCA.02623, GRCA.02625, GRCA.02627, GRCA.02652, GRCA.02655, GRCA.02659, GRCA.02672, GRCA.02674, GRCA.02675, GRCA.03021, GRCA.03026, GRCA.03027, GRCA.03028, GRCA.03029, GRCA.03510, GRCA.03512, GRCA.03542, GRCA.03543, GRCA.03549, GRCA.03552,

GRCA.03565, GRCA.03568, GRCA.03607, GRCA.03613, GRCA.03662, GRCA.03665, GRCA.03666, GRCA.03672, GRCA.03677, GRCA.03680, GRCA.03688, GRCA.03692, GRCA.03697, GRCA.04045, GRCA.04504, GRCA.04505, GRCA.04554, GRCA.04560, GRCA.04564, GRCA.04565, GRCA.04567, GRCA.04573, GRCA.04584, GRCA.04585, GRCA.04594, GRCA.04595, GRCA.04597, GRCA.04629, GRCA.04634, GRCA.04641, GRCA.04706, GRCA.04707, GRCA.04714.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

Encelia resinifera Shrubland

Sticky Brittlebush Shrubland
Identifier: CEGL005081

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Encelia resinifera* Shrubland

ELEMENT CONCEPT

Global Summary: This sticky brittlebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on low and mid sideslopes at 1025 to 1450 m (3375-4750 feet) elevation, but can be found as low as 600 m (1950 feet). It chiefly occurs on moderate to steep gradients (25-40 degrees), but is also found on gentler slopes (10-20 degrees). Soils are well- to rapidly-drained silty or sandy loams or clays, and the underlying geology can vary from limestone to sandstone or shale. Vegetation is characterized and dominated by the short shrub *Encelia resinifera*. A sparse tall-shrub layer that includes *Acacia greggii* is infrequently present. The short-shrub layer occasionally supports *Ephedra torreyana*. A fairly sparse dwarf-shrub layer of *Gutierrezia sarothrae* and *Thamnosma montana* occasionally occurs. The exotic *Bromus rubens* is very common in a relatively well-developed graminoid layer. *Muhlenbergia porteri*, *Achnatherum speciosum*, and *Aristida purpurea* are also somewhat common. A variety of species, including *Sphaeralcea grossulariifolia, Gilia* sp., *Galium stellatum*, and *Eriogonum inflatum*, occur in the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This brittlebush shrubland association typically occurs on low and mid sideslopes in the Inner Canyon and Western Grand Canyon. It usually occurs at 1025 to 1450 m (3375-4750 feet) elevation, but can be found as low as 600 m (1950 feet). It chiefly occurs on moderate to steep gradients (25-40 degrees), but is also found on gentler slopes (10-20 degrees). Soils are well- to rapidly-drained silty or sandy loams or clays. When unobscured, the underlying geology can vary from limestone to sandstone or shale. The ground cover tends to be dominated by gravel (40%) and rocks (30%), with relatively low amounts of litter (10%), bare soil or sand (8%), bedrock (8%), and cryptogamic soil crust (1%). A single stand was sampled from a similar environment in Grand Canyon-Parashant National Monument.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized and dominated by the short shrub *Encelia resinifera* (3-5%). A sparse tall-shrub layer that includes *Acacia greggii* (1%) is infrequently present. Along with *Encelia resinifera*, the short-shrub layer occasionally supports *Ephedra torreyana* (2%). A fairly sparse dwarf-shrub layer (3%) of *Gutierrezia sarothrae* (1%) and *Thamnosma montana* (1%) occasionally occurs. The exotic *Bromus rubens* (1%) is very common in a relatively well-developed graminoid layer (6%). *Muhlenbergia porteri* (3%), *Achnatherum speciosum* (1%), and *Aristida purpurea* (1%) are also somewhat common. A variety of species, including *Sphaeralcea grossulariifolia* (1%), *Gilia* sp. (trace cover), *Galium stellatum* (1%) and *Eriogonum inflatum* (up to 1%), occur in the forb understory (3%). Based upon the 12 stands sampled, this association hosts above-average species diversity, with 22 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia resinifera*
Herb (field)	Graminoid	*Muhlenbergia porteri*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Aristida purpurea*, *Encelia resinifera*, *Ephedra torreyana*, *Eriogonum inflatum*, *Galium stellatum*, *Gutierrezia sarothrae*, *Muhlenbergia porteri*, *Opuntia basilaris*, *Sphaeralcea grossulariifolia*, *Thamnosma montana*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Unkar Creek, Kwagunt Creek, near Basalt Canyon, near Tanner Canyon, near Horseshoe Mesa, near Sumner Point, Phantom Creek, and Tapeats Creek; from the Western Grand Canyon, where it was sampled from the "Hook" near the Grand Wash Cliffs; and from Grand Canyon-Parashant National Monument, where it was sampled near Grand Wash Bay.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.01529, GRCA.01592, GRCA.01594, GRCA.01604, GRCA.02009, GRCA.02546, GRCA.03022, GRCA.03541, GRCA.03548, GRCA.03616, GRCA.04627, GRCA.04675.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Fouquieria splendens* / *Encelia* (*farinosa, resinifera*) Shrubland**

Ocotillo / (Brittlebush, Sticky Brittlebush) Shrubland
Identifier: CEGL005118

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Fouquieria splendens* / *Encelia (farinosa, resinifera)* Shrubland

ELEMENT CONCEPT

Global Summary: This ocotillo shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It primarily occurs on xeric sideslopes at 450 to 825 m (1475-2750 feet) elevation, but has been found as high as 1025 m (3375 feet). It is typically found on moderately sloping gradients (10-30 degrees), across all aspects, but may also occur on gentler or steeper slopes. Soils are well- to rapidly-drained silty or sandy loams, and the underlying geology is usually limestone or occasionally shale. Vegetation is characterized by a tall-shrub layer of *Fouquieria splendens* and a short-shrub layer of *Encelia farinosa*. The short-shrub stratum also frequently supports *Ephedra fasciculata* and *Ferocactus cylindraceus*, and occasionally *Opuntia acanthocarpa* and *Krameria erecta*. *Opuntia basilaris* regularly occurs in a sparse dwarf-shrub layer. *Bromus rubens* (exotic), *Dasyochloa pulchella*, and *Vulpia octoflora* commonly occur in the sparse graminoid understory. Forb composition varies among stands; however, *Eriogonum inflatum, Sphaeralcea grossulariifolia, Cryptantha* spp., and *Stylocline micropoides* are among the most frequent forbs.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association primarily occurs on xeric sideslopes in the Western Grand Canyon at 450 to 825 m (1475-2750 feet) elevation, but has been found as high as 1025 m (3375 feet). It is typically found on moderately sloping gradients (10-30 degrees), across all aspects, but may also occur on gentler or steeper slopes. Soils are well- to rapidly-drained silty or sandy loams. When unobscured, the underlying geology is usually limestone or occasionally shale. Gravel (48%) and rocks (37%) dominate ground cover; cryptogamic soil crust (3%) occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized by a tall-shrub layer of *Fouquieria splendens* (2%) and a short-shrub layer of *Encelia farinosa* (5-10%). The short-shrub stratum also frequently supports *Ephedra fasciculata* (2%) and *Ferocactus cylindraceus* (1%), and occasionally *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%) and *Krameria erecta* (1%). *Opuntia basilaris* (1%) regularly occurs in a sparse dwarf-shrub layer. *Bromus rubens* (up to 1%), *Dasyochloa pulchella* (up to 1%), and *Vulpia octoflora* (up to 1%) commonly occur in the sparse graminoid understory (1%). Forb composition varies among stands; however, *Eriogonum inflatum* (up to 1%), *Sphaeralcea grossulariifolia* (1%), *Cryptantha* spp. (up to 1%), and *Stylocline micropoides* are among the most frequent forb (3%) components. Based upon the 19 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Fouquieria splendens*
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*
Herb (field)	Dwarf-shurb	*Opuntia basilaris*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Eriogonum inflatum*, *Ferocactus cylindraceus*, *Fouquieria splendens*, *Krameria erecta*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Sphaeralcea grossulariifolia*, *Stylocline micropoides*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Schismus barbatus* (exotic, High/Medium)
Global: Vulnerable: *Ephedra fasciculata* (G3?); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Fouquieria splendens* Shrubland (CEGL004452) also typically occurs on limestone sideslopes in the Western Grand Canyon and also supports a well-defined tall-shrub layer of *Fouquieria splendens*. *Encelia farinosa* occasionally occurs in this community as well (1%), but it is not a dominant component of the vegetation, as in the case of *Fouquieria splendens* / *(Encelia farinosa, resinifera)* Shrubland (CEGL005118).
Global Similar Associations:

- *Fouquieria splendens* Shrubland (CEGL004452) also typically occurs on limestone sideslopes and supports a well-defined tall-shrub layer of *Fouquieria splendens*; *Encelia farinosa* occasionally occurs, but it is not a dominant component of the vegetation.
- *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from various localities on xeric desert slopes, extending from Whitmore Canyon west to Quartermaster Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (19 plots): GRCA.01567, GRCA.01569, GRCA.01571, GRCA.01625, GRCA.01663, GRCA.02566, GRCA.03573, GRCA.03574, GRCA.03636, GRCA.03667, GRCA.03669, GRCA.03681, GRCA.03690, GRCA.03694, GRCA.04590, GRCA.04591, GRCA.04693, GRCA.04697, GRCA.04698.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Fouquieria splendens* Shrubland**

Ocotillo Shrubland
Identifier: CEGL004452

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Fouquieria splendens* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland occurs in southern Arizona, typically on gentle to moderate slopes of ridges, foothills and mountain canyons. Sites may occur on any aspect but are typically found on warmer southern and western aspects. Plot data from Buenos Aires National Wildlife Refuge indicate elevations of 1150-1250 m (3700-4100 feet) on well-drained sandy loam. Substrates are rocky with 50% surface rock. The vegetation is characterized by an open (30% cover) tall-shrub canopy dominated by *Fouquieria splendens* (10% or more cover). If present, *Prosopis velutina* has low cover (<10%) and does not codominate the tall-shrub layer. A low-shrub layer of *Calliandra eriophylla* (<20% cover), *Tiquilia mexicana (= Coldenia mexicana), Ferocactus wislizeni*, and *Mimosa aculeaticarpa var. biuncifera (= Mimosa biuncifera)* may be present. The herbaceous layer is sparse (about 10% cover) and dominated by mixed perennial graminoids. Characteristic species are *Aristida ternipes, Bothriochloa barbinodis, Bouteloua chondrosioides, Bouteloua curtipendula*, and *Setaria vulpiseta (= Setaria macrostachya)*. Other common species include *Evolvulus* spp., *Gutierrezia microcephala*, *Krameria erecta*, and *Talinum aurantiacum*. *Eragrostis*

lehmanniana may be present but at less 25% cover and less than a third of the total perennial graminoid layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This ocotillo shrubland association occurs primarily on sideslopes in Western Grand Canyon at approximately 550 to 675 m (1825-2175 feet) elevation, but can be found as high as 950 m (3125 feet). It can occur on gentle to steep slopes (up to 40 degrees), across all aspects. Soils are well- to rapidly-drained silty or sandy loams. When unobscured, the underlying geology is usually limestone. Gravel (37%), rocks (35%), and bedrock (9%) dominate the ground cover, while relatively high amounts of cryptogamic soil crust (4%) and moss (2%) occur in most stands.

Global Environment: This shrubland occurs in southern Arizona, typically on gentle to moderate slopes of ridges, foothills and mountain canyons. Sites may occur on any aspect but are typically found on warmer southern and western aspects. Plot data from Buenos Aires National Wildlife Refuge indicate elevations of 1150-1250 m (3700-4100 feet) on well-drained sandy loam. Substrates are rocky with 50% surface rock.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-12% in this association which is characterized by a strong component of *Fouquieria splendens* (3-7%) in the tall-shrub stratum. *Ferocactus cylindraceus* (1%), *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (up to 1%), and sometimes *Encelia farinosa* (1%) and *Krameria erecta* (1%) are common members of the short-shrub layer (4%). *Echinocereus engelmannii, Agave utahensis*, and *Echinocactus polycephalus* are frequent dwarf-shrubs (2%), all at low individual covers. *Bromus rubens* (up to 1%), *Dasyochloa pulchella* (1%), and sometimes *Tridens muticus* (trace) are common components of the very sparse graminoid understory (1%). *Tiquilia canescens* (up to 1%), *Sphaeralcea grossulariifolia* (1%), and *Allionia incarnata* (1%) are common in the forb understory (3%). The xerophytic fern *Astrolepis cochisensis* commonly occurs at relatively high cover (2%). Based upon the 4 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

Global Vegetation: The vegetation is characterized by an open (30% cover) tall-shrub canopy dominated by *Fouquieria splendens* (10% or more cover). If present, *Prosopis velutina* has low cover (<10%) and does not codominate the tall-shrub layer. A low-shrub layer of *Calliandra eriophylla* (<20% cover), *Tiquilia mexicana (= Coldenia mexicana), Ferocactus wislizeni*, and *Mimosa aculeaticarpa var. biuncifera (= Mimosa biuncifera)* may be present. The herbaceous layer is sparse (about 10% cover) and dominated by mixed perennial graminoids. Characteristic species are *Aristida ternipes, Bothriochloa barbinodis, Bouteloua chondrosioides, Bouteloua curtipendula*, and *Setaria vulpiseta (= Setaria macrostachya)*. Other common species include *Evolvulus* spp., *Gutierrezia microcephala, Krameria erecta*, and *Talinum aurantiacum*. *Eragrostis lehmanniana* may be present but at less 25% cover and less than a third of the total perennial graminoid layer.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Fouquieria splendens*
Herb (field)	Dwarf-shurb	*Agave utahensis, Echinocactus polycephalus, Echinocereus engelmannii*
Herb (field)	Graminoid	*Dasyochloa pulchella*
Herb (field)	Fern or fern ally	*Astrolepis cochisensis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Allionia incarnata*, *Astrolepis cochisensis*, *Bromus rubens*, *Dasyochloa pulchella*, *Echinocactus polycephalus*, *Echinocereus engelmannii*, *Ferocactus cylindraceus*, *Fouquieria splendens*, *Krameria erecta*, *Opuntia acanthocarpa*, *Sphaeralcea grossulariifolia*, *Tiquilia canescens*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)
Global: Vulnerable: *Echinocactus polycephalus* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (21-Apr-2004).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Fouquieria splendens* / *(Encelia farinosa, resinifera)* Shrubland (CEGL005118) also typically occurs on limestone sideslopes in the Western Grand Canyon and supports *Fouquieria splendens* in the tall-shrub stratum; however, it supports a strong *Encelia farinosa* (5-10%) component which is lacking in *Fouquieria splendens* Shrubland (CEGL004452).

Global Similar Associations:

- *Fouquieria splendens* / *Encelia (farinosa, resinifera)* Shrubland (CEGL005118) also typically occurs on limestone sideslopes and supports *Fouquieria splendens* in the tall-shrub stratum; however, it also has a strong *Encelia farinosa* component.

Global Related Concepts:

- *Fouquieria splendens* Sparse Plant Association (Muldavin et al. 1998d) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from the vicinity of Whitmore Canyon, "Gneiss" Canyon (north of the Colorado River), and Surprise Canyon.

Global Range: This desertscrub association occurs on foothills in southern Arizona and likely occurs in adjacent Sonora, Mexico.

Nations: MX?, US

States/Provinces: AZ, MXSO?, NM?

TNC Ecoregions: 19:C, 21:C, 22:C, 23:C, 24:C

USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322B:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant); USFWS (Buenos Aires, Sevilleta)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01655, GRCA.02668, GRCA.03567, GRCA.04665.

Local Description Authors: R. Meszaros

Global Description Authors: K.A. Schulz

References: Muldavin et al. 1998d, Reid and Hall 2010, Schulz 2004, Southeastern Ecology Working Group n.d., Western Ecology Working Group n.d.

***Krameria erecta* Shrubland [Park Special]**

Littleleaf Ratany Shrubland

Identifier: CEPS009688

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Krameria erecta* Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US

States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

***Larrea tridentata - Ambrosia dumosa - Fouquieria splendens* Shrubland**

Creosotebush - White Bursage - Ocotillo Shrubland
Identifier: CEGL005136

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata - Ambrosia dumosa - Fouquieria splendens* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes, terraces, and plateaus at 500 to 600 m (1650-1950 feet) elevation, but can be found as low as 425 m (1400 feet). It is primarily found on fairly gentle gradients (2-10 degrees), but also occasionally occurs on steeper slopes (20 degrees). Soils are rapidly-drained silty loams that typically lie above limestone bedrock. Vegetation is characterized by the codominance of the tall shrubs *Larrea tridentata* and *Fouquieria splendens*, and the dwarf-shrub *Ambrosia dumosa*. *Ephedra fasciculata* frequently occurs in a relatively weak short-shrub layer, while *Psorothamnus* sp., *Opuntia acanthocarpa*, and *Encelia farinosa* also occur occasionally. The dwarf-shrub layer invariably includes the cactus *Opuntia basilaris*. Few graminoids occur, but *Dasyochloa pulchella* does appear fairly consistently. *Cryptantha* spp., *Dichelostemma capitatum*, and *Phacelia* sp. are the most frequent forbs. *Eriogonum inflatum* and *Gilia* sp. also sporadically occur in this layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes, terraces, and plateaus in the Western Grand Canyon. It usually occurs at 500 to 600 m (1650-1950 feet) elevation, but can be found as low as 425 m (1400 feet). It is primarily found on fairly gentle gradients (2-10 degrees), but also occasionally occurs on steeper slopes (20 degrees). Soils are rapidly-drained silty loams that typically lie above limestone bedrock. Gravel (60%) and rocks (26%) dominate the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this somewhat sparsely vegetated community. It is characterized by the codominance of three species: the tall shrub *Larrea tridentata* (2-4%), the tall shrub *Fouquieria splendens* (3-4%), and the dwarf-shrub *Ambrosia dumosa* (3-4%). *Ephedra fasciculata* (1%) frequently occurs in a relatively weak short-shrub layer (3%), while *Psorothamnus* sp. (2%), *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%), and *Encelia farinosa* (1%) also occur occasionally. Along with *Ambrosia dumosa*, the dwarf-shrub layer invariably includes the cactus *Opuntia basilaris* (1%). Few graminoids (1%) occur, but *Dasyochloa pulchella* (1%) does appear fairly consistently. *Cryptantha* spp., *Dichelostemma capitatum*, and *Phacelia* sp. are the most frequent members of the forb understory (4%). *Eriogonum inflatum* (1%) and *Gilia* sp. (0-1%) also sporadically occur in this layer. Based upon the 4 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 18 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species

Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Tall shrub/sapling	Thorn shrub	*Fouquieria splendens*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Graminoid	*Dasyochloa pulchella*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Dasyochloa pulchella*, *Dichelostemma capitatum*, *Ephedra fasciculata*, *Fouquieria splendens*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138) is also codominated by *Larrea tridentata* and *Fouquieria splendens* and supports *Ambrosia dumosa*, *Ephedra fasciculata*, and *Encelia farinosa*; however, *Encelia farinosa* is codominant in this community and *Ambrosia dumosa* also occurs much less frequently.
Global Similar Associations:

- *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138) is also codominated by *Larrea tridentata* and *Fouquieria splendens* and supports *Ambrosia dumosa, Ephedra fasciculata*, and *Encelia farinosa*; however, *Encelia farinosa* is codominant and *Ambrosia dumosa* occurs much less frequently.

Global Related Concepts:

- *Larrea tridentata - Ambrosia dumosa - Fouquieria splendens* Shrubland (Evens and Hartman 2007) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from 194-Mile Canyon, near the mouth of Surprise Canyon, and to the east of Pearce Ferry.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (4 plots): GRCA.01508, GRCA.01673, GRCA.02502, GRCA.02504.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Evens and Hartman 2007, Reid and Hall 2010, Western Ecology Working Group n.d.

***Larrea tridentata - Ambrosia dumosa - Krameria* (*erecta, grayi*) Shrubland**

Creosotebush - White Bursage - (Littleleaf Ratany, White Ratany) Shrubland
Identifier: CEGL005137

USNVC CLASSIFICATION

Division North American Warm Desert Scrub & Grassland (3.A.2.Na)

Macrogroup Mojave-Sonoran Semi-Desert Scrub (M088)
Group Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs on a variety of landforms including sideslopes, drainage bottoms, and ridges at 375 to 625 m (1250-2075 feet) elevation, but can be found as high as 875 m (2850 feet). It is typically found on low gradients (1-5 degrees), but occasionally occurs on steeper slopes (10-30 degrees). The community seems to occur across all aspects besides west-facing, and seems to occur in various soil types. Vegetation is characterized by the codominance of three species: the tall shrub *Larrea tridentata*, the short shrub *Krameria grayi*, and the dwarf-shrub *Ambrosia dumosa*. The short-shrub layer also frequently supports the cactus *Opuntia acanthocarpa* and occasionally *Krameria erecta*. *Opuntia basilaris* is the only other dwarf-shrub that occurs regularly. *Bromus rubens* (exotic) and *Vulpia octoflora* are common in the sparse graminoid understory. *Plantago ovata, Antheropeas lanosum*, and *Erodium cicutarium* (exotic) are common members of the very sparse forb stratum.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association occurs on a variety of landforms including sideslopes, drainage bottoms, and ridges in Grand Canyon-Parashant National Monument. It mostly occurs at 375 to 625 m (1250-2075 feet) elevation, but can be found as high as 875 m (2850 feet). It is typically found on low gradients (1-5 degrees), but occasionally occurs on steeper slopes (10-30 degrees). The community seems to occur across all aspects besides west-facing, and seems to occur in various soil types. Gravel (60%), bare soil or sand (16%), rocks (14%), and a notable component of cryptogamic soil crust (2%) are the main constituents of the ground cover. Several stands were sampled in similar environments in the far Western Grand Canyon.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-25% in this association. This community is characterized by the codominance of three species: the tall shrub *Larrea tridentata* (5-10%), the short shrub *Krameria grayi* (3-5%), and the dwarf-shrub *Ambrosia dumosa* (5-10%). Along with *Krameria grayi*, the short-shrub layer also frequently supports the cactus *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%) and occasionally *Krameria erecta* (2%). Other than *Ambrosia dumosa, Opuntia basilaris* (up to 1%) is the only other dwarf-shrub that occurs regularly. *Bromus rubens* (up to 1%) and *Vulpia octoflora* (1%) are common in the sparse graminoid understory. *Plantago ovata* (1%), *Antheropeas lanosum* (4%), and *Erodium cicutarium* (2%) are common members of the forb stratum (4%). Based upon the 26 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 14 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Thorn shrub	*Krameria grayi*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Graminoid	*Vulpia octoflora*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Antheropeas lanosum*, *Krameria erecta*, *Krameria grayi*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Plantago ovata*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Schismus barbatus* (exotic, High/Medium)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic), *Erodium cicutarium* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also codominated by *Larrea tridentata* and *Ambrosia dumosa* and also supports *Krameria* spp.; however, *Krameria* spp. occur much less frequently and with much lower cover than *Larrea tridentata - Ambrosia dumosa - Krameria* spp. Shrubland (CEGL005137).

Global Similar Associations:

- *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also codominated by *Larrea tridentata* and *Ambrosia dumosa* and also supports *Krameria* spp., but they occur much less frequently and with much lower cover.
- *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL005295)

Global Related Concepts:

- *Larrea tridentata - Ambrosia dumosa - Krameria erecta* Shrubland (Keeler-Wolf and Thomas 2000) **<**
- *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland (Keeler-Wolf and Thomas 2000) **<**
- *Larrea tridentata - Ambrosia dumosa - Krameria grayi* Shrubland (Keeler-Wolf et al. 2005) **<**
- *Larrea tridentata - Ambrosia dumosa* (Creosote bush - white burr sage scrub) Alliance (Sawyer et al. 2009) **>**
- *Larrea tridentata* / *Ambrosia deltoidea - Krameria grayii* Association (Malusa 2003) **><**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is chiefly known from Grand Canyon-Parashant National Monument, where it was extensively sampled near Grand Wash Bay and east to the Grand Wash Cliffs. It also occurs in the Western Grand Canyon, where it was sampled near Whitmore Rapids and in Surprise Canyon.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Joshua Tree)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (26 plots): GRCA.01524, GRCA.01675, GRCA.02512, GRCA.02515, GRCA.03517, GRCA.03529, GRCA.03531, GRCA.03637, GRCA.04000, GRCA.04015, GRCA.04018, GRCA.04022, GRCA.04027, GRCA.04029, GRCA.04030, GRCA.04032, GRCA.04038, GRCA.04042, GRCA.04043, GRCA.04050, GRCA.04055, GRCA.04056, GRCA.04514, GRCA.04517, GRCA.04525, GRCA.04663.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 2005, Malusa 2003, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

***Larrea tridentata - Ambrosia dumosa* Shrubland**

Creosotebush - White Bursage Shrubland

Identifier: CEGL002954

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata - Ambrosia dumosa* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona and is reported from California and Nevada. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes, but also occurs on mesas, alluvial fans, and drainage channels at 375 to 500 m (1250-1625 feet) elevation, but can be found as high as 650 m (2100 feet). It is typically found on low gradients (0-10 degrees), across all aspects, but occasionally occurs on steeper slopes (10-20 degrees). Soils are well- to rapidly-drained silty or sandy clays or loams, and the underlying geology is usually limestone or less frequently basalt. Vegetation is characterized by the codominance of the tall shrub *Larrea tridentata* and the dwarf-shrub *Ambrosia dumosa*. *Ferocactus cylindraceus* and *Opuntia acanthocarpa* occur most frequently in the sparse short-shrub layer. The dwarf-shrub layer also occasionally includes the cactus *Opuntia basilaris*. *Dasyochloa pulchella* and *Vulpia octoflora* are relatively common in a very sparse graminoid layer. *Cryptantha* spp., *Plantago* sp., *Eriogonum inflatum*, and *Erodium cicutarium* are regularly present in the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association typically occurs on sideslopes, but also occurs on mesas, alluvial fans, and drainage channels in the far Western Grand Canyon and Grand Canyon-Parashant National Monument. It occurs at 375 to 500 m (1250-1625 feet) elevation, but can be found as high as 650 m (2100 feet). It is typically found on low gradients (0-10 degrees), across all aspects, but occasionally occurs on steeper slopes (10-20 degrees). Soils are well- to rapidly-drained silty or sandy clays or loams. When unobscured, the underlying geology is usually limestone or less frequently basalt. Gravel (50%) and rocks (32%) dominate the ground cover, and a notable amount of cryptogamic soil crust (2%) is present in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-25% in this association which is characterized by the codominance of the tall shrub *Larrea tridentata* (5-10%) and the dwarf-shrub *Ambrosia dumosa* (5-15%). A sparse short-shrub layer exists, in which *Ferocactus cylindraceus* (1%) and *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (3%) occur most frequently. Along with *Ambrosia dumosa*, the dwarf-shrub layer also occasionally includes the cactus *Opuntia basilaris* (1%). *Dasyochloa pulchella* (up to 1%) and *Vulpia octoflora* (1%) are relatively common in a very sparse graminoid layer. *Cryptantha* spp. (1%), *Plantago* sp. (1%), *Eriogonum inflatum* (up to 1%), and *Erodium cicutarium* (1%) are regularly present in the forb understory (4%). Based upon the 20 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Dasyochloa pulchella*, *Eriogonum inflatum*, *Ferocactus cylindraceus*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus arabicus* (exotic, High/Medium), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium altissimum* (exotic), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland (CEGL005137) is also codominated by *Larrea tridentata* and *Ambrosia dumosa*; however, *Krameria* spp. occur more frequently and with much higher cover than in *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954).
Global Similar Associations:
- *Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi)* Shrubland (CEGL005137) is also codominated by *Larrea tridentata* and *Ambrosia dumosa*; however, Krameria spp. occur more frequently and with much higher cover.
- *Larrea tridentata* Shrubland (CEGL005145)
- *Yucca schidigera - Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL005295)

Global Related Concepts:
- *Larrea tridentata - Ambrosia dumosa* Association (Warren et al. 1981) **?**
- *Larrea tridentata - Ambrosia dumosa* Association (Peterson 1984) **=**
- *Larrea tridentata - Ambrosia dumosa* Association (Kurzius 1981) **=**
- *Larrea tridentata - Ambrosia dumosa* Association (Annable 1985) **=**
- *Larrea tridentata - Ambrosia dumosa* Association (Warren et al. 1982) **=**
- *Larrea tridentata - Ambrosia dumosa* Shrubland (Keeler-Wolf and Thomas 2000) **=**
- *Larrea tridentata - Ambrosia dumosa* Shrubland (Evens and Hartman 2007) **=**
- *Larrea tridentata - Ambrosia dumosa* Shrubland (Keeler-Wolf et al. 2005) **=**
- *Larrea tridentata / Ambrosia dumosa* Association (Malusa 2003) **=**
- *Larrea tridentata-Ambrosia dumosa* (Bourgeron and Engelking 1994) **=**
- Creosote Bush Community (Armstrong 1969) **=**
- Mojave Creosote Bush Scrub, Sonoran Creosote Bush Scrub (Holland 1982) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is chiefly known from the far western extent of the Grand Canyon. It was sampled from Grand Canyon-Parashant National Monument in the vicinity of Grand Wash Bay; and from the Western Grand Canyon in the vicinity of Pearce Ferry. Two stands were also sampled in the Western Grand Canyon from Cove Canyon.
Global Range: This shrubland is currently reported from Arizona, California and Nevada. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA:S5, NV:S3S4
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Joshua Tree)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (20 plots): GRCA.01500, GRCA.01528, GRCA.02501, GRCA.02514, GRCA.02516, GRCA.02526, GRCA.02561, GRCA.03500, GRCA.03503, GRCA.03566, GRCA.04003, GRCA.04017, GRCA.04023, GRCA.04035, GRCA.04041, GRCA.04046, GRCA.04500, GRCA.04501, GRCA.04502, GRCA.04510.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Annable 1985, Armstrong 1969, Bourgeron and Engelking 1994, Bradley 1964, Evens and Hartman 2007, Faden 1977, Holland 1982, Keeler-Wolf and Thomas 2000, Keeler-Wolf et al. 2005, Kurzius 1981, Malusa 2003, Ostler et al. 2000, Peterson 1984, Peterson 2008, Reid and Hall 2010, Schramm 1982, Warren et al. 1981, Warren et al. 1982, Western Ecology Working Group n.d.

Larrea tridentata - Coleogyne ramosissima Shrubland

Creosotebush - Blackbrush Shrubland
Identifier: CEGL002717

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata - Coleogyne ramosissima* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park in Arizona and is reported from California and Nevada. More survey and classification work are needed to fully characterize this type. At Grand Canyon, it typically occurs on sideslopes, but also occurs on plateaus and valley bottoms, at 1050 to 1200 m (3575-3925 feet) elevation, but can be found as low as 950 m (3175 feet). It is typically found on gentle (3-10 degrees) east-facing slopes, but occasionally occurs on steeper slopes (20 degrees). Soils are well-drained silty or sandy clays or loams that usually lie on top of limestone or lava. Vegetation is characterized by strong components of *Larrea tridentata* in the tall-shrub stratum and *Coleogyne ramosissima* in the short-shrub layer. *Yucca baccata, Ephedra nevadensis*, and *Ferocactus cylindraceus* also regularly occur in the short-shrub stratum. An extremely sparse dwarf-shrub layer typically exists in which *Echinocereus engelmannii* and *Opuntia polyacantha* commonly occur. *Dasyochloa pulchella* and *Bromus rubens* (exotic) are common in a very sparse graminoid layer. *Plantago patagonica* and *Thymophylla pentachaeta* are occasionally present in a similarly weak forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association typically occurs on sideslopes, but also occurs on plateaus and valley bottoms in the Western Grand Canyon. It mostly occurs at 1050 to 1200 m (3575-3925 feet) elevation, but can be found as low as 950 m (3175 feet). It is typically found on gentle (3-10 degrees) east-facing slopes, but occasionally occurs on steeper slopes (20 degrees). Soils are well-drained silty or sandy clays or loams that usually lie on top of limestone or lava. Ground cover is dominated by gravel (61%), with some rocks (17%), bare soil (13%), and a notable amount of cryptogamic soil crust (3%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized by a strong component of *Larrea tridentata* (5-10%) in the tall-shrub stratum and a strong component of *Coleogyne ramosissima* (5-10%) in the short-shrub layer. *Yucca baccata* (1%), *Ephedra nevadensis* (1%) and *Ferocactus cylindraceus* (1%) also regularly occur in the short-shrub stratum. An extremely sparse dwarf-shrub layer (1%) typically exists in which *Echinocereus engelmannii* and *Opuntia polyacantha* occur commonly at trace covers. *Dasyochloa pulchella* (up to 1%) and *Bromus rubens* (up to 1%) are common in a very sparse graminoid layer (1%). *Plantago patagonica* and *Thymophylla pentachaeta* (trace cover) are occasionally present in a weak forb layer. This association hosts below-average species diversity with 13 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Coleogyne ramosissima*, *Dasyochloa pulchella*, *Echinocereus engelmannii*, *Ephedra nevadensis*, *Ferocactus cylindraceus*, *Larrea tridentata*, *Opuntia polyacantha*, *Plantago patagonica*, *Thymophylla pentachaeta*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4? (26-Jun-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This is the only association in Grand Canyon that is dominated by *Larrea tridentata* with significant cover of *Coleogyne ramosissima*.
Global Similar Associations:
- *Coleogyne ramosissima* Shrubland (CEGL001332)

Global Related Concepts:
- *Coleogyne ramosissima - Larrea tridentata - Abrosia dumosa* Shrubland (Keeler-Wolf and Thomas 2000) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from Whitmore Canyon and in the vicinity of Whitmore Point.
Global Range: This shrubland association is currently described from Grand Canyon National Park in northern Arizona. It is also reported from California and Nevada. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA, NV
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon-Parashant, Grand Canyon?)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (6 plots): GRCA.03626, GRCA.03631, GRCA.03638, GRCA.04654, GRCA.04660, GRCA.04661.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Keeler-Wolf 1997, Keeler-Wolf and Thomas 2000, Reid and Hall 2010, Western Ecology Working Group n.d.

***Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland**

Creosotebush - Brittlebush - Ocotillo Shrubland
Identifier: CEGL005138

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It primarily occurs on xeric desert sideslopes at 475 to 575 m (1550-1900 feet) elevation, but can be found as high as 645 m (2100 feet). It is typically found on low gradients (2-10 degrees) and on south- or east-facing aspects, but is also common on steeper slopes (20-28 degrees). Soils are well- to rapidly-drained sandy loams or clays, and the bedrock is typically limestone. Vegetation is characterized by the codominance of three shrub species: the tall shrubs *Larrea tridentata* (3-5%) and *Fouquieria splendens* (3-5%), and the short shrub *Encelia farinosa* (5-10%). In the short-shrub layer, *Encelia farinosa* is invariably accompanied by *Ephedra fasciculata*. *Krameria erecta, Ferocactus cylindraceus*, and *Opuntia acanthocarpa* also occur fairly frequently. A very weak dwarf-shrub layer exists in which *Opuntia basilaris* occurs occasionally. *Vulpia octoflora* and *Dasyochloa pulchella* are occasionally present in a meager graminoid layer. *Plantago ovata, Phacelia* sp., and *Allionia incarnata* sporadically occur in the fairly sparse forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association primarily occurs on xeric desert sideslopes in the Western Grand Canyon. It usually occurs at 475 to 575 m (1550-1900 feet) elevation, but can be found as high as 645 m (2100 feet). It is typically found on low gradients (2-10 degrees) and on south- or east-facing aspects, but is also common on steeper slopes (20-28 degrees). Soils are well- to rapidly-drained sandy loams or clays. Soils occasionally hide the underlying geology, but when unobscured, the bedrock is typically limestone. Gravel (50%) and rocks (34%) strongly dominate the ground cover, and most stands support a relatively high amount of cryptogamic soil crust (6%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-25% in this association which is characterized by the codominance of three different shrub species: the tall shrubs *Larrea tridentata* (3-5%) and *Fouquieria splendens* (3-5%), and the short shrub *Encelia farinosa* (5-10%). In the short-shrub layer, *Encelia farinosa* is invariably accompanied by *Ephedra fasciculata* (1%). *Krameria erecta* (1%), *Ferocactus cylindraceus* (1%), and *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%) also occur fairly frequently in this layer. A very weak dwarf-shrub layer exists in which *Opuntia basilaris* (1%) occurs occasionally. *Vulpia octoflora* (up to 1%) and *Dasyochloa pulchella* (up to 1%) are occasionally present in a meager graminoid layer (1%). *Plantago ovata* (2%), *Phacelia* sp. (up to 1%), and *Allionia incarnata* (up to 1%) sporadically occur in the fairly sparse forb layer (2%). Based upon the 9 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Tall shrub/sapling	Thorn shrub	*Fouquieria splendens*
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Allionia incarnata*, *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Ferocactus cylindraceus*, *Fouquieria splendens*, *Krameria erecta*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Plantago ovata*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)

Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Larrea tridentata - Encelia farinosa* Shrubland (CEGL002955) is also codominated by *Larrea tridentata* and *Encelia farinosa*, and contains *Fouquieria splendens*. However, *Fouquieria splendens* occurs much less frequently and with lower cover than in *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138). *Fouquieria splendens* / *(Encelia farinosa, resinifera)* Shrubland (CEGL005118) is also codominated by *Fouquieria splendens* and *Encelia farinosa*; however, *Larrea tridentata* occurs much less frequently and with much lower cover.

Global Similar Associations:

- *Fouquieria splendens* / *Encelia (farinosa, resinifera)* Shrubland (CEGL005118) is also codominated by *Fouquieria splendens* and *Encelia farinosa*, but *Larrea tridentata* occurs much less frequently and with much lower cover.
- *Larrea tridentata - Ambrosia dumosa - Fouquieria splendens* Shrubland (CEGL005136)

- *Larrea tridentata - Encelia farinosa* Shrubland (CEGL002955) is also codominated by *Larrea tridentata* and *Encelia farinosa*, but contains *Fouquieria splendens* much less frequently and with lower cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from Indian Canyon, 209-Mile Canyon, 214-Mile Canyon, an unnamed canyon west of Separation Canyon, "Gneiss" Canyon (north of the Colorado River), and Surprise Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (9 plots): GRCA.01662, GRCA.02571, GRCA.02660, GRCA.03572, GRCA.03663, GRCA.03685, GRCA.03686, GRCA.04592, GRCA.04711.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Larrea tridentata - Encelia farinosa* Shrubland**

Creosotebush - Brittlebush Shrubland
Identifier: CEGL002955

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata - Encelia farinosa* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona and is reported from California. More survey and classification work are needed to fully characterize this type. It primarily occurs on sideslopes but can occur on a variety of other landforms, including talus slopes, alluvial fans, and colluvium, and usually occurs at 375 to 575 m (1300-1850 feet) elevation, but can be found as high as 675 m (2250 feet). This association shows some preference for south- or west-facing slopes but does occur across all aspects. It is typically found on moderate to steep gradients (25-45 degrees), but can occur on gentler slopes (less than 20 degrees) as well. Soils are well- to rapidly-drained silty or sandy loams, and the bedrock is typically limestone. Vegetation is codominated by *Larrea tridentata* and *Encelia farinosa*. In addition *Fouquieria splendens* occasionally occurs in the tall-shrub stratum at low cover. In dense stands, *Encelia farinosa* cover can be as high as 40%, although it is usually much lower. *Ferocactus cylindraceus* and *Ephedra fasciculata* are typical in the short-shrub stratum. *Ambrosia dumosa* and *Opuntia basilaris* occasionally occur in the very sparse dwarf-shrub layer. *Vulpia octoflora* and *Dasyochloa pulchella* are common in a meager graminoid layer. A variety of species, including *Plantago ovata, Cryptantha* spp., and *Argythamnia neomexicana*, sporadically occur in the forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association primarily occurs on sideslopes but can occur on a variety of other landforms, including talus slopes, alluvial fans, and colluvium in the Western Grand Canyon and Grand Canyon-Parashant National Monument. It usually occurs at 375 to 575 m (1300-1850 feet) elevation, but can be found as high as 675 m (2250 feet). This association shows some preference for south- or west-facing slopes but does occur across all aspects. It is typically found on moderate to steep gradients

(25-45 degrees), but can occur on gentler slopes (less than 20 degrees) as well. Soils are well- to rapidly-drained silty or sandy loams. Soils occasionally hide the underlying geology, but when unobscured, the bedrock is typically limestone. Rocks (49%) and gravel (28%) dominate the ground cover, while a relatively high amount of cryptogamic soil crust (6%) occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-20% in this association which is codominated by *Larrea tridentata* (3-5%) and *Encelia farinosa* (7-10%). In addition to *Larrea tridentata*, *Fouquieria splendens* (1%) occasionally occurs in the tall-shrub stratum at low cover. In dense stands, *Encelia farinosa* cover can be as high as 40%, although it is usually much lower. *Ferocactus cylindraceus* (up to 1%) and *Ephedra fasciculata* (1%) typically accompany *Encelia farinosa* in the short-shrub stratum (10%). A very weak dwarf-shrub layer exists in which *Ambrosia dumosa* (1%) and *Opuntia basilaris* (1%) occasionally occur. *Vulpia octoflora* (1%) and *Dasyochloa pulchella* (0-1%) are common in a meager graminoid layer (1%). A variety of species, including *Plantago ovata* (2%), *Cryptantha* spp. (up to 1%), and *Argythamnia neomexicana* (up to 1%), sporadically occur in the forb layer (2%). Based upon the 36 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 13 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Encelia farinosa*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Dasyochloa pulchella*, *Encelia farinosa*, *Ephedra fasciculata*, *Ferocactus cylindraceus*, *Larrea tridentata*, *Opuntia basilaris*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (16-Oct-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138) is also codominated by *Larrea tridentata* and *Encelia farinosa*, and supports *Fouquieria splendens*; however, *Fouquieria splendens* occurs much more frequently and with higher cover here than in *Larrea tridentata - Encelia farinosa* Shrubland (CEGL002955).
Global Similar Associations:

- *Encelia farinosa* Shrubland (CEGL001251)
- *Larrea tridentata - Encelia farinosa - Fouquieria splendens* Shrubland (CEGL005138) is also codominated by *Larrea tridentata* and *Encelia farinosa*, but *Fouquieria splendens* occurs much more frequently and with higher cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the far Western Grand Canyon and Grand Canyon-Parashant National Monument, where it is best developed between Separation Canyon and Dry Canyon, and around Grand Wash Bay. A few scattered stands were sampled further to the east, from Andrus Canyon, Spring Canyon, and 220-Mile Canyon.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in northern Arizona. It is also reported from California. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA
TNC Ecoregions: 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (36 plots): GRCA.01523, GRCA.01573, GRCA.01672, GRCA.01676, GRCA.01680, GRCA.01687, GRCA.02565, GRCA.02568, GRCA.02573, GRCA.02658, GRCA.02661, GRCA.02670, GRCA.02676, GRCA.03530, GRCA.03571, GRCA.03673, GRCA.03682, GRCA.03691, GRCA.03693, GRCA.03696, GRCA.03698, GRCA.03700, GRCA.03704, GRCA.04006, GRCA.04016, GRCA.04024, GRCA.04031, GRCA.04053, GRCA.04703, GRCA.04704, GRCA.04705, GRCA.04710, GRCA.04713, GRCA.04715, GRCA.04716, GRCA.04741.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Larrea tridentata* Shrubland**

Creosotebush Shrubland
Identifier: CEGL005145

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Larrea tridentata* Shrubland

ELEMENT CONCEPT

Global Summary: This creosotebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It often occurs on sideslopes but can occupy a variety of other landforms, including drainage bottoms, alluvial fans, and valley bottoms. It usually occurs at 375 to 750 m (1250-2550 feet) elevation, but can be found as high as 1350 m (4450 feet), and occurs across all aspects. It is typically found on low gradients (1-10 degrees), but can occasionally occur on steeper slopes (10-30 degrees). Soils are well- to rapidly-drained silty or sandy loams, and the bedrock is often limestone. Vegetation is characterized by a homogenous tall-shrub layer of *Larrea tridentata* and lacks well-represented or codominant shrub components in any of the other strata. *Opuntia acanthocarpa*, *Ferocactus cylindraceus*, and *Krameria grayi* or *Krameria erecta* occasionally occur in the sparse short-shrub layer. *Ambrosia dumosa* and *Opuntia basilaris* occasionally occur in a very weak dwarf-shrub layer. *Vulpia octoflora* is very common in the graminoid understory, and *Bromus rubens* also occasionally occurs. *Antheropeas lanosum, Plantago ovata, Cryptantha* sp., *Gilia* sp., and *Amsinckia menziesii* are common components of a fairly well-developed herb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This creosotebush shrubland association often occurs on sideslopes but can occur on a variety of other landforms, including drainage bottoms, alluvial fans, and valley bottoms in the Western Grand Canyon and Grand Canyon-Parashant National Monument. It usually occurs at 375 to 750 m (1250-2550 feet) elevation, but can be found as high as 1350 m (4450 feet), and occurs across all aspects. It is typically found on low gradients (1-10 degrees), but can occasionally occur on steeper slopes (10-30 degrees). Soils are well- to rapidly-drained silty or sandy loams. Soils mostly hide the underlying geology, but when unobscured, the bedrock is often limestone. Gravel (53%), rocks (25%), and bare soil (11%) dominate the ground cover, while a relatively high amount of cryptogamic soil crust (4%) occurs in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This community is characterized by a homogenous tall-shrub layer of *Larrea tridentata* (typically 8-10% but up to 25% in dense stands) and lacks well-represented or codominant shrub components in any of the other strata. *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%), *Ferocactus cylindraceus* (1%), and *Krameria grayi* or *Krameria erecta* (2%) occasionally occur in the sparse short-shrub layer (2%). A very weak dwarf-shrub layer (1%) also exists in which *Ambrosia dumosa* (1%) and *Opuntia basilaris* (1%) occasionally occur. Total shrub cover typically averages 10-15%. *Vulpia octoflora* (1%) is very common in the graminoid understory (2%), and *Bromus rubens* also occasionally occurs. *Antheropeas lanosum* (3%), *Plantago ovata* (2%), *Cryptantha* sp. (up to 3%), *Gilia* sp. (up to 1%), and *Amsinckia menziesii* (1%) are common components of a fairly well-developed herb layer (6%). Based upon the 41 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 14 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Herb (field)	Graminoid	*Vulpia octoflora*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ambrosia dumosa*, *Amsinckia menziesii*, *Antheropeas lanosum*, *Ferocactus cylindraceus*, *Larrea tridentata*, *Opuntia acanthocarpa*, *Opuntia basilaris*, *Plantago ovata*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Schismus arabicus* (exotic, High/Medium), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also dominated by *Larrea tridentata*; however, *Ambrosia dumosa* is codominant here and occurs more frequently and with much higher cover in than in *Larrea tridentata* Shrubland (CEGL005145).

Global Similar Associations:

- *Larrea tridentata - Ambrosia dumosa* Shrubland (CEGL002954) is also dominated by *Larrea tridentata*, but *Ambrosia dumosa* is codominant and occurs more frequently and with much higher cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it extends from Toroweap west to Pearce Ferry. It is particularly well-developed between Toroweap and Andrus Canyon. It is also known from Grand Canyon-Parashant National Monument, where it is particularly well-developed near Grand Wash Bay and east to the Grand Wash Cliffs.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ

TNC Ecoregions: 19:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (41 plots): GRCA.01503, GRCA.01511, GRCA.01512, GRCA.01516, GRCA.01519, GRCA.01520, GRCA.01526, GRCA.01564, GRCA.01565, GRCA.02506, GRCA.02511, GRCA.02525, GRCA.02567, GRCA.03518, GRCA.03520, GRCA.03527, GRCA.03576, GRCA.03583, GRCA.03624, GRCA.03635, GRCA.03639, GRCA.03640, GRCA.03699, GRCA.04002, GRCA.04005, GRCA.04008, GRCA.04010, GRCA.04012, GRCA.04019, GRCA.04025, GRCA.04026, GRCA.04047, GRCA.04048, GRCA.04508, GRCA.04511, GRCA.04515, GRCA.04520, GRCA.04524, GRCA.04655, GRCA.04658, GRCA.04664.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Psorothamnus fremontii Shrubland

Fremont's Smokebush Shrubland
Identifier: CEGL005154

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	Mojave-Sonoran Semi-Desert Scrub (M088)
Group	Sonoran-Mojave Creosotebush - White Bursage Desert Scrub (G295)
Association	*Psorothamnus fremontii* Shrubland

ELEMENT CONCEPT

Global Summary: This Fremont's smokebush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs in drainage channels, on sideslopes, and rarely in valley bottoms or on badlands at 375 to 675 m (1250-2225 feet) elevation, but can be found as high as 1150 m (3750 feet). It is primarily found on gentle slopes (1-12 degrees), but can also occur on steeper gradients (25-30 degrees), and occurs across all aspects. Soils are mostly well-drained sandy or silty loams derived from various parent materials. Vegetation is dominated by the short shrub *Psorothamnus fremontii*. *Larrea tridentata* is commonly found in a very sparse tall-shrub layer. The short-shrub stratum also occasionally includes *Krameria grayi* and *Hymenoclea salsola*. *Ambrosia dumosa* and *Opuntia basilaris* frequently occur in a weak dwarf-shrub layer. Graminoid cover is quite sparse, but *Vulpia octoflora* and *Dasyochloa pulchella* may occur in some stands. *Eriogonum inflatum* regularly occurs in the forb understory, while *Cryptantha* sp., *Antheropeas lanosum, Plantago ovata*, and *Phacelia crenulata* occur sporadically.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs in drainage channels, on sideslopes, and rarely in valley bottoms or on badlands in the Western Grand Canyon and Grand Canyon-Parashant National Monument. It predominantly occurs at 375 to 675 m (1250-2225 feet) elevation, but can be found as high as 1150 m (3750 feet). It is primarily found on gentle slopes (1-12 degrees), but can also occur on steeper gradients (25-30 degrees), and occurs across all aspects. Soils are mostly well-drained sandy or silty loams derived from various parent materials. Gravel (52%), rocks (17%), bare soil (14%), and a relatively high amount of cryptogamic soil crust (7%) are major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is dominated by the short shrub *Psorothamnus fremontii* (5-10%). *Larrea tridentata* (2%) is commonly found in a very sparse tall-shrub layer. Along with *Psorothamnus fremontii*, the short-shrub stratum also occasionally includes *Krameria grayi* (1%) and *Hymenoclea salsola* (1%). *Ambrosia dumosa* (2%) and *Opuntia basilaris* (trace) frequently occur in a weak dwarf-shrub layer (2%). Graminoid cover is quite sparse, but *Vulpia octoflora* (1%) and *Dasyochloa pulchella* (up to 1%) may occur in some stands. *Eriogonum inflatum* (up to 1%) regularly occurs in the forb understory (3%), while *Cryptantha* sp. (1%), *Antheropeas lanosum* (1%), *Plantago ovata* (1%), and *Phacelia crenulata* (1%) occur sporadically. Based upon the 10 stands sampled, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Thorn shrub	*Psorothamnus fremontii*
Herb (field)	Dwarf-shurb	*Ambrosia dumosa*
Herb (field)	Graminoid	*Vulpia octoflora*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Ambrosia dumosa*, *Antheropeas lanosum*, *Dasyochloa pulchella*, *Eriogonum inflatum*, *Hymenoclea salsola*, *Krameria grayi*, *Larrea tridentata*, *Opuntia basilaris*, *Phacelia crenulata*, *Plantago ovata*, *Psorothamnus fremontii*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Descurainia sophia* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard

Grand Canyon National Park Comments: *Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation (CEPS009527) is also dominated by *Psorothamnus fremontii*; however, *Acacia greggii* regularly occurs as a codominant. This community also supports much lower floristic diversity than is typical of *Psorothamnus fremontii* Shrubland (CEGL005154).

Global Similar Associations:

- *Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation [Park Special] (CEPS009527) is also dominated by *Psorothamnus fremontii*, but *Acacia greggii* regularly occurs as a codominant, and it supports much lower floristic diversity.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled in Whitmore Canyon, along the Colorado River near 193-Mile Creek, and to the east of Pearce Ferry; and from Grand Canyon-Parashant National Monument, where it was sampled in the vicinity of Grand Wash Bay and east to the Gyp Hills.

Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.

Nations: US

States/Provinces: AZ, NM?

TNC Ecoregions: 19:C, 24:C

USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (10 plots): GRCA.02503, GRCA.02513, GRCA.02518, GRCA.02520, GRCA.02563, GRCA.03501, GRCA.04009, GRCA.04028, GRCA.04051, GRCA.04657.

Local Description Authors: R. Meszaros

Global Description Authors: R. Meszaros

References: Reid and Hall 2010, Western Ecology Working Group n.d.

Group Undetermined

Geraea canescens Ephemeral Herbaceous Vegetation [Park Special]

Hairy Desert-sunflower Ephemeral Herbaceous Vegetation
Identifier: CEPS009686

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Tridens muticus Herbaceous Vegetation [Park Special]

Slim Tridens Herbaceous Vegetation
Identifier: CEPS009529

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association typically occurs on sideslopes in the Western Grand Canyon. It has been observed at 1450 to 1600 m (4775-5225 feet) elevation, but may exist outside of this range. It is primarily found on gentle (6-8 degrees) north-facing slopes. Soils are rapidly-drained silty loams that lie on top of limestone bedrock. Gravel (53%), rocks (21%), litter (8%), and bare soil or sand (6%) are the major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous community is dominated by the perennial grass *Tridens muticus* (12-15%); however, shrubs are also present at about 5% total cover. A sparse short-shrub layer (3%) of *Ephedra viridis* (1%) and *Coleogyne ramosissima* (up to 1%) typically occurs, while *Encelia resinifera* (1%) and *Yucca baccata* (1%) may be present in some stands. A weak dwarf-shrub layer exists in which *Gutierrezia* spp. (2%) frequently occur. Along with *Tridens muticus*, the graminoid layer commonly supports *Bromus tectorum* (2%) and *Bouteloua eriopoda* (1%). *Cirsium* sp. (1%), *Stylocline micropoides* (trace cover), *Lepidium* sp. (up to 1%), and *Erodium cicutarium* (1%) consistently occur in the forb understory (3%). Based upon the 2 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Tridens muticus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua eriopoda*, *Bromus tectorum*, *Coleogyne ramosissima*, *Ephedra viridis*, *Tridens muticus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from the "Hook" near the Grand Wash Cliffs.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.01004, GRCA.01006.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

M512. North American Warm Desert Ruderal & Planted Scrub & Grassland
G676. Mojave-Sonoran Ruderal Grassland

Schismus (*arabicus, barbatus*) Semi-natural Herbaceous Vegetation [Park Special]

(Arabian Schismus, Common Mediterranean Grass) Semi-natural Herbaceous Vegetation
Identifier: CEPS009691

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm Desert Ruderal & Planted Scrub & Grassland (M512)
Group	Mojave-Sonoran Ruderal Grassland (G676)
Association	*Schismus (arabicus, barbatus)* Semi-natural Herbaceous Vegetation [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

M092. North American Warm-Desert Xero-Riparian
G541. Warm Semi-Desert Shrub & Herb Wash-Arroyo

Acacia greggii - Larrea tridentata - (Hymenoclea salsola) *Wash Shrubland [Park Special]*

Catclaw Acacia - Creosotebush - (Burrobrush) Wash Shrubland
Identifier: CEPS009522

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Acacia greggii - Larrea tridentata - (Hymenoclea salsola)* Wash Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs in drainage bottoms and desert washes in Grand Canyon-Parashant National Monument and the Western Grand Canyon. It usually occurs at 400 to 500 m (1300-1825 feet) elevation, but can be found as high as 650 m (2125 feet). It is primarily found in gently sloping washes (1-7 degrees) that generally flow southwest to due west. Soils are well- to rapidly-drained sand or sandy loams or clays that obscure the bedrock below. The ground cover tends to be dominated by gravel (32%), rocks (18%), and bare soil or sand (40%), with relatively low amounts of litter (6%) and cryptogamic soil crust (1%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is characterized and codominated by the tall shrubs *Acacia greggii* (7-10%) and *Larrea tridentata* (4-6%), as well as by the short shrub *Hymenoclea salsola* (2-3%). *Acacia greggii* is present in all stands, while *Larrea tridentata* and *Hymenoclea salsola* are present in most, but not all, stands. *Opuntia acanthocarpa (= Cylindropuntia acanthocarpa)* (1%) occasionally occurs in the short-shrub stratum as well. A sparse dwarf-shrub layer exists in which *Ambrosia dumosa* (up to 1%) and *Opuntia basilaris* (1%) occur sporadically. The annual species *Bromus rubens* (1%), *Schismus barbatus* (1%), and *Vulpia octoflora* (1%) are occasionally present in a poorly-developed graminoid layer (1%). The composition of the forb stratum (4%) varies considerably from stand to stand; *Cryptantha* spp., *Antheropeas lanosum, Chamaesyce polycarpa, Descurainia pinnata*, and *Phacelia crenulata* may all occur at low covers. The exotic *Erodium cicutarium* is present in most stands, sometimes at substantial cover (up to 20%). Based upon the 9 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Acacia greggii*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Larrea tridentata*
Short shrub/sapling	Broad-leaved deciduous shrub	*Hymenoclea salsola*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Allionia incarnata*, *Ambrosia dumosa*, *Erodium cicutarium*, *Hymenoclea salsola*, *Larrea tridentata*, *Opuntia basilaris*, *Psorothamnus fremontii*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Nonstandard

Grand Canyon National Park Comments: *Hymenoclea salsola* Wash Shrubland (CEGL002702) occurs in similar environments and supports *Larrea tridentata, Acacia greggii*, and *Hymenoclea salsola*. However, it typically supports higher *Hymenoclea salsola* cover and lower *Acacia greggii* cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled in the vicinity of Grand Wash Bay, and from the Western Grand Canyon, where it was sampled from Burnt Canyon and an unnamed canyon to the west of Separation Canyon.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (9 plots): GRCA.01527, GRCA.01530, GRCA.02523, GRCA.03676, GRCA.04007, GRCA.04037, GRCA.04049, GRCA.04526, GRCA.04717.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Acacia greggii Wash Shrubland

Catclaw Acacia Wash Shrubland
Identifier: CEGL005390

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Acacia greggii* Wash Shrubland

ELEMENT CONCEPT

Global Summary: This catclaw acacia shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in drainage channels, along ephemeral washes, and in valley bottoms at 425 to 1100 m (1350-3700 feet) elevation. It typically occurs on gentle gradients (1-4 degrees) and seems to favor south- and west-facing exposures, although it occurs across all aspects. Occasionally, this community occurs outside of washes, on benches, terraces, or sideslopes, often on low levels, interfluves, toeslopes, and step-in-slopes. Soils are predominantly well-drained sandy loams. The tall shrub *Acacia greggii* dominates and characterizes this community and accounts for the increased cover in denser stands. Other scattered tall shrubs such as *Larrea tridentata, Prosopis glandulosa*, and *Chilopsis linearis* occasionally occur. *Encelia farinosa* and *Ephedra fasciculata* commonly occur in the short-shrub layer, while *Bebbia juncea* occurs in some stands. Approximately 40 different short-shrub species can occur at relatively low individual covers. The dwarf-shrub component is fairly sparse and species composition is variable; *Gutierrezia sarothrae* and *Porophyllum gracile* occur most frequently among the roughly 25 species that can occur in this stratum. The exotic *Bromus rubens* comprises the majority of the graminoid understory, while *Aristida purpurea* occasionally occurs. *Sphaeralcea grossulariifolia, Allionia incarnata, Artemisia ludoviciana, Funastrum cynanchoides, Descurainia pinnata*, and *Lepidium montanum* are the most frequent members of the variable forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This acacia shrubland association occurs in the Inner Canyon and Western Grand Canyon in drainage channels, along ephemeral washes, and in valley bottoms at 425 to 1100 m (1350-3700 feet) elevation. It typically occurs on gentle gradients (1-4 degrees) and seems to favor south- and west-facing exposures, although it occurs across all aspects. Occasionally, this community occurs outside of washes, on benches, terraces, or sideslopes, often on low levels, interfluves, toeslopes, and step-in-slopes. Soils are predominantly well-drained sandy loams. Rocks (33%), gravel (21%), bare soil (13%), sand (6%), and a relatively high cover of cryptogamic soil crust (4%) are common components of the ground cover. A single stand was sampled from a similar environment in Grand Canyon-Parashant National Monument.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 30% in this association but can be much higher (up to 50-60%) in denser stands. The tall shrub *Acacia greggii* (20%) dominates and characterizes this community and accounts for the increased cover in denser stands. Other scattered tall shrubs such as *Larrea tridentata* (1%), *Prosopis glandulosa* (2%), and *Chilopsis linearis* occasionally occur. *Encelia farinosa* (2%) and *Ephedra fasciculata* (2-3%) commonly occur in the short-shrub layer (5-7%), while *Bebbia juncea* (2%) occurs in some stands. Approximately 40 different short-shrub species can occur at relatively low individual covers. The dwarf-shrub component is fairly sparse (1%) and species composition is variable; *Gutierrezia sarothrae* and *Porophyllum gracile* occur most frequently among the roughly 25 species that can occur in this stratum. The exotic *Bromus rubens* (2-4%) comprises the majority of the graminoid understory (5%), while *Aristida purpurea* occasionally occurs at trace cover. *Sphaeralcea grossulariifolia, Allionia incarnata, Artemisia ludoviciana, Funastrum cynanchoides, Descurainia pinnata*, and *Lepidium montanum* are the most frequent members of the variable forb understory (2-3%). Based upon the 30 Grand Canyon Vegetation Mapping Program stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Acacia greggii*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Bebbia juncea*, *Bromus rubens*, *Encelia farinosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Agrostis stolonifera* (exotic, Medium/Low), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Ephedra fasciculata* (G3?); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Acacia greggii* Shrubland (CEGL005053) is also dominated by *Acacia greggii* and supports a similar assemblage of species; however, it chiefly occurs on sideslopes and typically supports 6-8% *Acacia greggii* cover. *Acacia greggii* Wash Shrubland (CEGL005390) typically occurs in washes and drainage channels and supports 15-30% *Acacia greggii* cover.
Global Similar Associations:
- *Acacia greggii* Shrubland (CEGL005053) is also dominated by *Acacia greggii* and supports a similar assemblage of species; however, it chiefly occurs on sideslopes and typically supports less *Acacia greggii* cover.

Global Related Concepts:
- 253.422 - *Acacia greggii* Association (Warren et al. 1982) **=**

- *Acacia greggii* (Catclaw acacia thorn scrub) Alliance (Sawyer et al. 2009) **>**
- *Acacia greggii* wash (*Justiicia californica*) (Keeler-Wolf et al. 1998) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from throughout the Inner Canyon, Western Grand Canyon, and Colorado River corridor. It was sampled at various sites stretching from Saddle Canyon in Marble Canyon to Burnt Canyon in the far Western Grand Canyon. A single stand was also sampled from Grand Canyon-Parashant National Monument in Pigeon Wash.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (30 plots): GRCA.01026, GRCA.02656, GRCA.01664, GRCA.04014, GRCA.02620, GRCA.03671, GRCA.01657, GRCA.03570, GRCA.03612, GRCA.04555, GRCA.04638, GRCA.01568, GRCA.02402, GRCA.01109, GRCA.03569, GRCA.03670, GRCA.04696, GRCA.01665, GRCA.03575, GRCA.04631, GRCA.01661, GRCA.02669,GRCA.03678, GRCA.01670, GRCA.01682, GRCA.03515, GRCA.02624, GRCA.04712, GRCA.03687, GRCA.03689. Twenty (20) Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots were also used to write the *Vegetation Description*, *Most Abundant and Characteristic Species*, and *Other Noteworthy Species* sections.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Keeler-Wolf et al. 1998, Reid and Hall 2010, Sawyer et al. 2009, Warren et al. 1982, Western Ecology Working Group n.d.

***Bebbia juncea* Shrubland**

Sweetbush Shrubland
Identifier: CEGL005391

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Bebbia juncea* Shrubland

ELEMENT CONCEPT

Global Summary: This sweetbush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in low-level drainage channels and along benches and terraces just above these dry washes. It typically occurs at 425 to 875 m (1400-2975 feet) elevation, on gentle gradients (up to 8 degrees), and favors south- and west-facing aspects. Soils are sandy and rapidly-drained. Rocks, gravel, and sand are major components of the ground cover, while a notable amount of cryptogamic soil crust occurs in many stands. *Bebbia juncea* dominates and characterizes this vegetation type. Other scattered species, such as *Acacia greggii*, *Encelia farinosa*, *Ephedra fasciculata*, and *Trixis californica*, also commonly occur in the short-shrub stratum. The dwarf-shrub layer is particularly sparse, although *Porophyllum gracile* and *Opuntia basilaris* commonly occur. Graminoid cover is similarly sparse; *Aristida purpurea* is common. Forbs are also poorly-represented and composition varies considerably.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sweetbush shrubland association occurs in the Inner Canyon,

Western Grand Canyon, and Grand Canyon-Parashant National Monument in low-level drainage channels and along benches and terraces just above these dry washes. It typically occurs at 425 to 875 m (1400-2975 feet) elevation, on gentle gradients (up to 8 degrees), and favors south- and west-facing aspects. Soils are sandy and rapidly-drained. Rocks (35%), gravel (25%), and sand (10%) are major components of the ground cover, while a notable amount of cryptogamic soil crust (4%) occurs in many stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this fairly sparse association. *Bebbia juncea* (6-8% cover, occasionally up to 15%) dominates and characterizes this vegetation type. Other scattered species, such as *Acacia greggii* (2%), *Encelia farinosa* (2%), *Ephedra fasciculata* (1%), and *Trixis californica* (1%), also commonly occur in the short-shrub stratum (12%). The dwarf-shrub layer is particularly sparse, although *Porophyllum gracile* and *Opuntia basilaris* commonly occur at trace covers. Graminoid cover is similarly sparse (1%); *Aristida purpurea* is common at trace covers. Forbs are also poorly-represented (2%) and composition varies considerably among plots. Based upon the 6 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Bebbia juncea*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Aristida purpurea*, *Bebbia juncea*, *Encelia farinosa*, *Ephedra fasciculata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Schismus arabicus* (exotic, High/Medium), *Solanum elaeagnifolium* (exotic)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. It was sampled in the Inner Canyon from lower Bright Angel Canyon, Hotauta Canyon, and in small side tributaries along the Colorado River; in the Western Grand Canyon from Separation Canyon, an unnamed canyon west of Separation Canyon, and "Gneiss" Canyon (north of the Colorado River); and from Grand Canyon-Parashant National Monument in the vicinity of Grand Wash Bay.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (6 plots): GRCA.01518, GRCA.03609, GRCA.03679, GRCA.04575, GRCA.04691, GRCA.04695; and two (2) Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots.

Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Brickellia longifolia Shrubland

Longleaf Brickellbush Shrubland
Identifier: CEGL005392

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Brickellia longifolia* Shrubland

ELEMENT CONCEPT

Global Summary: This brickellbush shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in cobble-filled, rocky drainage bottoms, most commonly in low-level, low-gradient (1-3 degrees) drainages which experience intermittent flooding events. It chiefly occurs at 700 to 1250 m (2350-4100 feet) elevation, and across all aspects besides north-facing. Soils are rapidly-drained sandy loams and/or sand. Rocks (often cobble-sized), gravel, and sand strongly dominate the ground cover. This sparse association is characterized and dominated by the short shrub *Brickellia longifolia*. Trees are lacking, but the exotic *Tamarix ramosissima* occurs in the tall-shrub stratum somewhat frequently. The short-shrub layer is almost devoid of associate species, although *Ephedra fasciculata* and *Acacia greggii* rarely occur. The dwarf-shrub layer is also essentially lacking, but *Gutierrezia sarothrae* does occur in the majority of stands. Annuals, particularly non-native annuals, constitute the majority of the sparse graminoid layer. *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* frequently occur. The forb understory is particularly variable in this association; no particular species regularly occur.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This brickellbush shrubland association occurs in the Inner Canyon and Western Grand Canyon in cobble-filled, rocky drainage bottoms. It occurs most commonly in low-level, low-gradient (1-3 degrees) drainages which experience intermittent flooding events. It chiefly occurs at 700 to 1250 m (2350-4100 feet) elevation, and across all aspects besides north-facing. Soils are rapidly-drained sandy loams and/or sand. Rocks (often cobble-sized) (35%), gravel (30%), and sand (25%) strongly dominate the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 10-12% in this sparse association which is characterized and dominated by the short shrub *Brickellia longifolia* (8-10%). Trees are lacking, but the exotic *Tamarix ramosissima* (1-2%) occurs in the tall-shrub stratum somewhat frequently. The short-shrub layer is almost devoid of associate species, although *Ephedra fasciculata* and *Acacia greggii* rarely occur at trace individual covers. The dwarf-shrub layer is also essentially lacking, but *Gutierrezia sarothrae* (trace) does occur in the majority of stands. Annuals, particularly non-native annuals, constitute the majority of the sparse graminoid layer (2-3%). *Bromus rubens, Bromus tectorum*, and *Vulpia octoflora* frequently occur at low (1-2%) individual covers. The forb understory (2%) is particularly variable in this association; no particular species regularly occur. Based upon the 6 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 23 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Tamarix ramosissima*
Short shrub/sapling	Broad-leaved deciduous shrub	*Brickellia longifolia*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Brickellia longifolia*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus catharticus* (exotic, Insignificant), *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Cynodon dactylon* (exotic, Medium/Low), *Erodium cicutarium* (exotic, Medium/Low), *Malva neglecta* (exotic, Medium/Insignificant), *Melilotus officinalis* (exotic, Medium/Low), *Polypogon monspeliensis* (exotic, High/Low), *Polypogon viridis* (exotic, High/Low), *Salsola tragus* (exotic), *Schismus barbatus* (exotic, High/Medium), *Tamarix ramosissima* (exotic, High)
Global: Invasive/Exotic: *Bromus rubens* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High), *Tamarix ramosissima* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled in South Canyon, North Canyon, lower White Creek/North Bass, Stone Creek, Kanab Creek, and in other tributaries near the Colorado River corridor; and from the Western Grand Canyon, where it was sampled in Twin Springs Canyon.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (6 plots): GRCA.01029, GRCA.01531, GRCA.01557, GRCA.01628, GRCA.02039, GRCA.02628; and nine (9) Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Chilopsis linearis* Shrubland**

Desert-willow Shrubland
Identifier: CEGL001164

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Chilopsis linearis* Shrubland

ELEMENT CONCEPT

Global Summary: This palustrine shrubland occurs along desert washes in the southwestern U.S. and northwestern Mexico. Sites are intermittently flooded drainages on alluvial fans and basins from 960-1080 (3135-3550 feet)

elevation at Buenos Aires National Wildlife Refuge. Stands in the Verde Valley at Tuzigoot National Monument occur on floodplains at around 1500 m. Substrates are generally sandy. The vegetation is characterized by a tall-shrub layer dominated by *Chilopsis linearis*. *Acacia greggii* may codominate in the tall-shrub layer, but *Prosopis velutina* generally has low cover (<10%). *Baccharis sarothroides* forms an open short-shrub layer in some stands. A sparse to moderately dense herbaceous layer is present and composed of a mixture of annual and perennial forbs and grasses. Common species include *Acalypha neomexicana, Amaranthus palmeri, Boerhavia coccinea, Bouteloua aristidoides, Urochloa arizonica (= Brachiaria arizonica), Eriogonum polycladon, Gutierrezia microcephala*, and *Setaria* spp. The exotic grass *Eragrostis lehmanniana* is present in some stands but at relatively low cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This desert-willow shrubland association predominantly occurs in dry desert washes, drainage channels, and along ephemeral or intermittent streams in the Western Grand Canyon. It occurs from approximately 415 to 650 m (1340-2100 feet) elevation, but has been found as high as 1350 m (4400 feet). It typically occurs on flat to gently sloping gradients (0-5 degrees). Soils are mostly sandy but occasionally include silt, loam or clay, and typically obscure the underlying geology. The ground cover tends to be dominated by rocks (30%), bare soil (25%) and gravel (20%) with lesser amounts of litter (9%) and wood (2%).

Global Environment: This palustrine shrubland occurs along desert washes in the southwestern U.S. and northwestern Mexico. Sites are intermittently flooded drainages on alluvial fans and basins from 960-1080 (3135-3550 feet) elevation at Buenos Aires National Wildlife Refuge. Stands in the Verde Valley at Tuzigoot National Monument occur on floodplains at around 1500 m. Substrates are generally sandy.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 25-30% in this association, but can be as high as 50% in extremely dense stands. A tall-shrub layer of *Chilopsis linearis* (20-25%) characterizes this association. *Chilopsis linearis* is usually accompanied by *Acacia greggii* (3%) and occasionally *Tamarix ramosissima* (3%). *Encelia farinosa* (1%) and *Bebbia juncea* (2%) often occur in the short-shrub layer, while other short shrubs, such as *Isocoma acradenia* (3%), *Larrea tridentata* (2%), and *Fallugia paradoxa* (7%), occur sporadically. The dwarf-shrub *Gutierrezia sarothrae* is frequently present at trace covers. Graminoids and forbs are both quite sparse, averaging only about 1% cover each. No graminoids are particularly dominant; however, *Bromus rubens* (1%) and *Aristida purpurea* (1%) do commonly occur. Of the forbs that are typical of this association, *Funastrum cynanchoides* (1%) and *Allionia incarnata* (1%) occur most frequently. Based upon the 7 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 13 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a tall-shrub layer dominated by *Chilopsis linearis*. *Acacia greggii* may codominate in the tall-shrub layer, but *Prosopis velutina* generally has low cover (<10%). *Baccharis sarothroides* forms an open short-shrub layer in some stands. A sparse to moderately dense herbaceous layer is present and composed of a mixture of annual and perennial forbs and grasses. Common species include *Acalypha neomexicana, Amaranthus palmeri, Boerhavia coccinea, Bouteloua aristidoides, Urochloa arizonica (= Brachiaria arizonica), Eriogonum polycladon, Gutierrezia microcephala*, and *Setaria* spp. The exotic grass *Eragrostis lehmanniana* is present in some stands but at relatively low cover.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Chilopsis linearis*
Short shrub/sapling	Broad-leaved deciduous shrub	*Bebbia juncea*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Chilopsis linearis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Bebbia juncea*, *Bromus rubens*, *Chilopsis linearis*, *Gutierrezia sarothrae*
Global: *Chilopsis linearis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Hordeum murinum* (exotic, High/Low), *Polypogon monspeliensis* (exotic, High/Low), *Tamarix ramosissima* (exotic, High)
Global: Invasive/Exotic: *Eragrostis lehmanniana* (invasive/exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This association is unique within Grand Canyon National Park; no other association found within the park has a dominant *Chilopsis linearis* component.
Global Comments: More survey is needed to characterize this association across its full range.
Global Related Concepts:

- *Chilopsis linearis* (Desert willow woodland) Alliance (Sawyer et al. 2009) **>**
- *Chilopsis linearis* (Bourgeron and Engelking 1994) **=**
- *Chilopsis linearis* Association (Evens 2000) **?**
- *Chilopsis linearis* Shrubland (Keeler-Wolf et al. 2005) **=**
- DRISCOLL FORMATION CODE:III.B.3.c. (Driscoll et al. 1984) **>**
- Desert Riparian Community (Armstrong 1969) **>**
- Desertwillow (Plumb 1988) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known primarily from the canyons in the Western Grand Canyon. It was sampled from 209 Mile Canyon, Separation Canyon, Surprise Canyon, Burnt Canyon, and Tincanebits Canyon.
Global Range: This riparian shrubland is found along desert washes across the southwestern U.S. and northwestern Mexico.
Nations: MX, US
States/Provinces: AZ, CA:S3, MXSO, NM, NV:S3?
TNC Ecoregions: 16:C, 17:C, 19:C, 22:C, 23:C, 24:?
USFS Ecoregions (1994/95): 313A:CC, 321A:CC, 322A:CC, 322B:CC, 322C:CC, M262B:CC
Federal Lands: NPS (Grand Canyon, Joshua Tree, Tuzigoot); USFWS (Buenos Aires)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (7 plots): GRCA.01669, GRCA.01683, GRCA.02569, GRCA.02645, GRCA.04013, GRCA.04699, GRCA.04709.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: Armstrong 1969, Bourgeron and Engelking 1994, Driscoll et al. 1984, Evens 2000, Keeler-Wolf et al. 2005, Plumb 1988, Reid and Hall 2010, Sawyer et al. 2009, Schulz 2004, TNC 1995e, Western Ecology Working Group n.d.

***Ericameria paniculata* Wash Shrubland**

Mojave Rabbitbrush Wash Shrubland
Mojave Rabbitbrush Desert Wash
Identifier: CEGL002706

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Ericameria paniculata* Wash Shrubland

ELEMENT CONCEPT

Global Summary: This Mojave rabbitbrush shrubland association is currently described from Grand Canyon-Parashant National Monument in Arizona. It is also reported from California and Nevada. More survey and classification work are needed to fully characterize this type. It predominantly occurs in desert washes and drainage channels from approximately 375 to 650 m (1225-2150 feet) elevation, but can occasionally occur at higher elevations (1100-1200 m). It typically occurs in flat to very low-sloping (1-4 degrees), mostly south-flowing drainages. Soils are rapidly-drained and composed mostly of sand, but also occasionally contain loam or silt. This association is characteristically sparse. *Ericameria paniculata* characterizes the association and can occur as either a tall or short shrub. In the short-shrub layer, *Larrea tridentata* and *Hymenoclea salsola*, and occasionally *Ambrosia dumosa* and *Psorothamnus fremontii* may occur. A sparse dwarf-shrub layer occurs, but no species are consistent from site to site. This association supports a very sparse graminoid layer that is not dominated by any particular species. The graminoids *Bromus rubens* and *Vulpia octoflora* occur frequently but typically at low cover. *Chamaesyce polycarpa, Eriogonum inflatum, Erodium cicutarium, Plantago ovata, Cryptantha* sp., Gilia sp., and *Sphaeralcea ambigua* may be present in the sparse forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Mojave rabbitbrush shrubland association predominantly occurs in desert washes and drainage channels in Grand Canyon-Parashant National Monument. It occurs from approximately 375 to 650 m (1225-2150 feet) elevation, but can occasionally occur at higher elevations (1100-1200 m). It typically occurs in flat to very low-sloping (1-4 degrees), mostly south-flowing drainages. Soils are rapidly-drained and composed mostly of sand, but also occasionally contain loam or silt. Ground cover is dominated by gravel (37%), bare sand or soil (35%), and rocks (20%), but also includes small amounts of litter (3%) and cryptogamic soil crust (2%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is characteristically sparse and typically supports 10-15% shrub cover. *Ericameria paniculata* (5-15%) characterizes the association, and can occur as either a tall or short shrub. Tall shrubs occasionally occur but rarely at significant covers. In the short-shrub layer, the dominant *Ericameria paniculata* is typically found with *Larrea tridentata* (1%) and *Hymenoclea salsola* (2%), and occasionally with *Ambrosia dumosa* (2%) and *Psorothamnus fremontii* (2%) as well. A sparse dwarf-shrub layer (1%) occurs, but no species are consistent from site to site. This association supports a very sparse graminoid layer (1%) that is not dominated by any particular species. The graminoids *Bromus rubens* and *Vulpia octoflora* occur frequently but typically at low covers (0-1%). *Chamaesyce polycarpa, Eriogonum inflatum, Erodium cicutarium, Plantago ovata, Cryptantha* sp., Gilia sp., and *Sphaeralcea ambigua* may be present (at low covers) in the sparse forb layer (2%). Based upon the 12 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15.5 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Ericameria paniculata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Chamaesyce polycarpa*, *Ericameria paniculata*, *Eriogonum inflatum*, *Erodium cicutarium*, *Hymenoclea salsola*, *Larrea tridentata*, *Plantago ovata*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4G5 (26-Jun-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Related Concepts:

- *Ericameria paniculata* (Black-stem rabbitbrush scrub) Alliance (Sawyer et al. 2009) >
- *Ericameria paniculata* Association (Evens 2000) =
- *Ericameria paniculata* Wash Shrubland (Keeler-Wolf 1997) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, and potentially can be expected in the Western Grand Canyon. It was sampled from around Grand Wash Bay, Tassi Wash, Garden Wash, Whitmore Canyon, Snap Canyon, and Pigeon Wash.
Global Range: This association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from California and Nevada. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, CA, NV
TNC Ecoregions: 17:C, 19:C, 23:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 322B:CC, 322C:CC, 341F:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.02521, GRCA.03522, GRCA.03646, GRCA.04004, GRCA.04011, GRCA.04020, GRCA.04021, GRCA.04036, GRCA.04039, GRCA.04044, GRCA.04513, GRCA.04667.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Evens 2000, Keeler-Wolf 1997, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

Fallugia paradoxa Grand Canyon Desert Wash Shrubland

Apache Plume Grand Canyon Desert Wash Shrubland
Identifier: CEGL005298

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Fallugia paradoxa* Grand Canyon Desert Wash Shrubland

ELEMENT CONCEPT

Global Summary: This Apache plume shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It predominantly occurs in the bottom of drainage channels and desert washes but occasionally occurs on the benches or terraces adjacent to or just above channel bottoms. It occurs from approximately 1100 to 1600 m (3600-5300 feet) elevation, typically in the bottom of flat to low-gradient (1-6 degrees) drainage channels. Soils are fairly well-drained and composed mostly of sand and loam. Bedrock is typically limestone or sandstone. Ground cover is dominated by rocks and gravel. Trees are essentially lacking from this association; however, scattered *Pinus edulis, Juniperus*

osteosperma, and *Populus fremontii* rarely occur. *Fallugia paradoxa* dominates this association and is usually found in the short-shrub layer. A wide variety of other short shrubs are typically seen as well. *Rhus trilobata* is common, while *Ephedra viridis, Atriplex canescens, Ericameria nauseosa, Brickellia longifolia*, and *Encelia resinifera* are occasionally present. A sparse dwarf-shrub layer dominated by *Gutierrezia sarothrae* is typical. *Opuntia polyacantha* and *Agave utahensis* also occur sporadically in this layer. The graminoid component frequently includes *Bromus rubens* and occasionally includes *Muhlenbergia porteri, Bromus tectorum, Achnatherum speciosum, Aristida purpurea*, and *Bouteloua curtipendula*. A large variety of different forb species are associated with this community type but cover is low. *Artemisia ludoviciana* is the most commonly found forb, while *Penstemon palmeri, Sphaeralcea ambigua*, and *Datura wrightii* may also be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This Apache plume shrubland association predominantly occurs in the bottom of drainage channels and desert washes in the Inner Canyon; however, it occasionally occurs on the benches or terraces adjacent to or just above channel bottoms. It occurs from approximately 1100 to 1600 m (3600-5300 feet) elevation, typically in the bottom of flat to low-gradient (1-6 degrees) drainage channels. Soils are fairly well-drained and composed mostly of sand and loam. The soil usually obscures the underlying geology, but when exposed, the bedrock is typically limestone or sandstone. Ground cover is dominated by rocks (37%) and gravel (21%), with significant amounts of bare soil or sand (13%) and litter (17%) as well.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees are essentially lacking from this association; however, scattered *Pinus edulis* (1%), *Juniperus osteosperma* (2%), and *Populus fremontii* (2%) rarely occur. Total shrub cover averages 20-25%, but can be higher in denser stands. *Fallugia paradoxa* (15-20%) dominates this association and is usually found in the short-shrub layer. A wide variety of other short shrubs are typically seen in this association as well. *Rhus trilobata* (2%) is common, while *Ephedra viridis* (1%), *Atriplex canescens* (3%), *Ericameria nauseosa* (2%), *Brickellia longifolia* (2%), and *Encelia resinifera* (1%) are occasionally present. A sparse dwarf-shrub layer (2%) dominated by *Gutierrezia sarothrae* (1%) is typical. *Opuntia polyacantha* (1%) and *Agave utahensis* (1%) also occur sporadically in this layer. The graminoid component (4%) frequently includes *Bromus rubens* (1%) and occasionally includes *Muhlenbergia porteri* (1%), *Bromus tectorum* (2%), *Achnatherum speciosum* (1%), *Aristida purpurea* (1%), and *Bouteloua curtipendula* (1%). A large variety of different forb species are associated with this community type; however, total forb cover rarely exceeds 3%. *Artemisia ludoviciana* (1%) is the most commonly found forb, while *Penstemon palmeri, Sphaeralcea ambigua*, and *Datura wrightii* may also be present at trace covers (0-1%). Based upon the 16 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 25 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Fallugia paradoxa*
Short shrub/sapling	Dwarf-shurb	*Ericameria nauseosa*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Aristida purpurea*, *Artemisia ludoviciana*, *Atriplex canescens*, *Bouteloua curtipendula*, *Brickellia longifolia*, *Bromus rubens*, *Bromus tectorum*, *Encelia resinifera*, *Ephedra viridis*, *Fallugia paradoxa*, *Gutierrezia sarothrae*, *Muhlenbergia porteri*, *Penstemon palmeri*, *Quercus turbinella*, *Rhus trilobata*, *Sphaeralcea ambigua*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Medicago lupulina* (exotic, Medium/Insignificant), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (13-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and the Western Grand Canyon. In the Inner Canyon, it was sampled from South Canyon, Kwagunt Creek, Phantom Creek, Bright Angel Creek, Clear Creek, and from Indian Hollow. In the Western Grand Canyon, it was sampled from the Toroweap Valley east of Vulcan's Throne, Twin Springs Canyon, Tincanebits Canyon, and upper Cave Canyon.
Global Range: This association is currently known from Grand Canyon National Park in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (16 plots): GRCA.01011, GRCA.01593, GRCA.02040, GRCA.02592, GRCA.02605, GRCA.02619, GRCA.02637, GRCA.02647, GRCA.02650, GRCA.03003, GRCA.03017, GRCA.03540, GRCA.03601, GRCA.04623, GRCA.04624.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Hymenoclea salsola* Wash Shrubland**

Burrobrush Wash Shrubland
Identifier: CEGL005398

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Hymenoclea salsola* Wash Shrubland

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This burrobrush shrubland association predominantly occurs in the bottom of drainage channels and desert washes in Grand Canyon-Parashant National Monument. It occurs from approximately 400 to 570 m (1300-1900 feet) elevation, typically in flat to very low-gradient (1-3 degrees) washes that generally flow south. Soils are well-drained and usually sandy, but occasionally contain silt, clay, and loam. The underlying geology is typically obscured by soil. Gravel (37%) and rocks (25%), as well as sand (18%) and some bare soil (8%), are common components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 10-15 % in this association. The scattered tall shrub *Acacia greggii* (1%) punctuates stands; however, a short-shrub layer dominated by *Hymenoclea salsola* (4-7%) characterizes this association. The short shrubs *Larrea tridentata* (2%), *Psorothamnus fremontii* (2%), and *Ericameria paniculata* (1%) are also commonly present. The low-growing cactus *Opuntia basilaris*, while usually occurring in only trace amounts, is frequently seen in the dwarf-shrub layer. A very sparse graminoid layer exists in which *Bromus rubens* (up to 1%) and *Vulpia octoflora* (up to 2%) occur most frequently. Notable forbs include *Antheropeas lanosum* (1%), *Chamaesyce polycarpa* (1%), *Cryptantha* spp. (1%), and the exotic *Erodium cicutarium* (2%), all of which occur occasionally. Based upon the 7 stands sampled, this association hosts below-average species

diversity among Grand Canyon plant communities, with 14 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Hymenoclea salsola*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Bromus rubens*, *Ericameria paniculata*, *Hymenoclea salsola*, *Opuntia basilaris*, *Psorothamnus fremontii*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (15-Jul-2010).

CLASSIFICATION

Status: Standard
Global Related Concepts:
- *Ambrosia salsola* (Cheesebush scrub) Alliance (Sawyer et al. 2009) **>**
- *Hymenoclea salsola* (Keeler-Wolf et al. 1998) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Grand Wash Bay area and Pigeon Wash, as well as from the Whitmore Canyon area.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (7 plots): GRCA.02522, GRCA.03516, GRCA.03622, GRCA.03632, GRCA.04033, GRCA.04040, GRCA.04054.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Keeler-Wolf et al. 1998, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

Isocoma acradenia Shrubland

Alkali Goldenbush Shrubland
Identifier: CEGL005395

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Isocoma acradenia* Shrubland

ELEMENT CONCEPT

Global Summary: This goldenbush shrubland association is currently described from Grand Canyon National

Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It occurs in low-level drainage channels and valley bottoms, and on adjacent benches and terraces, typically in areas which receive additional moisture compared to adjacent habitats. It occurs at 400 to 1100 m (1300-3750 feet) elevation, on gentle slopes (2-5 degrees), across all aspects. Soils are sandy or sometimes silty, often alkaline, and moderately well-drained; cryptogamic soil crust is relatively common. *Isocoma acradenia* characterizes this association and dominates the short-shrub layer. *Tamarix ramosissima* and *Acacia greggii* occasionally occur as associates in the tall-shrub stratum, while various short shrubs, including *Encelia farinosa, Bebbia juncea, Baccharis emoryi, Ephedra fasciculata, Salix exigua*, and *Trixis californica*, may sporadically occur. Dwarf-shrubs are essentially lacking in this community, although *Gutierrezia sarothrae* occasionally occurs. The graminoid layer is fairly sparse, quite variable, and may include *Aristida purpurea, Sporobolus cryptandrus*, and *Sporobolus flexuosus*, as well as the non-natives *Bromus rubens* and *Bromus tectorum*. Forbs are similarly sparse and variable; *Artemisia ludoviciana*, *Thymophylla pentachaeta*, and *Aletes macdougalii* are somewhat common.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs in the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument in low-level drainage channels and valley bottoms, and on adjacent benches and terraces, typically in areas which receive additional moisture compared to adjacent habitats. It occurs at 400 to 1100 m (1300-3750 feet) elevation, on gentle slopes (2-5 degrees), across all aspects. Soils are sandy or sometimes silty, often alkaline, and moderately well-drained. Bare soil or sand (40%), litter (20%), rocks (17%), and gravel (13%) are major components of the ground cover, while cryptogamic soil (3%) crust is also relatively common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 20-25% in this association. *Isocoma acradenia* (15%) characterizes this association and dominates the fairly pure short-shrub layer. *Tamarix ramosissima* (1-2%, occasionally higher) and *Acacia greggii* (3-4%) occasionally occur as associates in the tall-shrub stratum (5-6%), while various short shrubs (18%), including *Encelia farinosa, Bebbia juncea, Baccharis emoryi, Ephedra fasciculata, Salix exigua*, and *Trixis californica*, may sporadically occur at very low individual covers (1-2%). Dwarf-shrubs are essentially lacking in this community, although *Gutierrezia sarothrae* occasionally occurs at trace cover. The graminoid layer is fairly sparse (2-3%) and quite variable, and may include *Aristida purpurea, Sporobolus cryptandrus*, and *Sporobolus flexuosus*, as well as the non-natives *Bromus rubens* and *Bromus tectorum*. Forbs are similarly sparse (1%) and variable; *Artemisia ludoviciana*, *Thymophylla pentachaeta*, and *Aletes macdougalii* are somewhat common. Based upon the 6 Grand Canyon Vegetation Mapping Project stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Isocoma acradenia*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Isocoma acradenia*, *Sporobolus cryptandrus*, *Sporobolus flexuosus*, *Tamarix ramosissima*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Aletes macdougalii* (state-imperiled, G3); **Invasive/Exotic**: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic), *Tamarix ramosissima* (exotic, High)

Global: Vulnerable: *Aletes macdougalii* (G3)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Standard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled from Clear Creek, Crystal Canyon, the mouth of Forster Canyon, and from several locations along the Colorado River corridor; in the Western Grand Canyon, it was sampled from Burnt Canyon; and in Grand Canyon-Parashant National Monument, it was sampled from Grand Wash.
Global Range: This association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (6 plots): GRCA.01684, GRCA.02507, GRCA.02510, GRCA.03511, GRCA.04509, GRCA.04622; and four (4) Grand Canyon Monitoring and Research Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors: K. Christie
References: Reid and Hall 2010, Western Ecology Working Group n.d.

***Salazaria mexicana* Shrubland**

Mexican Bladdersage Shrubland
Identifier: CEGL005293

USNVC CLASSIFICATION

Division	North American Warm Desert Scrub & Grassland (3.A.2.Na)
Macrogroup	North American Warm-Desert Xero-Riparian (M092)
Group	Warm Semi-Desert Shrub & Herb Wash-Arroyo (G541)
Association	*Salazaria mexicana* Shrubland

ELEMENT CONCEPT

Global Summary: This Mexican bladdersage shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes of cinder cones at 1275 to 1400 m (4250-4600 feet) elevation, on south- and west-facing aspects of moderately steep (10-24 degrees) slopes. Soils are moderately well-drained silty clays that lie above volcanic cinders. Vegetation is dominated by the short shrub *Salazaria mexicana*. Tall shrubs are absent. The short-shrub layer includes *Lycium andersonii* and *Ephedra fasciculata*. Dwarf-shrubs are rare, but *Thamnosma montana* does occur sporadically. The graminoid understory is extremely sparse and almost non-existent in some stands; however, species such as *Bromus arvensis*, *Achnatherum speciosum*, *Bromus rubens*, and *Elymus elymoides* sporadically occur at trace covers. *Mentzelia albicaulis* and *Astragalus* sp. are consistently present in the forb understory. *Amsinckia menziesii, Mirabilis multiflora*, and *Chaenactis stevioides* also commonly occur.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes of cinder cones in the Western Grand Canyon. It occurs at 1275 to 1400 m (4250-4600 feet) elevation, on south- and west-facing aspects of moderately steep (10-24 degrees) slopes. Soils are moderately well-drained silty clays that lie above volcanic cinders. Gravel (85%) strongly dominates the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-25% in this association which is dominated by the short shrub *Salazaria mexicana* (8-12%). Tall shrubs are non-existent in this association. Along with *Salazaria mexicana*, the short-shrub layer (16%) invariably includes *Lycium andersonii* (3-5%) and *Ephedra fasciculata* (2-3%). Dwarf-shrubs are rare, but *Thamnosma montana* (1%) does occur sporadically. The graminoid understory is extremely sparse and almost non-existent in some stands; however, species such as *Bromus arvensis*, *Achnatherum speciosum*, *Bromus rubens*, and *Elymus elymoides* sporadically occur at trace covers. *Mentzelia albicaulis* (1%) and *Astragalus* sp. (up to 1%) are consistently present in the forb understory (3%). *Amsinckia menziesii* (1%), *Mirabilis multiflora* (1%), and *Chaenactis stevioides* (1%) also commonly occur. Based upon the 3 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 14 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Thorn shrub	*Salazaria mexicana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Amsinckia menziesii*, *Bromus arvensis*, *Chaenactis stevioides*, *Ephedra fasciculata*, *Hymenoclea salsola*, *Lycium andersonii*, *Mentzelia albicaulis*, *Mirabilis multiflora*, *Salazaria mexicana*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus arvensis* (exotic), *Bromus rubens* (exotic)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Standard
Global Related Concepts:

- *Salazaria mexicana* (Bladder sage scrub) Alliance (Sawyer et al. 2009) **>**
- *Salazaria mexicana* Association (Beatley 1976) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon where it was sampled from Vulcans Throne in the Toroweap Valley.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, NV
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (3 plots): GRCA.02580, GRCA.02581, GRCA.02582.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Beatley 1976, Reid and Hall 2010, Sawyer et al. 2009, Western Ecology Working Group n.d.

3.B.1. Cool Semi-Desert Scrub & Grassland

3.B.1.Ne. Western North American Cool Semi-Desert Scrub & Grassland

M171. Great Basin & Intermountain Dry Shrubland & Grassland
G312. Colorado Plateau Blackbrush - Mormon-tea Shrubland

Coleogyne ramosissima Shrubland
Blackbrush Shrubland
Identifier: CEGL001332

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Association	*Coleogyne ramosissima* Shrubland

ELEMENT CONCEPT

Global Summary: This broadly defined, common shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills in areas with hot summers and cold winters. Elevations range from 1065-2133 m (3500-7000 feet). Sites are on level to steep slopes, rarely exceeding 45%. In Nevada, stands occur on lower foothills and upper bajadas, often with cooler northern and eastern aspects. In the Colorado Plateau, stands occupy plateaus, ridges, dunes, alluvial fans, benches and colluvial slopes oriented to any aspect. The unvegetated surface is dominated by bare ground, except on some sandy sites, where biological soil crusts may provide more than 50% cover. Substrates range from barren shales to alluvium and eolian sands to broken limestone. Soils tend to be shallow, calcareous, sandy-textured on eolian sand sites, and clay-textured on shale sites. There is often a caliche subhorizon. Gravel, boulders and rock outcrops are common. The vegetation is characterized by an open to moderately dense short-shrub layer that is clearly dominated by the evergreen microphyllous shrub *Coleogyne ramosissima*, sometimes in nearly pure stands. Shrub cover is usually around 20%, although it can range as low as 5% or as high as 50%. Other shrub and dwarf-shrub species may be present with low cover, including *Ambrosia dumosa, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, Ephedra torreyana, Ephedra nevadensis, Ephedra viridis, Ericameria linearifolia, Ericameria teretifolia, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., and *Yucca baccata*. Occasional *Juniperus* spp., *Pinus edulis*, or *Pinus monophylla* trees are present in some stands. The herbaceous layer generally includes only sparse cover of graminoids and forbs, except during wet years when cover of annuals may be high. Cover of the introduced annual *Bromus* spp. may be high in disturbed stands, but in general, the substrate does not support the growth of more than a trace of grasses.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This blackbrush shrubland association is extremely common and widespread throughout the Inner Canyon and the Western Grand Canyon. It occurs primarily on sideslopes but can be found on a variety of landforms, including plateaus, ridges, terraces, and valley bottoms. It generally occurs below the rims on both sides of the Colorado River from approximately 1300 to 1850 m (4275-6050 feet) elevation. While predominantly found on flat or low-gradient settings (0 to 12 degrees), this community occasionally occurs on moderately steep slopes (17 to 25 degrees) as well. Soils are rapidly-drained silty or sandy loams that intermittently contain clay. When unobscured, the underlying geology is usually limestone or less frequently sandstone. Gravel (47%), rocks (18%), bare soil (12%), litter (9%), bedrock (6%) and cryptogamic crust (2%) are common components of the ground cover. When it occurs, this vegetation type often forms vast expanses across these environments.

Global Environment: This broadly defined shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills in areas with hot summers and cold winters. Elevations range from 1065-2133 m (3500-7000 feet). Sites are frequently on level to moderate slopes rarely exceeding 20% but have also been found on steep slopes (>45%). In Nevada, stands occur on lower foothills and upper bajadas, often with cooler northern and eastern aspects. In the Colorado Plateau, stands occupy plateaus, ridges, dunes, alluvial fans, canyon rims, bench ledges valleys, plains, and colluvial slopes with any aspect. The upper elevation ecotones are generally narrow, and *Coleogyne ramosissima* may mix with *Artemisia* spp. or *Pinus edulis* and *Juniperus osteosperma*.

The lower elevation ecotones tend to be broader, and *Coleogyne ramosissima* may mix with grasslands or with shrublands dominated by *Larrea tridentata, Ambrosia dumosa*, *Atriplex* spp., or *Grayia spinosa* (Beatley 1976). Stands described from the Colorado Plateau often occur in a mosaic with pinyon-juniper woodlands (Warren et al. 1982). The unvegetated surface is dominated by bare ground, except on some sandy sites, where biological soil crusts may provide more than 50% cover. Substrates range from barren shales to alluvium and eolian sands to broken limestone. Soils tend to be shallow, calcareous, sandy-textured on eolian sand sites, and clay soils on shale sites. There is often with a caliche subhorizon. Gravel, boulders and rock outcrops are common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 30-35% in this association. Trees are rare in this short shrub-dominated community; however, scattered *Pinus edulis* (2%) individuals can occur at higher-elevation sites. The tall-shrub layer is also infrequent, but *Purshia stansburiana* (1%) occurs occasionally. A short-shrub layer dominated by *Coleogyne ramosissima* (20-30%) characterizes this association. *Ephedra viridis* (1%) and *Yucca baccata* (2%) also occur with some frequency here. *Agave utahensis* (3%) and *Gutierrezia microcephala* (up to 1%) occur as both short and dwarf-shrubs on a fairly regular basis. *Bromus tectorum* (1%) and *Tridens muticus* (1%) commonly occur in a fairly sparse graminoid layer. A variety of species such as *Sphaeralcea ambigua* (up to 1%) and *Thymophylla pentachaeta* (up to 1%) are the most common components of the sparse forb understory. Based upon the 23 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 14 species per 400-square-meter plot.

Global Vegetation: This common association is characterized by an open to moderately dense short-shrub layer that is clearly dominated by the evergreen microphyllous shrub *Coleogyne ramosissima*. Shrub cover is usually around 20%, although it can range as low as 5% or as high as 50%. It can occur in almost pure stands. Other shrub and dwarf-shrub species may be present with low cover, including *Ambrosia dumosa, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, Ephedra torreyana, Ephedra nevadensis, Ephedra viridis, Ericameria linearifolia, Ericameria teretifolia, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., and *Yucca baccata*. Locally, disturbance may reduce abundance of *Coleogyne ramosissima* and favor *Artemisia filifolia* until it nearly codominates. Occasional *Juniperus* spp., *Pinus edulis*, or *Pinus monophylla* trees are present in some stands. The herbaceous layer generally includes only sparse cover of graminoids and forbs, except during wet years when cover of annuals may be high. Cover of the introduced annual *Bromus* spp. may be high in disturbed stands, but in general, the substrate does not support the growth of more than a trace of grasses. Forbs may include species of *Chaenactis, Cryptantha, Phacelia, Plantago*, and *Streptanthella*. Scattered *Juniperus osteosperma* may also be present.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Coleogyne ramosissima*
Short shrub/sapling	Dwarf-shurb	*Agave utahensis*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Coleogyne ramosissima*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Agave utahensis*, *Bromus tectorum*, *Coleogyne ramosissima*, *Ephedra viridis*, *Gutierrezia microcephala*, *Purshia stansburiana*, *Sphaeralcea ambigua*, *Tridens muticus*, *Yucca baccata*

Global: *Atriplex canescens*, *Atriplex confertifolia*, *Coleogyne ramosissima*, *Ephedra nevadensis*, *Ephedra torreyana*, *Ephedra viridis*, *Gutierrezia microcephala*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Agave utahensis* (state-vulnerable, G4); **Invasive/Exotic**: *Bromus rubens*

(exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)
Global: Vulnerable: *Ephedra funerea* (G2); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High); **Other**: *Quercus havardii* var. *tuckeri* (G4T3?Q)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland (CEGL005297) is also dominated by *Coleogyne ramosissima* and is found on similar landforms, but the associate *Ephedra* spp. occur more frequently and with more cover than in *Coleogyne ramosissima* Shrubland (CEGL001332).
Global Comments: This widespread plant association is broadly defined by the strong dominance of *Coleogyne ramosissima* without diagnostic codominate shrubs or a developed herbaceous layer. It is similar to the broadly defined *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334) and is separated from it by the lack of a *Pleuraphis jamesii*-dominated herbaceous layer. In cases where the grass element is missing or is greatly reduced because of grazing and not because of edaphic factors, there is potential for misclassification of stands.
Global Similar Associations:

- *Coleogyne ramosissima - Ephedra* spp. Warm Desert Shrubland (CEGL005297) is also dominated by *Coleogyne ramosissima* and is found on similar landforms, but the associate Ephedra spp. occur more frequently and with more cover.
- *Coleogyne ramosissima - Eriogonum fasciculatum* Shrubland (CEGL001333)
- *Coleogyne ramosissima - Purshia stansburiana - Quercus havardii var. tuckeri* Shrubland (CEGL002348)
- *Coleogyne ramosissima - Purshia stansburiana* Shrubland (CEGL002720)
- *Coleogyne ramosissima - Thamnosma montana* Shrubland (CEGL002718)
- *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334)
- *Larrea tridentata - Coleogyne ramosissima* Shrubland (CEGL002717)
- *Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima* Woodland (CEGL000781)
- *Quercus turbinella - Coleogyne ramosissima* Shrubland (CEGL000982)

Global Related Concepts:

- 152.1311 *Coleogyne ramosissima - Ephedra viridis - Yucca baccata* (Warren et al. 1982) **=**
- *Coleogyne ramosissima - Ephedra nevadensis* Association (Peterson 1984) **=**
- *Coleogyne ramosissima - Ephedra nevadensis* Shrubland (Ostler et al. 2000) **=**
- *Coleogyne ramosissima* (Bourgeron and Engelking 1994) **=**
- *Coleogyne ramosissima* Association (Annable 1985) **?**
- *Coleogyne ramosissima* Communities (Beatley 1976) **>**
- Blackbrush Plant Community (Armstrong 1969) **=**
- Blackbrush Type (Schultz et al. 1987) **=**
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) **>**
- Desert Shrub (BIA 1979) **>**
- Mohavean Shrub (*Coleogyne*) Formation (Wells 1960) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from expansive areas of the Inner Canyon and Western Grand Canyon. It seems to be best developed from roughly Unkar Creek west to Matkatamiba Canyon, and also on the Sanup Plateau, and in the Hook around the Grand Wash Cliffs. It can be expected in appropriate habitats from the Little Colorado River west to Lake Mead.
Global Range: This widespread and common desert shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills.
Nations: US
States/Provinces: AZ:S4, CA:S4, NV, UT:S4S5, WY
TNC Ecoregions: 11:C, 12:C, 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC

Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (23 plots): GRCA.01001, GRCA.01008, GRCA.01113, GRCA.01114, GRCA.01548, GRCA.01606, GRCA.02001, GRCA.02012, GRCA.02015, GRCA.02404, GRCA.02644, GRCA.02646, GRCA.02648, GRCA.02651, GRCA.03001, GRCA.03002, GRCA.03012, GRCA.03610, GRCA.03648, GRCA.03650, GRCA.03651, GRCA.04194, GRCA.04682.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Annable 1985, Armstrong 1969, BIA 1979, Beatley 1976, Bourgeron and Engelking 1994, Bowns and West 1976, Bradley 1964, Callison et al. 1985, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2009a, Driscoll et al. 1984, Ostler et al. 2000, Peterson 1984, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Schultz et al. 1987, Shields et al. 1959, WNDD unpubl. data, Warren et al. 1982, Wells 1960, West 1983d, Western Ecology Working Group n.d., Wright 1980

Ephedra (*torreyana, viridis*) / Mixed Semi-desert Grasses Shrubland

(Torrey's Joint-fir, Mormon-tea) / Mixed Semi-desert Grasses Shrubland
Identifier: CEGL005113

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Association	*Ephedra (torreyana, viridis)* / Mixed Semi-desert Grasses Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes at 950 to 1400 m (3125-4600 feet) elevation, but can be found as low as 775 m (2600 feet). It is primarily found on moderate gradients (15-22 degrees) and southern aspects, but is also occasionally found on steeper slopes (30-35 degrees). Soils are rapidly-drained silty or sandy loams. Vegetation is characterized by the dominance of the short shrub *Ephedra torreyana* together with a well-developed mixed-species graminoid understory. Tall shrubs are absent. The short-shrub layer also occasionally includes *Encelia resinifera, Rhus trilobata*, and *Ephedra viridis*. *Gutierrezia sarothrae* and *Opuntia polyacantha* are common components of the dwarf-shrub stratum. A rich and varied graminoid understory that includes *Muhlenbergia porteri, Bouteloua eriopoda*, and *Tridens muticus* characterizes this association. *Pleuraphis jamesii* occasionally occurs, as do *Achnatherum speciosum, Dasyochloa pulchella*, and *Aristida purpurea*. The non-native *Bromus rubens* also occurs in most stands. *Sphaeralcea grossulariifolia, Artemisia ludoviciana, Eriogonum inflatum*, and *Acourtia wrightii* occasionally occur in the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes in the Inner Canyon and Western Grand Canyon. It usually occurs at 950 to 1400 m (3125-4600 feet) elevation, but can be found as low as 775 m (2600 feet). It is primarily found on moderate gradients (15-22 degrees) and southern aspects, but is also occasionally found on steeper slopes (30-35 degrees). Soils are rapidly-drained silty or sandy loams that usually obscure the underlying bedrock. Rocks (37%), gravel (26%), and litter (20%) dominate the ground cover. A single stand was sampled from a similar environment in Grand Canyon-Parashant National Monument.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the dominance of the short shrub *Ephedra torreyana* (4-7%), together with a strong mixed-species graminoid understory. Tall shrubs are non-existent in this association. Along with *Ephedra torreyana*, the short-shrub layer (8-10%) also occasionally includes *Encelia resinifera* (1%), *Rhus trilobata* (2%), and *Ephedra viridis* (2%). *Gutierrezia sarothrae* (2%) and *Opuntia polyacantha* (2%) are common components of the dwarf-shrub stratum

(4%). A rich and varied graminoid understory (10-12%), including *Muhlenbergia porteri* (up to 8%), *Bouteloua eriopoda* (up to 4%), and *Tridens muticus* (up to 4%), is characteristic of this association. *Pleuraphis jamesii* occasionally occurs (at up to 12% cover), as do *Achnatherum speciosum, Dasyochloa pulchella*, and *Aristida purpurea* at low individual covers. The non-native *Bromus rubens* (2%) also occurs in most stands. *Sphaeralcea grossulariifolia* (1%), *Artemisia ludoviciana* (1%), *Eriogonum inflatum* (1%), and *Acourtia wrightii* (trace) occasionally occur in the forb understory (3%). Based upon the 10 stands sampled, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae, Opuntia polyacantha*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Artemisia ludoviciana*, *Bouteloua eriopoda*, *Encelia resinifera*, *Ephedra torreyana*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Muhlenbergia porteri*, *Opuntia polyacantha*, *Pleuraphis jamesii*, *Sphaeralcea grossulariifolia*, *Tridens muticus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland (CEGL005084) is dominated by *Ephedra fasciculata* (and not *Ephedra torreyana* or *Ephedra viridis*) in the shrub layer, and supports a similar assemblage of codominant graminoids. It typically occurs at lower elevations, however.
Global Similar Associations:

- *Ephedra fasciculata* / Mixed Semi-desert Grasses Shrubland (CEGL005084) typically occurs at lower elevations and is dominated by *Ephedra fasciculata* rather than *Ephedra torreyana* or *Ephedra viridis* in the shrub layer, and supports a similar assemblage of codominant graminoids.
- *Lycium andersonii - Ephedra (torreyana, viridis)* Shrubland (CEGL005150)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, Western Grand Canyon, and Grand Canyon-Parashant National Monument. In the Inner Canyon, it was sampled from Nankoweap Creek, Red Canyon, Bright Angel Canyon, Ottoman Amphitheater, lower White Creek/Shinumo Creek, and Royal Arch Creek; in the Western Grand Canyon, it was sampled from 150-Mile Canyon, Tuckup Canyon, and the "Hook" near the Grand Wash Cliffs; and in Grand Canyon-Parashant National Monument, it was sampled from Whitmore Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (10 plots): GRCA.01106, GRCA.01615, GRCA.02003, GRCA.02085, GRCA.02611, GRCA.03032, GRCA.03537, GRCA.04613, GRCA.04618, GRCA.04668.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Ephedra torreyana - (*Atriplex canescens, Atriplex confertifolia*) Sparse Vegetation

Torrey's Joint-fir - (Fourwing Saltbush, Shadscale) Sparse Vegetation
Identifier: CEGL005801

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Association	*Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation

ELEMENT CONCEPT

Global Summary: This sparsely vegetated association is widely distributed locally in Canyonlands National Park and Glen Canyon National Recreation Area in Utah, but is also found in northern Arizona. It occurs on a broad range of depositional and erosional landforms, including alluvial fans, benches, dunes, canyon bottoms, stream terraces, ledges, badlands, canyon rims, colluvial slopes, toeslopes, hillsides, ridges, mesas, and plateaus. Slopes range from flat to steep at elevations from 1183 to 1603 m. Substrates vary from rapidly drained clay soils to sand derived from colluvium or alluvium, riverine and basaltic cobbles, and sandstone bluffs. This sparsely vegetated shrubland is characterized by *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* as codominant species with associated shrubs contributing little cover. The herbaceous layer is diverse but contributes only sparse to low cover. Graminoids commonly present include *Pleuraphis jamesii, Achnatherum hymenoides*, and *Bromus tectorum*. Forbs are highly variable in composition and include *Eriogonum inflatum, Tiquilia latior, Sphaeralcea leptophylla, Stanleya pinnata, Amsonia tomentosa, Sphaeralcea parvifolia, Abronia fragrans*, and *Chamaesyce fendleri*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association typically occurs on sideslopes in the Inner Canyon (particularly in Marble Canyon) at 950 to 1300 m (3225-4275 feet) elevation, but can be found as high as 1700 m (5550 feet). It primarily occurs on steep (30-40 degrees), south- to east-facing slopes, but also occasionally occurs on gentler slopes (3-10 degrees). Soils are well- to rapidly-drained silty or sandy loams. The underlying geology can vary from limestone to sandstone or less frequently shale. Rocks (52%) and gravel (30%) strongly dominate ground cover. A single stand was sampled from a similar environment in the Western Grand Canyon.

Global Environment: This sparsely vegetated association occurs on a broad range of depositional and erosional landforms, including alluvial fans, benches, dunes, canyon bottoms, stream terraces, ledges, badlands, canyon rims, colluvial slopes, toeslopes, hillsides, ridges, mesas, and plateaus. Slopes range from flat to steep (0-60% slopes) on all aspects at elevations from 1183 to 1603 m. Substrates vary from rapidly drained clay soils to sand derived from colluvium or alluvium, riverine and basaltic cobbles, and sandstone bluffs. Bare soil or gravel cover most of the unvegetated surface, with lesser cover by litter, large rocks and biological soil crusts.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the dominance of *Ephedra torreyana* (5-7%) in the short-shrub layer. Tall shrubs are nearly non-existent. Along with *Ephedra torreyana*, the short-shrub layer typically includes *Atriplex canescens* (1-3%). *Opuntia basilaris* (1%) is the most frequent component of a relatively sparse dwarf-shrub layer. *Atriplex confertifolia* (5%) rarely occurs but can occupy significant cover when it does. The native *Muhlenbergia porteri* (1%) and *Dasyochloa pulchella* (up to 1%) sometimes occur in the graminoid understory (5%); however, this stratum is typically dominated by non-natives including *Bromus rubens* (2%) and sometimes *Bromus tectorum* (5%). *Tiquilia*

latior, Thymophylla pentachaeta, Cryptantha spp., and *Machaeranthera pinnatifida* frequently occur at low individual covers in the forb layer (4%). Based upon the 16 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

Global Vegetation: Total vegetation cover ranges from less than 1 to 17% and is characterized by sparsely distributed shrubs. The typical dominant species is *Ephedra torreyana* with between 1 and 5% cover, usually accompanied by *Atriplex confertifolia* and/or *Atriplex canescens* which may be absent, codominant or occasionally dominant. Other associated shrubs never contribute more than 5% cover and include *Artemisia filifolia, Ericameria nauseosa, Coleogyne ramosissima, Eriogonum corymbosum, Gutierrezia sarothrae, Xylorhiza tortifolia, Opuntia erinacea, Opuntia polyacantha, Fallugia paradoxa, Gutierrezia microcephala*, and *Sclerocactus whipplei*. Herbaceous species can be few to diverse and contribute only sparse to low cover. Graminoids commonly present include *Pleuraphis jamesii, Achnatherum hymenoides, Muhlenbergia porteri*, and *Bromus tectorum*. Forbs are highly variable in composition and include *Eriogonum inflatum, Tiquilia latior, Sphaeralcea leptophylla, Stanleya pinnata, Amsonia tomentosa, Sphaeralcea parvifolia, Abronia fragrans*, and *Chamaesyce fendleri*. Biological soil crust cover is variable, with some stands having none, but cover can be as high as 59%.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex canescens*, *Atriplex confertifolia*, *Bromus rubens*, *Bromus tectorum*, *Dasyochloa pulchella*, *Ephedra torreyana*, *Machaeranthera pinnatifida*, *Muhlenbergia porteri*, *Opuntia basilaris*, *Thymophylla pentachaeta*, *Tiquilia latior*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Psorothamnus thompsoniae* (G3?), *Tiquilia latior* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High); **Other**: *Ericameria nauseosa* var. *juncea* (G5T3T4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (CEGL001288) also supports both *Ephedra torreyana* and *Atriplex canescens*; however, *Ephedra torreyana* is not dominant in the short-shrub layer of this community as it is in *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801).
Global Similar Associations:

- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)
- *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (CEGL001288) also supports both *Ephedra torreyana* and *Atriplex canescens*, but *Ephedra torreyana* is not dominant in the short-shrub layer.
- *Ephedra torreyana - Opuntia basilaris* Shrubland (CEGL005107)
- *Ephedra torreyana* Sparse Vegetation (CEGL002353)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon (primarily from Marble Canyon), and also from a single stand from the Western Grand Canyon. In the Inner Canyon, it was sampled from

near 24-Mile Rapids, South Canyon, North Canyon, Rider Canyon, near Temple Butte, Tanner Canyon, and Red Canyon; and in the Western Grand Canyon, it was sampled from near the Dome.
Nations: US
States/Provinces: AZ, NM, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Chaco Culture, Glen Canyon, Grand Canyon, Wupatki)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (16 plots): GRCA.01024, GRCA.01540, GRCA.02042, GRCA.02043, GRCA.02047, GRCA.02048, GRCA.02049, GRCA.02050, GRCA.02528, GRCA.03019, GRCA.03039, GRCA.03043, GRCA.03533, GRCA.04550, GRCA.04551, GRCA.04602.
Local Description Authors: R. Meszaros
Global Description Authors: M.E. Hall
References: Coles et al. 2003, Hansen et al. 2004b, Reid and Hall 2010, Salas et al. 2011, Western Ecology Working Group n.d.

Ephedra torreyana - Opuntia basilaris Shrubland

Torrey's Joint-fir - Beavertail Prickly-pear Shrubland
Identifier: CEGL005107

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Colorado Plateau Blackbrush - Mormon-tea Shrubland (G312)
Association	*Ephedra torreyana - Opuntia basilaris* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is currently described from Grand Canyon National Park in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on sideslopes at 900 to 1000 m (2900-3275 feet) elevation, but can be found as high as 1125 m (3675 feet). It primarily occurs on moderately steep gradients (20-30 degrees) of south- to east-facing slopes, but is also occasionally found on gentler slopes (10-18 degrees). Soils are well- to rapidly-drained silty or sandy loams that rarely contain clay. The underlying geology is usually limestone or less frequently sandstone. Vegetation is characterized by the codominance of the short shrub *Ephedra torreyana* (5-7%) and the dwarf-shrub *Opuntia basilaris* (3-5%). Tall shrubs are absent. The short-shrub layer sporadically includes *Yucca elata*, and the dwarf-shrub layer regularly includes *Echinocactus polycephalus*. *Bromus rubens* and *Dasyochloa pulchella* are the most frequent components of the graminoid understory, and in some stands, the cover of *Bromus rubens* can be significantly higher. *Tiquilia latior*, *Thymophylla pentachaeta*, and *Machaeranthera pinnatifida* all commonly occur in the sparse forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes in the Marble Canyon region of the Inner Canyon. It usually occurs at 900 to 1000 m (2900-3275 feet) elevation, but can be found as high as 1125 m (3675 feet). It primarily occurs on moderately steep gradients (20-30 degrees) of south- to east-facing slopes, but is also occasionally found on gentler slopes (10-18 degrees) as well. Soils are well- to rapidly-drained silty or sandy loams that rarely contain clay. The underlying geology is usually limestone or less frequently sandstone. Gravel (35%), rocks (35%), and bare soil or sand (16%) are the major components of the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the codominance of the short shrub *Ephedra torreyana* (5-7%) and the dwarf-shrub *Opuntia basilaris* (3-5%). Tall shrubs are non-existent in this association. Along with *Ephedra torreyana*, the short-shrub layer

sporadically includes *Yucca elata* (1%). Besides *Opuntia basilaris*, the only other dwarf-shrub that occurs regularly is *Echinocactus polycephalus* (1%). *Bromus rubens* (3%) and *Dasyochloa pulchella* (1%) are the most frequent components of the graminoid understory (5%), and in some stands, the cover of *Bromus rubens* can be significantly higher. Total forb cover averages 4%; *Tiquilia latior*, *Thymophylla pentachaeta*, and *Machaeranthera pinnatifida* all commonly occur at about 1% cover each. Based upon the 10 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Dwarf-shrub	*Opuntia basilaris*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Dasyochloa pulchella*, *Echinocactus polycephalus*, *Ephedra torreyana*, *Machaeranthera pinnatifida*, *Opuntia basilaris*, *Thymophylla pentachaeta*, *Tiquilia latior*, *Yucca elata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/Medium)
Global: Vulnerable: *Echinocactus polycephalus* (G3G4), *Tiquilia latior* (G3G4); **Invasive/Exotic**: *Bromus rubens* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801) *Ephedra torreyana* also dominates this community and *Opuntia basilaris* is present in some stands as well; however, *Opuntia basilaris* occurs much less frequently and with lower cover than in *Ephedra torreyana - Opuntia basilaris* Shrubland (CEGL005107).
Global Similar Associations:

- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801) is also dominated by *Ephedra torreyana*, but *Opuntia basilaris* occurs much less frequently and with lower cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known chiefly from the Marble Canyon region of the Inner Canyon; it was sampled from Soap Creek, the vicinity of Vasey's Paradise, and near North Canyon. A single stand was sampled in the Inner Canyon from Tanner Canyon.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (10 plots): GRCA.01532, GRCA.01533, GRCA.02044, GRCA.02046, GRCA.02529, GRCA.02530, GRCA.03020, GRCA.03034, GRCA.03532, GRCA.03535.

Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

G311. Intermountain Semi-Desert Grassland

Aristida purpurea Herbaceous Vegetation

Purple Three-awn Herbaceous Vegetation
Identifier: CEGL005800

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Aristida purpurea* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This purple three-awn grassland association occurs widely in the interior western U.S. and the western Great Plains. This semi-arid grassland is found on a variety of sites, such as western shortgrass prairie, intermountain basins, alluvial flats, and a Pleistocene lake bench. Substrates are often sandy or gravelly soils. The vegetation is characterized by the dominance of *Aristida purpurea* in a sparse to open grass layer. Associates vary depending on the pre-disturbance community, but frequently include other dry, grazing-tolerant grasses such as scattered *Bouteloua gracilis, Poa secunda*, or *Sporobolus cryptandrus*; occasional shrubs that my be present include *Ericameria nauseosa* or *Gutierrezia sarothrae* that are common in disturbed areas, or remnants of late-seral communities such as *Artemisia tridentata ssp. tridentata*. Introduced species may be common, such as *Bromus tectorum* in disturbed stands.

ENVIRONMENTAL DESCRIPTION

Global Environment: This semi-arid grassland association occurs widely the interior western U.S. and the western Great Plains, but is infrequently sampled because it is associated with disturbance. Stands are reported from a Pleistocene lake bench in northern Utah and alluvial flats in northern Arizona; however, it is found on a variety of sites, including western prairie and intermountain basins. Elevation ranges from 1465-1970 m. Substrates are often sandy or gravelly soils.

VEGETATION DESCRIPTION

Global Vegetation: This generally sparse or open grassland is characterized by the dominance of *Aristida purpurea*. Associates are variable depending on what community existed before disturbance, but frequently include low cover of other dry, grazing-tolerant grasses. *Bouteloua gracilis, Poa secunda*, or *Sporobolus cryptandrus* may be present but do not codominate. Occasional shrubs may include *Ericameria nauseosa* or *Gutierrezia sarothrae* that are common in disturbed areas, or remnants of late-seral communities such as *Artemisia tridentata*. *Yucca* spp. are common on sites with coarse-textured soils. Introduced species may be common, such as *Bromus tectorum, Sisymbrium altissimum*, and *Verbascum thapsus*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Aristida purpurea*

CHARACTERISTIC SPECIES

Global: *Aristida purpurea*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Sisymbrium altissimum* (invasive/exotic),

Verbascum thapsus (invasive/exotic, Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: Stands of this association are strongly dominated by *Aristida purpurea* and are frequently disturbed, either naturally or anthropogenically. Some stands are the result of excessive livestock grazing of other perennial grassland types. This type is likely to occur throughout much of the Colorado Plateau and western Great Plains. Further documentation is needed.
Global Similar Associations:
- *Aristida purpurea var. longiseta - Poa secunda* Herbaceous Vegetation (CEGL001781)
- *Aristida purpurea var. longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001589)
- *Aristida purpurea var. longiseta - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001515)

Global Related Concepts:
- *Yucca glauca / Aristida longiseta* Plant Community (Shaw et al. 1989) **><**

ELEMENT DISTRIBUTION

Global Range: This grassland association is reported from the Colorado Plateau, Great Basin and shortgrass prairie, but likely occurs widely in the semi-arid interior western U.S. and the western Great Plains.
Nations: US
States/Provinces: AZ, CO, NM?, NV, UT
TNC Ecoregions: 11:C, 19:C, 21:C, 26:?, 27:C
USFS Ecoregions (1994/95): 313A:CC, 331F:??, 341A:CC, M313A:CC
Federal Lands: NPS (Golden Spike, Grand Canyon, Walnut Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Coles et al. 2011, Hansen et al. 2004a, Howard 1997a, Peterson 2008, Reid and Hall 2010, Shaw et al. 1989, USFS 1937, Western Ecology Working Group n.d.

***Bouteloua eriopoda - Pleuraphis jamesii* Herbaceous Vegetation**

Black Grama - James' Galleta Herbaceous Vegetation
Black Grama - Galleta Shortgrass Prairie
Identifier: CEGL001751

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Bouteloua eriopoda - Pleuraphis jamesii* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This Colorado Plateau desert grassland has been documented from the upper Rio Puerco watershed in northwestern New Mexico, in north-central Arizona and southeastern Utah, and extends south to central New Mexico at Sevilleta National Wildlife Refuge. Stands occur on flat to gently sloping plains, basin floors, mesatops, and less often on steeply sloping mesa sides. Substrates are variable and include loam to clay-loam soils derived from basalt outcrop, shale, clay and sandstone, and coarser textured soils derived from black cinders and sandstone. *Bouteloua eriopoda* and *Pleuraphis jamesii (= Hilaria jamesii)* dominate the low to moderate herbaceous cover. Associates include low cover of *Aristida purpurea, Bouteloua gracilis, Hesperostipa neomexicana (= Stipa*

neomexicana), Muhlenbergia porteri, Sporobolus airoides, and *Sporobolus cryptandrus*. Shrubs are few and scattered and may include *Atriplex canescens, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa*, and *Gutierrezia sarothrae*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This Colorado Plateau desert grassland has been documented from the upper Rio Puerco watershed in northwestern New Mexico, in north-central Arizona, and from a single station in southeastern Utah. Elevations range from 1455-1830 m (4770-6000 feet) at the southern end of the range and at 1275 m on a south-facing slope in Utah. Stands occur on flat to gently sloping plains, basin floors, or steeply sloping mesa sides. Substrates are variable and include weakly developed Entisols and Entisol-Mollisol complexes often with loam to clay-loam soils derived from basalt outcrop, shale, clay and sandstone, and coarser textured soils derived from black cinders and sandstone.

VEGETATION DESCRIPTION

Global Vegetation: This association is characterized by *Bouteloua eriopoda* and *Pleuraphis jamesii (= Hilaria jamesii)* codominating an open to moderately dense perennial graminoid layer. Associates include low cover of *Aristida purpurea, Bouteloua gracilis, Hesperostipa neomexicana (= Stipa neomexicana), Muhlenbergia porteri, Sporobolus airoides, Sporobolus cryptandrus*, and *Sporobolus flexuosus*. Forb cover and diversity are low. Scattered shrubs and dwarf-shrub may be present, including *Atriplex canescens, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa*, and *Gutierrezia sarothrae* (Francis 1986). The presence of *Bouteloua eriopoda* and *Muhlenbergia porteri*, and its occurrence at Sevilleta National Wildlife Refuge, suggests that this grassland is transitional to Chihuahuan Desert grasslands that begin over 100 miles to the south.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua eriopoda, Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Global: *Bouteloua eriopoda*, *Pleuraphis jamesii*

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (14-Nov-2005). This transitional Colorado Plateau-Chihuahuan Desert grassland has had its range significantly reduced by the impacts of livestock grazing over the last 150 years, particularly during years of extreme drought. Few examples remain that have not been significantly impacted by grazing and altered fire regimes. Overall, high-quality occurrences are not likely to exceed 50 in number. Inventory of potential occurrences in both the Chihuahuan Desert and Colorado Plateau ecoregions is needed. The range of this association is not likely to extend much further north than southern Utah, as *Bouteloua eriopoda* is known only from the Colorado River drainage (including the Virgin River) south of Moab.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: Limited quantitative documentation exists for this type, outside of plots taken at Capitol Reef National Park, near the northern end of the association's range.
Global Similar Associations:
- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777)

Global Related Concepts:
- *Bouteloua eriopoda-Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Gutierrezia sarothrae / Bouteloua eriopoda - Hilaria jamesii* Plant Community (Francis 1986) ?
- *Hilaria jamesii - Bouteloua eriopoda* PA (Muldavin et al. 1998d) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: This Colorado Plateau association is known from the upper Rio Puerco watershed in northwestern New Mexico, Wupatki National Monument and Petrified Forest National Park in north-central Arizona, and scattered small sites at Capitol Reef National Park in southeastern Utah. It extends south to the Sevilleta National Wildlife Refuge in central New Mexico in the transition zone with the northern Chihuahuan Desert.
Nations: MX?, US
States/Provinces: AZ, CO:SU, NM:S3, UT
TNC Ecoregions: 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 321A:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Grand Canyon, Petrified Forest, Wupatki); USFWS (Sevilleta)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: E. Muldavin, mod. K.A. Schulz and J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Coles et al. 2003, Driscoll et al. 1984, Francis 1986, Hansen et al. 2004b, Muldavin et al. 1998d, Reid and Hall 2010, Romme et al. 1993, Thomas et al. 2009a, Western Ecology Working Group n.d.

Bouteloua eriopoda Coconino Plateau Shrub Herbaceous Vegetation

Black Grama Coconino Plateau Shrub Herbaceous Vegetation
Identifier: CEGL002787

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This shrub herbaceous association is currently only known from Wupatki National Monument in Arizona, and the following description is based on occurrences there. Additional information will be added as it becomes available. Elevation ranges from 1450-1770 m (4757-5807 feet). The substrate consists mainly of limestone cobbles, gravel, and bedrock with black cinders and clay loam soils. A few examples are also characterized by sand and sandstone. The slope varies from gentle to steep (0-20%). Total vegetation cover ranges from 21-46%. The total species diversity ranges from 4-16 species in the 21 sampled plots. The shrub layer is not dominated by a single species; rather, several species characteristic of the Colorado Plateau can dominate or codominate in the shrub canopy depending on abiotic factors and land-use history. These shrubs include *Atriplex confertifolia, Atriplex canescens, Ephedra viridis, Ericameria nauseosa* , and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Bouteloua eriopoda*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association typically occurs on sideslopes and rarely on valley bottoms in the Inner Canyon and Western Grand Canyon. It usually occurs from approximately 1225 to 1550 m (4000-5050 feet) elevation, but can be found as low as 1000 m (3250 feet). It chiefly occurs on gentle slopes (2-10 degrees), but can also occur on steeper gradients (20-30 degrees). Soils are well- to rapidly-drained sandy or silty loams; when unobscured, the underlying geology is typically limestone. Gravel (43%), rocks (16%), bare soil (15%), and litter (15%) are the most common components of the ground cover; moss (2%) and cryptogamic soil crust (2%) are also relatively common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This community is characterized by the dominance of the perennial grass *Bouteloua eriopoda* (15-20%), but shrubs also are present with significant cover. The short-shrub layer is dominated by *Ephedra fasciculata* (7-10%), which occurs regularly. *Encelia resinifera* (up to 1%) also occurs sporadically. A sparse dwarf-shrub layer (4%) of *Gutierrezia sarothrae* (3%), *Agave utahensis* (up to 1%) and

Echinocereus engelmannii (up to 1%) occurs occasionally. Along with *Bouteloua eriopoda*, the graminoid layer frequently includes *Hesperostipa comata* (3%), *Pleuraphis jamesii* (2%), and *Bromus rubens* (1%). *Eriogonum inflatum, Gilia* sp., *Plantago patagonica*, and *Erodium cicutarium* are frequent components of a relatively sparse forb understory (2%). Based upon the 6 stands sampled, this association hosts average diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra fasciculata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua eriopoda*

Global

Stratum	Lifeform	Species
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Shrub/sapling (tall & short)	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Short shrub/sapling	Dwarf-shurb	*Ephedra viridis, Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua eriopoda*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua eriopoda*, *Bromus rubens*, *Echinocereus engelmannii*, *Encelia resinifera*, *Ephedra fasciculata*, *Eriogonum inflatum*, *Gutierrezia sarothrae*, *Hesperostipa comata*, *Plantago patagonica*, *Pleuraphis jamesii*
Global: *Atriplex canescens*, *Atriplex confertifolia*, *Bouteloua eriopoda*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation (CEGL001748) is also dominated by *Bouteloua eriopoda*; however, there is a codominant component of *Bouteloua gracilis* that is lacking in *Bouteloua eriopoda* Coconino Plateau Shrub Herbaceous Vegetation (CEGL002787).
Global Similar Associations:

- *Bouteloua eriopoda - Bouteloua gracilis* Herbaceous Vegetation (CEGL001748) is also dominated by *Bouteloua eriopoda*; however, it has a codominant component of *Bouteloua gracilis*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from near Freya Castle, Phantom Creek, and Royal Arch Creek; and from the Western Grand Canyon, where it was sampled from Tuckup Canyon and the "Hook" near the Grand Wash Cliffs.
Global Range: This association is currently only known from Wupatki National Monument in Arizona. Additional range information will be added as it becomes available.

Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313D:CC
Federal Lands: NPS (Grand Canyon, Wupatki)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (6 plots): GRCA.01105, GRCA.01576, GRCA.01598, GRCA.02005, GRCA.04600, GRCA.04612.
Local Description Authors: R. Meszaros
Global Description Authors: Hansen et al., mod. M.J. Russo
References: Coles et al. 2003, Hansen et al. 2004b, Reid and Hall 2010, Western Ecology Working Group n.d.

Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation

Blue Grama - James' Galleta Herbaceous Vegetation
Blue Grama - Galleta Shortgrass Prairie
Identifier: CEGL001759

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: These grasslands occur on alluvial flats, mesas and plains in the semi-arid southwestern Great Plains and the Colorado Plateau in southeastern Colorado, New Mexico, northern Arizona and southern Utah. Elevation ranges from 1625-2230 m (5330-6110 feet) in central and western New Mexico and on the Colorado Plateau and extends below 1525 m (5000 feet) in the southwestern Great Plains. Sites are flat to undulating, with shallow to moderately deep, loam to silty clay loam-textured soils. In western New Mexico, it is typically found on gently rolling, weathered, lava plateaus with substrates derived from volcanic basalt, but occasionally on gentle sideslopes of low hills on alluvium derived from sandstone. The ground surface is characterized by scattered bunch grasses intermixed with exposed soil and litter; there may also be a strong component of gravel and rock. Stands are codominated by the graminoids *Bouteloua gracilis* and *Pleuraphis jamesii (= Hilaria jamesii)*. These short and medium-tall perennial bunch grasses may form a sod-like ground cover with patches of bare ground, especially where grazing by livestock encourages a prostrate growth form. Canopy cover is relatively sparse to moderately dense (20-80% cover). Other grasses include *Buchloe dactyloides, Muhlenbergia torreyi, Sporobolus cryptandrus, Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii, Hesperostipa comata (= Stipa comata)*, or *Hesperostipa neomexicana (= Stipa neomexicana)*. Forb cover is generally sparse but may be diverse. Characteristic species include *Cryptantha* spp., *Grindelia squarrosa, Machaeranthera pinnatifida, Ratibida* spp., *Sphaeralcea coccinea*, and *Zinnia grandiflora*. Scattered dwarf-shrubs, shrubs and cacti, such as *Artemisia bigelovii, Artemisia frigida, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata (= Cylindropuntia imbricata), Opuntia polyacantha, Prosopis glandulosa* (southern stands), and *Yucca glauca*, are not uncommon. Codominance of *Bouteloua gracilis* and *Pleuraphis jamesii* distinguishes this vegetation from several closely related grasslands. Seedling and sapling *Juniperus monosperma* and *Pinus edulis*, when present, are scattered in these grasslands, and shrubs are scarce (making up less than 2% of cover) and most commonly represented by *Gutierrezia sarothrae* and *Ericameria nauseosa*.

ENVIRONMENTAL DESCRIPTION

Global Environment: These grasslands occur on alluvial flats, mesas and plains in the semi-arid southwestern Great Plains and the Colorado Plateau in southeastern Colorado, New Mexico, northern Arizona and southern Utah. Elevation ranges from 1625-1860 m (5330-6110 feet) in central and western New Mexico and on the Colorado Plateau and extends below 1525 m (5000 feet) in the southwestern Great Plains. Sites are flat to undulating, with shallow to moderately deep, loam to silty clay loam-textured soil. In western New Mexico, it is typically found on

gently rolling, weathered, lava plateaus with substrates derived from volcanic basalt, but occasionally on gentle sideslopes of low hills on alluvium derived from sandstone. The ground surface is characterized by scattered bunch grasses intermixed with exposed soil and litter; there may also be a strong component of gravel and rock.

VEGETATION DESCRIPTION

Global Vegetation: This association is characterized by an open to moderately dense (20-80% cover) herbaceous layer that is codominated by the graminoids *Bouteloua gracilis* and *Pleuraphis jamesii (= Hilaria jamesii)*. These short and medium-tall perennial bunch grasses may form a sod-like ground cover with patches of bare ground, especially where grazing by livestock encourages a prostrate growth form. Other grasses include *Buchloe dactyloides, Muhlenbergia torreyi, Sporobolus cryptandrus, Aristida* spp., *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii, Hesperostipa comata (= Stipa comata)*, or *Hesperostipa neomexicana (= Stipa neomexicana)*. Forb cover is generally sparse but may be diverse. Characteristic species include *Cryptantha* spp., *Grindelia squarrosa, Machaeranthera pinnatifida, Ratibida* spp., *Sphaeralcea coccinea*, and *Zinnia grandiflora*. Scattered dwarf-shrubs, shrubs and cacti, such as *Artemisia bigelovii, Artemisia frigida, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia imbricata (= Cylindropuntia imbricata), Opuntia polyacantha, Prosopis glandulosa* (southern stands), and *Yucca glauca* are not uncommon. Codominance of *Bouteloua gracilis* and *Pleuraphis jamesii* distinguishes this vegetation from several closely related grasslands. Seedling and sapling *Juniperus monosperma* and *Pinus edulis*, when present, are scattered in these grasslands, and shrubs are scarce (making up less than 2% of cover) and most commonly represented by *Gutierrezia sarothrae* and *Ericameria nauseosa*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua gracilis, Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Global: *Bouteloua gracilis*

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (15-Oct-1999). Historically, most sites supporting this association have been converted to dryland or irrigated cropland in the plains. Overgrazing by livestock has changed some of these grasslands to sparse desert grasslands or desert scrubland. In addition, the reduction of fire frequency, either by livestock grazing the fine fuels that carry fires or by active suppression, has allowed the invasion of trees and shrubs. Loss to urban development has been significant in recent decades. Transformation to pinyon/juniper woodlands or desert grassland/scrubland, and urban development continue the negative trend. More classification and survey work are needed to distinguish this type from closely related grasslands over its relatively broad geographic range, and to inventory its extent and condition.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: More classification and survey work is needed to distinguish this type from closely related grasslands over its relatively broad geographic range, and to inventory its extent and condition.
Global Similar Associations:

- *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760)
- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777)

Global Related Concepts:

- *Bouteloua gracilis - Hilaria jamesii* Plant Community (Shaw et al. 1989) =
- *Bouteloua gracilis / Hilaria jamesii* Plant Association (Johnston 1987) =
- *Bouteloua gracilis / Hilaria jamesii* Plant Community (Francis 1986) =
- *Bouteloua gracilis-Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Hilaria jamesii - Bouteloua gracilis* Plant Association (Muldavin et al. 1998d) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: These grasslands are found in the southern shortgrass steppe of southeastern Colorado and eastern New Mexico, and alluvial flats and mesas of the Colorado Plateau in New Mexico and Utah, south to Sevilleta National Wildlife Refuge and Salinas Pueblo Missions National Monument in central New Mexico. It is also report from Utah and Wyoming.
Nations: US
States/Provinces: AZ, CO:S3, NM:SU, UT:S2S4, WY
TNC Ecoregions: 19:C, 21:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, M313B:CC
Federal Lands: NPS (Capitol Reef, El Malpais, Grand Canyon, Petrified Forest, Salinas Pueblo Missions); USFWS (Sevilleta)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz, mod. K.S. King and M.E. Hall
References: Beavis et al. 1982, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Dick-Peddie 1993, Driscoll et al. 1984, Francis 1986, Johnston 1987, Muldavin et al. 1998d, Muldavin et al. 2011a, Muldavin et al. 2011c, Reid and Hall 2010, Rogers 1953, Romme et al. 1993, Shaw et al. 1989, Soil Conservation Service 1978, Terwilliger et al. 1979a, Thomas et al. 2009a, Van Pelt 1978, WNDD unpubl. data, Western Ecology Working Group n.d.

***Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation**

Blue Grama - Sand Dropseed Herbaceous Vegetation
Blue Grama - Sand Dropseed Shortgrass Prairie
Identifier: CEGL001761

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This herbaceous association is currently only known from El Malpais National Monument in New Mexico, and the following description is based on occurrences there. Additional information will be added as it becomes available. This association occurs between 2085 and 2200 m (6840-7230 feet) elevation on a variety of landforms including valley bottoms, gentle shoulders or footslopes of low hills, and occasionally kipukas and depositional areas in lavaflows. Substrates are mainly derived from alluvium or sometimes from volcanics or sandstone formations. Typically, ground surface cover is dominated by soil, with gravel, rock, litter, and coarse woody debris as minor components. In some areas, pocket gopher mounds and kangaroo rat burrows have disturbed the soil. In this shortgrass prairie grassland, graminoids dominate (generally >25% cover) with *Bouteloua gracilis* and *Sporobolus cryptandrus* the most frequent and abundant species. Forbs are scattered and most frequently include *Sphaeralcea coccinea* and *Artemisia carruthii*, along with the non-native *Salsola tragus*. Among trees, *Juniperus monosperma* and *Pinus edulis* are scattered about this grassland association, along with the shrubs *Ericameria nauseosa* and *Gutierrezia sarothrae*, but seldom exceed 1 or 2% cover.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association predominantly occurs on low- to moderate-gradient (5-20 degrees) sideslopes that occur on the plateau of the eastern portion of the South Rim. It seems to occur from approximately 2025 to 2050 m (6670 to 6730 feet) elevation, but may have a wider elevational range. Soils are well-drained silt loams that usually overlie limestone bedrock. Ground cover tends to be dominated by litter (40%), gravel (30%), bare soil (17%), and rocks (9%).
Global Environment: This association is only known from El Malpais National Monument, therefore no global information is currently available.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association does not support any trees or tall shrubs and hosts fairly sparse short- and dwarf-shrub layers (typically up to 5% total shrub cover). *Atriplex canescens* (2%) and *Ephedra viridis* (1%) are typical members of the short-shrub layer, while *Gutierrezia sarothrae* (1%), *Opuntia macrorhiza* (1%), and *Yucca baccata* (1%) usually occur in the dwarf-shrub layer. *Bouteloua gracilis* (10-15%) and *Sporobolus cryptandrus* (5-10%) are the major components of the graminoid layer (25%) which dominates this community. *Bromus tectorum* (1%) also usually occurs with fairly low cover. A poorly-developed forb layer exists, with *Descurainia* sp. (up to 1%), *Plantago patagonica* (1%), and *Erodium cicutarium* (up to 1%) occurring most frequently. Based upon the 2 stands sampled, this association hosts average species diversity for Grand Canyon plant communities, with 20 species per 400-square-meter plot

Global Vegetation: This association is only known from El Malpais National Monument, therefore no global information is currently available.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Forb	*Plantago patagonica*
Herb (field)	Graminoid	*Bouteloua gracilis, Sporobolus cryptandrus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex canescens*, *Bouteloua gracilis*, *Bromus tectorum*, *Enneapogon desvauxii*, *Ephedra viridis*, *Erodium cicutarium*, *Gutierrezia sarothrae*, *Opuntia macrorhiza*, *Plantago patagonica*, *Sporobolus cryptandrus*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNRQ (23-Feb-1994).

CLASSIFICATION

Status: Standard

Classification Confidence: 3 - Weak

Grand Canyon National Park Comments: *Atriplex canescens* Shrubland (CEGL001281) occurs within a larger matrix of grassland and sparse shrubland types, including *Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001761). In some areas, the distinction between this grassland type and *Atriplex canescens* Shrubland may be vague. Typically, a threshold shrub cover of 10% distinguishes the communities.

Global Similar Associations:

- *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760)
- *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation (CEGL002691)

Global Related Concepts:

- *Bouteloua gracilis - Sporobolus cryptandrus* PA (Muldavin and Mehlhop 1992) =
- *Bouteloua gracilis-Sporobolus cryptandrus* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, where it was sampled from the plateau east of Palisades of the Desert.

Global Range: This association is currently only known from El Malpais National Monument in New Mexico. Additional range information will be added as it becomes available.

Nations: MX?, US

States/Provinces: AZ, NM
TNC Ecoregions: 19:C, 21:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 321A:CC
Federal Lands: NPS (El Malpais, El Morro, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (2 plots): GRCA.02056, GRCA.02058.
Local Description Authors: R. Meszaros
Global Description Authors: A. Kennedy, E. Muldavin and A. Cully
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 2011a, Reid and Hall 2010, Salas and Bolen 2010a, Western Ecology Working Group n.d.

Hesperostipa comata - (*Bouteloua eriopoda, Pleuraphis jamesii*) Herbaceous Vegetation

Needle-and-Thread - (Black Grama, James' Galleta) Herbaceous Vegetation
Identifier: CEGL002997

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii)* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This herbaceous association is currently only known from Wupatki National Monument in Arizona, and the following description is based on occurrences there. Additional information will be added as it becomes available. Elevation ranges from 1560-1690 m (5118-5545 feet). The substrate always consists of a black cinder component, with intermixed basaltic cobbles, lavaflow, clay, and limestone soils. The slope is often flat; however, it ranges from 0-25%. Total vegetation cover ranges from 25-60% with 0-20% in the shrub layer and 22-52% in the herbaceous layer. The total species diversity ranges from 5-17 species within the 21 samples. The shrub layer is not dominated by a single species; however, *Ericameria nauseosa* is often present. *Hesperostipa comata* is dominant. *Bouteloua eriopoda* and *Pleuraphis jamesii* both frequently occur within this association, but do not need to be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs in the Inner Canyon and Western Grand Canyon on low-level valley bottoms and lower sideslopes and toeslopes. It typically occurs at 1275 to 1450 m (4150-4750 feet) elevation, on gentle slopes (2-8 degrees), across various aspects. It tends to favor rapidly-drained sandy soils. Bare soil (usually 50% or greater), gravel (10-30%), and litter (10-35%) are dominant components of the ground cover. This association often occurs within matrices of other graminoid-dominated or more often shrub-dominated communities.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This herbaceous community lacks tree and tall shrub cover. Scattered short shrubs (3%) occur in most stands and include *Yucca baccata* most frequently, but also occasionally include *Ephedra fasciculata, Atriplex canescens*, and *Ericameria nauseosa*. A similarly dense dwarf-shrub stratum (3%) of *Gutierrezia sarothrae* and *Opuntia whipplei (= Cylindropuntia whipplei)* occurs in most stands. Occasionally, other small cacti species can occur as well. A well-developed graminoid understory (20-25%) dominated by *Hesperostipa comata* (15%) characterizes this community. *Pleuraphis jamesii* (5%) and *Bouteloua eriopoda* (5%) occur in many, but not all stands, as either codominants or associates. In some stands, *Hesperostipa comata* is overwhelmingly dominant, while in other stands, the three major grass species occur with roughly equal cover. Other native graminoids, including *Elymus elymoides, Aristida purpurea*, and *Vulpia octoflora* are also fairly common at low covers. Various forb species such as *Chaetopappa ericoides* and *Layia glandulosa*, occur in a relatively well-developed forb understory (5%). Based upon the 3 stands sampled, this association hosts average species diversity among plant communities in

Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Yucca baccata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Forb	*Chaetopappa ericoides, Layia glandulosa*
Herb (field)	Graminoid	*Hesperostipa comata*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bouteloua eriopoda, Hesperostipa comata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua eriopoda*, *Gutierrezia sarothrae*, *Hesperostipa comata*, *Pleuraphis jamesii*
Global: *Bouteloua eriopoda*, *Hesperostipa comata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Opuntia whipplei* (state-critically imperiled, G4?); **Invasive/Exotic**: *Bromus rubens* (exotic), *Chorispora tenella* (exotic, Insignificant), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)
Global: Other: *Pleuraphis jamesii* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Hesperostipa comata* Great Basin Herbaceous Vegetation (CEGL001705) occurs on the North Rim mostly in previously burned areas near the canyon rim but does not support either *Bouteloua eriopoda* or *Pleuraphis jamesii* in the understory. *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) occurs on the rims and supports a codominant component of *Muhlenbergia montana* in the understory. It does not support either *Bouteloua eriopoda* or *Pleuraphis jamesii*.
Global Similar Associations:

- *Hesperostipa comata* Great Basin Herbaceous Vegetation (CEGL001705) often occurs in previously burned areas but does not support either *Bouteloua eriopoda* or *Pleuraphis jamesii*.
- *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) supports a codominant component of *Muhlenbergia montana* but does not support either *Bouteloua eriopoda* or *Pleuraphis jamesii*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled in Phantom Creek, and from the Western Grand Canyon, where it was sampled in Toroweap Valley.
Global Range: This association is currently only known from Wupatki National Monument in Arizona. Additional range information will be added as it becomes available.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC
Federal Lands: NPS (Grand Canyon, Wupatki)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (3 plots): GRCA.01599, GRCA.02597, GRCA.03597.
Local Description Authors: K. Christie
Global Description Authors: Hansen et al., mod. M.J. Russo
References: Coles et al. 2003, Hansen et al. 2004b, Reid and Hall 2010, Western Ecology Working Group n.d.

Hesperostipa comata Great Basin Herbaceous Vegetation

Needle-and-Thread Great Basin Herbaceous Vegetation
Identifier: CEGL001705

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Hesperostipa comata* Great Basin Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This semi-arid grassland occurs on the Great Basin and Colorado Plateau and high plateaus of southern Utah, east into the western slope of the southern Rocky Mountains. Stands are found on a variety of sites, such as on point bars, stream terraces, in sand-filled potholes in slickrock washes, on plains, valleys, canyon floors, gentle hillslopes, knolls and bluffs, mesatops, and plateau parks. Sites are generally flat to gently sloping, but occasionally are steep (to 53% slope). Soils are variable and range from sand to silty clay. The unvegetated surface has moderate to high cover of bare soil with sparse to moderate cover of litter. Biological soil crusts are often present with low cover. The vegetation is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the medium-tall, cool-season bunchgrass *Hesperostipa comata*, but it may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii, Poa fendleriana*, or *Sporobolus cryptandrus*, may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated forbs include *Balsamorhiza sagittata, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana*, and species of *Antennaria, Astragalus, Cryptantha, Eriogonum, Gilia*, and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. Common species include *Artemisia tridentata, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha*, and *Symphoricarpos oreophilus*. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of biological soil crusts.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs on the North Rim in areas close to the actual rim. It seems to occur in transitional areas between ponderosa pine and pinyon-juniper woodlands. It occurs on the plateau at approximately 2425 m (7975 feet) elevation, on flat to gentle (2 degrees), south- or south-east-facing slopes. Soils are typically well-drained silty loams. Litter (77%) ubiquitously dominates the ground cover. This association occurs in burned areas in which the canopy layer has completely died as a result of fire. It generally exists within a matrix of live ponderosa pine vegetation types.
Global Environment: This grassland occurs on the Great Basin and Colorado Plateau east into the western slope of the southern Rocky Mountains. Stands are found a variety of sites, such as on point bars, stream terraces, in sand-filled potholes in slickrock washes, on plains, valleys, canyon floors, gentle hillslopes, knolls and bluffs, mesatops, and plateau parks. Sites are generally flat to gently sloping, but occasionally are steep (to 53% slope). Elevation ranges from 1250-2683 m. The unvegetated surface has moderate to high cover of bare soil with sparse to moderate cover of litter. Biological soil crusts are often present with low cover. Soils are variable and include sand, cobbles, sandy, silt and clay loams and silty clay. Common parent materials are sandstones and shale that have been eroded and redistributed in alluvial and eolian deposits, but include Tertiary volcanic rocks. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage *Hesperostipa comata* plants.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association does not support a live tree canopy; however, dead standing *Pinus ponderosa* snags may persist. Likewise, it only supports a very sparse tall-shrub stratum, and many dead and standing *Purshia stansburiana* skeletons may endure. The tall shrub *Quercus gambelii* (2%) and the characteristic short shrub *Ericameria nauseosa* (3%) comprise a fairly sparse layer. *Mahonia repens, Chrysothamnus depressus*, and regenerating *Purshia stansburiana* occupy the dwarf-shrub layer at trace covers. The graminoid layer consists of roughly 35% cover and dominates this plant community; both *Hesperostipa comata* (18%) and *Poa fendleriana* (12%) are major components. *Leptodactylon pungens* (3%) and *Artemisia carruthii* (2%) dominate a relatively sparse forb layer, while other species such as *Asclepias asperula, Castilleja linariifolia, Eriogonum umbellatum, Penstemon barbatus*, and *Tetraneuris acaulis* may be present at trace covers. Based upon the single stand sampled, this association hosts average species diversity for Grand Canyon plant communities, with 22 species per 400-square-meter plot.
Global Vegetation: This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the medium-tall, cool-season bunchgrass *Hesperostipa comata*, but it may also include stands with less than 10% total vegetation cover. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Koeleria macrantha, Leymus salinus, Pleuraphis jamesii, Poa fendleriana, Poa secunda, Sporobolus airoides*, or *Sporobolus cryptandrus*, may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species include *Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana, Balsamorhiza sagittata, Cirsium arizonicum, Cryptantha crassisepala, Hymenopappus filifolius, Machaeranthera canescens, Sphaeralcea coccinea, Vicia americana*, and species of *Antennaria, Astragalus, Eriogonum, Gilia*, and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. *Artemisia tridentata ssp. tridentata, Artemisia tridentata ssp. vaseyana, Atriplex canescens, Chrysothamnus depressus, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia polyacantha, Purshia tridentata, Ribes cereum*, and *Symphoricarpos oreophilus* have been reported from this grassland. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Several other exotic species may be present to abundant and include *Salsola tragus, Bassia scoparia (= Kochia scoparia), Poa pratensis, Sisymbrium altissimum*, and *Tragopogon dubius*. Some stands have high cover of cryptogams on the soil, including *Collema tenax, Tortula ruralis, Buellia papillata*, and *Fulgensia bracteata* (Kleiner and Harper 1977).

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved deciduous shrub	*Quercus gambelii*
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Dwarf-shurb	*Chrysothamnus depressus, Mahonia repens, Purshia stansburiana*
Herb (field)	Forb	*Artemisia carruthii, Leptodactylon pungens*
Herb (field)	Graminoid	Hesperostipa comata, Poa fendleriana

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Hesperostipa comata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Chrysothamnus depressus*, *Ericameria nauseosa*, *Hesperostipa comata*, *Purshia stansburiana*
Global: *Hesperostipa comata*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Arabis crandallii* (G2), *Astragalus anisus* (CO endemic, G2G3), *Cirsium arizonicum* (UT state-rare, G5); **Invasive/Exotic**: *Bassia scoparia* (invasive/exotic, Low), *Bromus tectorum* (invasive/exotic, High), *Poa pratensis* (invasive, Medium), *Salsola tragus* (invasive/exotic), *Sisymbrium altissimum* (invasive/exotic), *Tragopogon dubius* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pinus ponderosa* / *Purshia stansburiana* Woodland (CEGL000854) likely exists on sites before *Hesperostipa comata* Herbaceous Vegetation (CEGL001705) becomes established. Fires remove the tree and shrub canopies from extant woodland types, thus providing the conditions for succession and eventual establishment of *Hesperostipa comata* Herbaceous Vegetation. *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) is somewhat similar in that it has a substantial component of *Hesperostipa comata* in the graminoid layer; however *Muhlenbergia montana* is codominant in this stratum. It does not seem to occur in previously burned areas and exists well inland from the canyon rim. It also lacks shrub components.
Global Comments: This association is composed of relatively pure *Hesperostipa comata* grasslands in the Intermountain West. The similar associations are distinguished by the codominance by other grass species or a shrub layer.
Global Similar Associations:

- *Achnatherum hymenoides* Colorado Plateau Herbaceous Vegetation (CEGL002343)
- *Elymus lanceolatus - Hesperostipa comata* Herbaceous Vegetation (CEGL001746)
- *Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii)* Herbaceous Vegetation (CEGL002997)
- *Hesperostipa comata - Achnatherum hymenoides* Herbaceous Vegetation (CEGL001703)
- *Hesperostipa comata - Carex filifolia* Herbaceous Vegetation (CEGL001700)
- *Hesperostipa comata - Poa secunda* Herbaceous Vegetation (CEGL001704)
- *Muhlenbergia montana - Hesperostipa comata* Herbaceous Vegetation (CEGL001647) has a substantial component of *Hesperostipa comata*, but *Muhlenbergia montana* is codominant.
- *Pseudoroegneria spicata - Hesperostipa comata* Herbaceous Vegetation (CEGL001679)

Global Related Concepts:

- *Stipa comata* dominated grassland (Kleiner and Harper 1977) =
- *Stipa comata*-West (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:V.B.4.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association occurs on the Walhalla Plateau of the North Rim and in areas next to the actual canyon rim. It was sampled by a single classification plot from near Ariel Point.
Global Range: This grassland is found on the west slope of the Colorado Rocky Mountains, on the Colorado Plateau and in the Great Basin in Colorado and Utah, and probably occurs in adjacent states.
Nations: US
States/Provinces: AZ, CO:S2, NV, UT:S2S4, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 18:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341A:CC, 341B:CC, 341C:CC, 342G:??, M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Bryce Canyon, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Natural Bridges, Zion); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.03136.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Coles
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Coles pers. comm., Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2010, Tendick et al. 2011b, Thilenius et al. 1995, Von Loh et al. 2002, Von Loh et al. 2007, WNDD unpubl. data, Western Ecology Working Group n.d.

Pleuraphis jamesii Herbaceous Vegetation

James' Galleta Herbaceous Vegetation
Identifier: CEGL001777

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Pleuraphis jamesii* Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This widespread grassland association is found on alluvial flats, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Landforms vary from mesatops and slopes to basin floors. Stands may be small woodland parks or more extensive grasslands on the plains. Soils in bottomland stands tend to be fine-textured; however, stands also occur on a variety of substrates. Vegetation is characterized by a relatively sparse to moderately dense (10-60% cover) perennial herbaceous layer that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides*, or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes species of *Plantago, Gilia, Lappula*, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present; however, they are not dense enough to form a shrub layer. Some stands have high cover of cryptogams on the soil surface.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association predominantly occurs on moderately steep (20 degrees) sideslopes in the Inner Canyon and Western Grand Canyon, but has been seen in valley bottoms and on ridges. It occurs from approximately 1050 to 1415 m (3500-4650 feet) elevation, but has been found as low as 700 m (2280 feet). Soils are rapidly-drained sandy loams that occasionally contain clay. When unobscured by the soil, the underlying geology is usually limestone, sandstone or shale. The ground cover tends to be dominated by bare soil (25%), litter (23%), rocks (19%) and gravel (19%), with lesser amounts of bedrock (7%) and cryptogamic soil crust (2%).

Global Environment: This widespread grassland association is found on a variety of sites, including alluvial flats, toeslopes, valley floors, benches, hillsides, washes, colluvial slopes, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Elevation ranges from 1220-1930 m, with a few sites on the western edge of the southern Rocky Mountains extending to 2400 m. Landforms vary from mesatops and slopes to basin floors. Sites are flat to moderately steep (up to 53% slope). Stands may be small woodland parks or more extensive on the plains. Soils are variable. In bottomland stands, soils tend to be fine-textured; however, stands also occur on sandy loams derived from sandstone, remnant lavaflow, basaltic cobbles, black or red cinders, or alluvium derived from relict Pleistocene river cobbles, sandstone, sand, or clay soils.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees and tall shrubs are absent from this graminoid-dominated community. A relatively sparse short-shrub layer (3%) occurs, in which *Ephedra torreyana* (1%) and *Encelia resinifera* (1%) are the most frequent components. *Echinocereus* spp. (1%), *Gutierrezia sarothrae* (1%), and *Opuntia polyacantha* (1%) are all commonly seen in the dwarf-shrub stratum (3%). A well-developed graminoid layer, dominated by *Pleuraphis jamesii* (20-25%), characterizes this association. The invasive grass *Bromus rubens* (1%) also occurs regularly. A variety of forbs are common, with *Sphaeralcea grossulariifolia* (up to 1%), *Calochortus flexuosus* (1%), *Erodium cicutarium* (1%), *Eriogonum inflatum* (up to 1%), and *Gilia* sp. (up to 1%) occurring most often. Based upon the 10 stands sampled, this association hosts somewhat above-average species diversity among plant communities in Grand Canyon, with 21 species per 400-square-meter plot.

Global Vegetation: This association is characterized by a sparse to moderately dense perennial herbaceous layer (5-60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Aristida* spp., *Achnatherum hymenoides, Achnatherum speciosum, Bouteloua eriopoda, Bouteloua*

gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides, or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes *Artemisia campestris, Cymopterus newberryi, Eriogonum inflatum, Phacelia crenulata, Plantago patagonica, Sphaeralcea parvifolia*, and *Townsendia annua* along with species of *Gilia, Lappula, Zinnia*, and prickly-pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present, but they are not abundant enough to form a shrub layer. Woody species may include *Artemisia bigelovii, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa, Gutierrezia* spp., *Krascheninnikovia lanata, Tetradymia* spp., and occasional *Juniperus* spp. trees. The widespread introduced annual grass *Bromus tectorum* and several other exotic species, such as *Salsola kali, Bassia scoparia (= Kochia scoparia)*, and *Sisymbrium altissimum*, may be present to abundant, especially on disturbed sites. Some stands have high cover of cryptogams on the soil, including *Collema tenax, Tortula ruralis, Buellia papillata*, and *Fulgensia bracteata*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum speciosum*, *Artemisia ludoviciana*, *Bromus rubens*, *Calochortus flexuosus*, *Encelia resinifera*, *Ephedra torreyana*, *Erodium cicutarium*, *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Pleuraphis jamesii*, *Sphaeralcea grossulariifolia*
Global: *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Salsola tragus* (exotic)
Global: Invasive/Exotic: *Bassia scoparia* (invasive/exotic, Low), *Bromus tectorum* (invasive/exotic, High), *Salsola kali* (invasive/exotic), *Sisymbrium altissimum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pleuraphis rigida* Herbaceous Vegetation (CEGL003051) is found on similar landforms (although typically at lower elevations) and hosts a similar set of common species; however, *Pleuraphis rigida*, and not *Pleuraphis jamesii*, is the dominant graminoid species.
Global Comments: This association is defined by the dominance of *Pleuraphis jamesii* in the graminoid layer without codominance of other grass species or the presence of a shrub layer.
Global Similar Associations:

- *Artemisia nova* / *Pleuraphis jamesii* Shrubland (CEGL001420)
- *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (CEGL001288)
- *Atriplex confertifolia* / *Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex gardneri* / *Pleuraphis jamesii* Dwarf-shrubland (CEGL001441)
- *Atriplex obovata* / *Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001775)
- *Bouteloua eriopoda - Pleuraphis jamesii* Herbaceous Vegetation (CEGL001751)
- *Bouteloua gracilis - Pleuraphis jamesii* Herbaceous Vegetation (CEGL001759)
- *Coleogyne ramosissima* / *Pleuraphis jamesii* Shrubland (CEGL001334)

- *Gutierrezia sarothrae* / *Sporobolus airoides - Pleuraphis jamesii* Shrub Herbaceous Vegetation (CEGL001776)
- *Krascheninnikovia lanata* / *Pleuraphis jamesii* Dwarf-shrubland (CEGL001322)
- *Opuntia polyacantha* / *Pleuraphis jamesii* Shrubland (CEGL002299)
- *Pleuraphis jamesii - Sporobolus airoides* Herbaceous Vegetation (CEGL001778)
- *Pleuraphis rigida* Herbaceous Vegetation (CEGL003051) is found on similar landforms (although typically at lower elevations) and hosts a similar set of common species; however, *Pleuraphis rigida* rather than *Pleuraphis jamesii* is dominant.

Global Related Concepts:
- *Hilaria jamesii* (Bourgeron and Engelking 1994) =
- *Hilaria jamesii* Habitat Type (Francis and Aldon 1983) =
- *Hilaria jamesii* Series (Francis 1986) >
- *Hilaria jamesii* cover type (Collins 1984) =
- *Hilaria jamesii*-dominated stands (Kleiner and Harper 1977) =
- DRISCOLL FORMATION CODE:V.C.5.a. (Driscoll et al. 1984) >
- Pure *Hilaria jamesii* (Cannon 1960) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from Palisades Creek, Kwagunt Creek, near Nankoweap Butte, Clear Creek, and near Tapeats Rapids. It is also known the Western Grand Canyon, where it was sampled from Toroweap Valley and Cottonwood Canyon.
Global Range: This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S.
Nations: US
States/Provinces: AZ:S2, CA, CO:S1, NM, NV, UT:S2S4, WY
TNC Ecoregions: 9:C, 10:C, 11:C, 17:C, 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 322A:CC, 341B:CC, 341C:CC, 341D:CC, 341E:CC, M331E:CC, M331G:CC
Federal Lands: NPS (Arches, Aztec Ruins, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Curecanti, Dinosaur, Glen Canyon, Grand Canyon, Hovenweep, Natural Bridges, Pipe Spring, Wupatki, Zion); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (10 plots): GRCA.01609, GRCA.02537, GRCA.03538, GRCA.03578, GRCA.04557, GRCA.04558, GRCA.04578, GRCA.04609, GRCA.04620, GRCA.04621.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz, mod. J. Coles and G. Kittel
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Cannon 1960, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2003, Coles et al. 2008a, Coles et al. 2008b, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Collins 1984, Driscoll et al. 1984, Francis 1986, Francis and Aldon 1983, Hansen et al. 2004b, Helm 1981, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1972, Kleiner and Harper 1977, Marr et al. 1973a, Nichol 1937, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Salas et al. 2009, Stewart et al. 1940, Tendick et al. 2010, USFS 1937, Utah Environmental and Agricultural Consultants 1973, Von Loh et al. 2002, Von Loh et al. 2007, Von Loh et al. 2008, WNDD unpubl. data, Weaver and Albertson 1956, West et al. 1972, Western Ecology Working Group n.d.

Sporobolus cryptandrus Great Basin Herbaceous Vegetation

Sand Dropseed Great Basin Herbaceous Vegetation
Identifier: CEGL002691

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Grassland (G311)
Association	*Sporobolus cryptandrus* Great Basin Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This plant association is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of major rivers, sandy upper stream terraces along intermittent washes, and on sand deposits on mesas and plains. Elevation ranges from 1226 to 1630 m. Soils are loamy sands and sandy loams derived from alluvium, eolian deposits or sandstone residuum. Sites have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation. The vegetation is dominated by the warm-season perennial graminoid *Sporobolus cryptandrus*. *Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus, Sporobolus giganteus*, or *Equisetum variegatum* frequently occur in low abundance. Low cover of native forbs such as *Sphaeralcea grossulariifolia* or *Chamaesyce fendleri* may be present. The introduced annual grass *Bromus tectorum* and several other exotic species such as *Bromus rigidus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. Occasional *Brickellia* spp. or other shrubs may occur, but they are not dense enough to form a shrub layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This grassland association occurs on plateau lands of the South Rim and Grand Canyon-Parashant National Monument at 1475 to 1850 m (4875-6050 feet) elevation. It typically occurs on gentle slopes (up to 10 degrees), across all aspects, of plateaus, sideslopes, and drainage bottoms. Soils are composed of well-drained sandy loams. Gravel (up to 90%), bare soil (up to 45%), and some herbaceous litter (up to 45%) are the major components of the ground cover. This vegetation type often occurs in openings within shrubland communities.

Global Environment: This grassland is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of large rivers, sandy upper stream terraces along intermittent washes, and on sand deposits on mesas and plains. Elevation ranges from 1226-1630 m. Sites are flat to gently sloping valley bottoms, plains or plateaus. Soils are loamy sands and sandy loams derived from alluvium, eolian deposits or sandstone residuum. Biological soil crusts are generally present and may provide up to 30% cover. Stands have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover is lacking in this herbaceous association; however, scattered short shrubs (6-8%) are commonly present. *Yucca baccata* (2%) and *Coleogyne ramosissima* (2%) occur frequently, while various other species, such as *Atriplex canescens, Artemisia tridentata, Krascheninnikovia lanata, Ephedra* spp., and *Lycium pallidum*, may occur at relatively low covers. The dwarf-shrubs *Gutierrezia sarothrae* (1%), *Opuntia polyacantha* (1%), and *Ferocactus cylindraceus* occur in many stands. Even when a rich variety of shrub species are present, total shrub cover does not exceed 10%. This association is characterized and dominated by a rich and typically diverse graminoid understory (25%) that is dominated by *Sporobolus cryptandrus* (10-15%). *Vulpia octoflora, Dasyochloa pulchella, Bouteloua eriopoda*, and *Muhlenbergia porteri* occur frequently at low individual covers. Other native bunchgrass of the Great Basin, including *Bouteloua gracilis, Pleuraphis jamesii, Achnatherum speciosum*, as well as the Mojave *Pleuraphis rigida*, occasionally occur as associates in the graminoid stratum. Forb cover is relatively low (4%) and may be composed of various species, including *Sphaeralcea grossulariifolia* (1%) and *Allionia incarnata* (1%). Based upon the 3 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

Global Vegetation: This plant association is found on alluvial terraces of large rivers and on sand deposits on mesas and plains. The sparse to moderately dense (10-30% cover) herbaceous layer is characterized by the dominance of the warm-season perennial graminoid *Sporobolus cryptandrus*. *Hesperostipa comata (= Stipa comata), Pleuraphis jamesii, Sporobolus contractus, Sporobolus giganteus*, or *Equisetum variegatum* may occur in low abundance. Low cover of native forbs, such as *Abronia fragrans, Chamaesyce fendleri, Plantago patagonica, Sphaeralcea grossulariifolia, Sphaeralcea parvifolia*, or the succulent *Opuntia polyacantha* may be present. The widespread introduced annual grass Bromus tectorum and several other exotic species such as *Bromus rigidus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. An occasional *Brickellia* spp or other shrubs may occur, but they are not dense enough to form a shrub layer. Moss is important in some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus cryptandrus*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Sporobolus cryptandrus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua eriopoda*, *Dasyochloa pulchella*, *Sporobolus cryptandrus*
Global: *Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Allionia incarnata* (state-vulnerable, G5); **Invasive/Exotic**: *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic), *Salsola tragus* (exotic)
Global: Invasive/Exotic: *Bromus rigidus* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High), *Helianthus annuus* (weedy native), *Salsola kali* (invasive/exotic), *Sisymbrium altissimum* (invasive/exotic), *Tribulus terrestris* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (26-Jul-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001761) also supports a strong *Sporobolus cryptandrus* component and may occur in similar habitats; however, *Bouteloua gracilis* strongly codominates the understory in this association. *Atriplex canescens* Shrubland (CEGL001281) occurs within a larger matrix of grassland and sparse shrubland types, including *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation (CEGL002691). In some areas, the distinction between this grassland type and *Atriplex canescens* Shrubland may be vague. Typically, a threshold shrub cover of 10% distinguishes the communities.
Global Comments: The association is broadly defined to include *Sporobolus cryptandrus*-dominated stands from both riparian and sandy upland sites. This plant association is similar to the threatened, regionally endemic *Sporobolus cryptandrus* plant associations from the Columbia Basin and lower Snake River that have declined significantly due to loss of habitat from hydroelectric dam construction and conversion of land to cultivation. Many of the riparian stands in these associations are in poor condition because of past management and invasion of introduced species.
Global Similar Associations:

- *Aristida purpurea var. longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001589) similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta - Pseudoroegneria spicata*.
- *Aristida purpurea var. longiseta - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001515) similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta*.
- *Artemisia tridentata / Sporobolus cryptandrus - Achnatherum hymenoides* Shrub Herbaceous Vegetation (CEGL001545)
- *Bouteloua gracilis - Sporobolus cryptandrus* Herbaceous Vegetation (CEGL001761) also supports a strong *Sporobolus cryptandrus* component and may occur in similar habitats; however, *Bouteloua gracilis* strongly codominates.
- *Ephedra viridis / Achnatherum hymenoides - Sporobolus cryptandrus* Shrub Herbaceous Vegetation (CEGL001649) sandy site grasslands with shrub layer.
- *Schizachyrium scoparium - Aristida basiramea - Sporobolus cryptandrus - Eragrostis trichodes* Herbaceous Vegetation (CEGL005221) central Great Plains type.
- *Sporobolus cryptandrus - Poa secunda* Herbaceous Vegetation (CEGL001516) similar vegetation and

environmental conditions except codominated by *Poa secunda*.
- *Sporobolus cryptandrus* Shrub Herbaceous Vegetation (CEGL001514) similar vegetation except with significant shrub component.

Global Related Concepts:
- Palustrine (Cowardin et al. 1979) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim to the east of Palisades of the Desert, and from Grand Canyon-Parashant National Monument from the Whitmore area.
Global Range: The association is found on terraces of large rivers in the Colorado Plateau and Uinta Basin and likely occurs elsewhere in the southwestern U.S.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 9:C, 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, 341C:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Dinosaur, Grand Canyon, Grand Canyon-Parashant, Petrified Forest, Zion); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.02236, GRCA.03623, GRCA.04648.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2009a, Cowardin et al. 1979, Reid and Hall 2010, Thomas et al. 2009a, USFS 1937, Von Loh et al. 2002, Western Ecology Working Group n.d.

G310. Intermountain Semi-Desert Shrubland & Steppe

Ericameria nauseosa / *Bouteloua gracilis* Shrub Herbaceous Vegetation

Rubber Rabbitbrush / Blue Grama Shrub Herbaceous Vegetation
Identifier: CEGL003495

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Shrubland & Steppe (G310)
Association	*Ericameria nauseosa* / *Bouteloua gracilis* Shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This shrub herbaceous association occurs on valley floors, swales and alluvial flats in the southern and central part of the Colorado Plateau, southern Rocky Mountains and western New Mexico mountains. Its presence generally indicates disturbance from grazing and/or recent flooding, and it may represent degraded forms of other grassland, shrubland or woodland communities. Stands occupy gentle to moderate slopes (2-13%) between 1635 and 2400 m (5360-7870 feet) elevation. Aspect does not affect the distribution of this association. Litter and bare soil cover most of the unvegetated surface. Parent materials are variable and include sandstones and shale that have eroded and been re-deposited as alluvium or windblown sediments (loess). Soils are well-drained and fine-sandy or silty in texture. Occasionally *Juniperus monosperma* or *Pinus edulis* seedlings, saplings, or mature individuals may be found in these grasslands, but shrubs are the most common woody vegetation. Total vegetation cover ranges from 10 to 65%, roughly equally divided between the shrub and herbaceous layers. The vegetation is characterized by an open short-shrub canopy of *Ericameria nauseosa* that ranges in cover from 5 to 25% and an understory dominated by *Bouteloua gracilis* that ranges in cover from 5 to 35%. Other shrubs may be present with very low cover, including *Tetradymia canescens*, *Atriplex* spp., *Gutierrezia sarothrae*, and *Opuntia polyacantha*. Associated graminoids present include the bunch grasses *Achnatherum hymenoides, Aristida purpurea, Pascopyrum smithii, Pleuraphis jamesii, Sporobolus airoides, Sporobolus cryptandrus*, and *Muhlenbergia pungens*. Only scattered

forbs are present but diversity can be high.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This rubber rabbitbrush association occurs on the South Rim in openings in pinyon-juniper or ponderosa pine / pinyon-juniper communities. It typically occurs at 2150 m (7050 feet) elevation, on the flat or gently sloping plateau, or in the bottom of shallow drainage channels. It often shows preference for xeric, south-facing aspects, and favors silt loam soils. Litter (62%) and bare soil (32%) dominate the ground cover.

Global Environment: This shrub herbaceous association occurs on valley floors, swales and alluvial flats in the central part of the Colorado Plateau, southern Rocky Mountains and western New Mexico mountains. Stands occupy gentle to moderate slopes (2-13%) between 1635 and 2400 m (5360-7870 feet) elevation. Aspect does not control the distribution of this association. Litter and bare soil cover most of the unvegetated surface. Parent materials are variable and include sandstones and shale that have eroded and been re-deposited as alluvium or windblown sediments. Soils are well-drained and fine-sandy or silty in texture.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrub-herbaceous association lacks tree cover, and total shrub cover typically averages 25-30%. *Ericameria nauseosa* ubiquitously dominates the shrub strata, while scattered *Artemisia tridentata, Gutierrezia sarothrae*, and *Krascheninnikovia lanata* can occur at about 1% cover each. Along with the well-developed shrub layer, this association supports a codominant graminoid component (of up to 40% cover), which is dominated by *Bouteloua gracilis* (14%) and *Pascopyrum smithii* (18%). Other grasses, such as *Sporobolus* sp., *Monroa squarrosa* (1%), and the exotic *Bromus tectorum* (1%), may occur in some stands. Various forbs (up to 15% cover total), including *Portulaca oleracea* (sometimes up to 8%), *Chamaesyce fendleri, Chenopodium graveolens, Erigeron divergens, Machaeranthera canescens, Nama dichotomum, Packera multilobata, Polygonum douglasii*, and *Sphaeralcea parvifolia*, are common at 1% cover each. Tree seedlings rarely occur in this community, although *Juniperus osteosperma* seedlings are occasionally present. Based upon the single stand sampled, this association hosts above-average species diversity among Grand Canyon plant communities, with 26 species per 400-square-meter plot. Weedy species account for some of this diversity.

Global Vegetation: Occasionally *Juniperus monosperma* or *Pinus edulis* seedlings, saplings, or mature individuals may be found in these grasslands, but shrubs are the most common woody vegetation. The total vegetation cover ranges from 10 to 65%, roughly equally divided between the shrub and herbaceous layers. The vegetation is characterized by a short-shrub canopy of *Ericameria nauseosa* that ranges in cover from 5 to 25% and an understory dominated by *Bouteloua gracilis* that ranges in cover from 5 to 35%. Other shrubs may be present with very low cover, including *Tetradymia canescens, Atriplex canescens, Atriplex confertifolia, Gutierrezia sarothrae*, and *Opuntia polyacantha*. Associated graminoids present include the bunch grasses *Achnatherum hymenoides, Aristida purpurea, Pascopyrum smithii, Sporobolus airoides, Sporobolus cryptandrus*, and *Muhlenbergia pungens*. Only scattered forbs are present, such as *Chaetopappa ericoides, Ipomopsis longiflora*, and *Senecio spartioides*. Diversity can be high; 17 graminoids and 60 forbs were identified from this association at El Malpais National Monument in western New Mexico.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Forb	*Portulaca oleracea*
Herb (field)	Graminoid	*Bouteloua gracilis, Pascopyrum smithii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Graminoid	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bouteloua gracilis*, *Ericameria nauseosa*, *Pascopyrum smithii*
Global: *Bouteloua gracilis*, *Ericameria nauseosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Apr-2003).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: Former CEGL001738 and CEGL001739 were lumped into this new association; separation of these two types by ssp. of *Ericameria nauseosa* was not supported by the data in Francis (1986).
Global Similar Associations:

- *Ericameria nauseosa* / *Muhlenbergia pungens - Achnatherum hymenoides* Shrub Herbaceous Vegetation (CEGL002921)

Global Related Concepts:

- *Chrysothamnus nauseosus ssp. bigelovii* / *Bouteloua gracilis - Agropyron smithii* Phyto-edaphic Community (Francis 1986) **<**
- *Chrysothamnus nauseosus ssp. graveolens* / *Bouteloua gracilis - Agropyron smithii* Phyto-edaphic Community (Francis 1986) **<**
- *Ericameria nauseosa* / *Bouteloua gracilis* Shrub Herbaceous Vegetation (Muldavin 1987) **?**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, where it was sampled on the plateau south of Papago Point.
Global Range: This association has been documented from widely scattered sites in southern Utah, northern Arizona, from the upper Rio Puerco watershed in northern New Mexico (Francis 1986), El Malpais National Monument in western New Mexico, Petrified Forest National Park in northeastern Arizona, in Utah, and is likely to occur across the central part of the Colorado Plateau.
Nations: US
States/Provinces: AZ, CO, NM, UT
TNC Ecoregions: 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC, M313A:CC, M331F:CC
Federal Lands: NPS (Capitol Reef, El Malpais, El Morro, Grand Canyon, Great Sand Dunes, Petrified Forest, Walnut Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.03215.
Local Description Authors: K. Christie
Global Description Authors: J. Coles and K.A. Schulz, mod. M.E. Hall
References: Clark et al. 2009, Francis 1986, Hansen et al. 2004a, Muldavin 1987, Muldavin et al. 2011a, Reid and Hall 2010, Romme et al. 1993, Salas and Bolen 2010a, Salas et al. 2010b, Thomas et al. 2009a, Western Ecology Working Group n.d.

Ericameria nauseosa / *Pleuraphis jamesii* - (*Hesperostipa comata*) Shrub Herbaceous Vegetation

Rubber Rabbitbrush / James' Galleta - (Needle-and-Thread) Shrub Herbaceous Vegetation
Identifier: CEGL002996

USNVC CLASSIFICATION

Division Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)

Macrogroup Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group Intermountain Semi-Desert Shrubland & Steppe (G310)
Association *Ericameria nauseosa / Pleuraphis jamesii - (Hesperostipa comata)* Shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This shrub herbaceous association is currently only known from Wupatki National Monument in Arizona, and the following description is based on occurrences there. Additional information will be added as it becomes available. This association occurs over a wide range of elevations from 1400-1680 m (4593-5512 feet) and slopes from 0-45%. All examples contain cinder soils with some of them also containing remnant basaltic lavaflow or a limestone component. Total vegetation cover ranges from 25-80% with most of that cover found in the herbaceous layer. The total species diversity ranges from 6-16 species within the 10 sampled plots. The shrub layer is dominated by *Ericameria nauseosa*. *Pleuraphis jamesii* is the dominant understory species. *Hesperostipa comata* is also a frequent but less dominant understory component.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Hesperostipa comata, Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Global: *Hesperostipa comata*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Global: Other: *Ericameria nauseosa* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (29-Aug-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak

ELEMENT DISTRIBUTION

Global Range: This association is currently only known from Wupatki National Monument in Arizona. Additional range information will be added as it becomes available.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC
Federal Lands: NPS (Grand Canyon, Wupatki)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: Hansen et al., mod. M.J. Russo
References: Coles et al. 2003, Hansen et al. 2004b, Reid and Hall 2010, Western Ecology Working Group n.d.

Gutierrezia (*microcephala, sarothrae*) Dwarf-shrubland [Park Special]

(Threadleaf Snakeweed, Broom Snakeweed) Dwarf-shrubland
Identifier: CEPS009523

USNVC CLASSIFICATION

Division Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup Great Basin & Intermountain Dry Shrubland & Grassland (M171)

Group Intermountain Semi-Desert Shrubland & Steppe (G310)
Association *Gutierrezia (microcephala, sarothrae)* Dwarf-shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This dwarf-shrubland association typically occurs on sideslopes but also sometimes occurs in valley bottoms and on plateaus in the Western Grand Canyon and Grand Canyon-Parashant National Monument. It usually occurs at 1100 to 1425 m (3625-4625 feet) elevation, but can be found as high as 1900 m (6200 feet). It is primarily found on flat slopes (0-3 degrees), but may sometimes occur on steeper slopes (up to 15 degrees) as well. Soils are well- to rapidly-drained and vary from loamy sands to silty clays. When unobscured, the underlying geology is typically sandstone. Bare soil (60-80%) strongly dominates the ground cover, but gravel (12%) and rocks (11%) are also common.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees and tall shrubs are essentially lacking in this dwarf-shrubland association; however, scattered *Juniperus osteosperma* (3%) rarely occur. Total shrub cover averages 15-20% in this community which is characterized and dominated by the dwarf-shrub *Gutierrezia sarothrae* (8-12%). In rare stands in which *Gutierrezia sarothrae* is not present (typically at lower elevations), *Gutierrezia microcephala* (12%) takes its place as the dominant species. *Ericameria nauseosa* (2%), *Yucca baccata* (1%), *Acacia greggii* (1%), *Ephedra fasciculata* (1%), and *Coleogyne ramosissima* (1%) all sporadically occur in a fairly sparse short-shrub layer (3%). Along with *Gutierrezia sarothrae*, the dwarf-shrub layer also occasionally includes *Opuntia polyacantha* (up to 1%), and *Opuntia phaeacantha* (8%) infrequently occurs as well. *Bromus rubens, Dasyochloa pulchella*, and *Vulpia octoflora* are the most common members of a sparse graminoid layer (2%), and all occur at low individual covers. Forb cover is similarly sparse, and composition varies among stands. The exotic *Erodium cicutarium* can be seen in most stands at trace covers. Based upon the 6 stands sampled, this association hosts slightly below-average species diversity among plant communities in Grand Canyon, with 17 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Erodium cicutarium*, *Gutierrezia microcephala*, *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: *Gutierrezia (sarothrae, microcephala) - Ephedra* spp. - *Agave utahensis* Shrubland (CEGL005130) is also dominated by *Gutierrezia sarothrae*. However, *Gutierrezia (microcephala, sarothrae)* Dwarf-shrubland (CEPS009523) does not support *Agave utahensis* and contains much less *Ephedra* spp.
Global Similar Associations:

- *Gutierrezia (sarothrae, microcephala) - Ephedra* spp. - *Agave utahensis* Dwarf-shrubland (CEGL005130) is also dominated by *Gutierrezia sarothrae* along with *Agave utahensis* but contains much more *Ephedra* spp.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was

sampled in Whitmore Canyon and near Whitmore Point, near Mollies Nipple, Tuckup Canyon, and the Toroweap Valley; and from Grand Canyon-Parashant National Monument, where it was sampled on the Shivwits Plateau to the east of Mount Dellenbaugh.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (6 plots): GRCA.03595, GRCA.03627, GRCA.04166, GRCA.04587, GRCA.04611, GRCA.04669.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda Shrub Herbaceous Vegetation

Broom Snakeweed - Winterfat - Fourwing Saltbush / Black Grama Shrub Herbaceous Vegetation
Identifier: CEGL001733

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Shrubland & Steppe (G310)
Association	*Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens* / *Bouteloua eriopoda* Shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: Grassland with shrubs and dwarf-shrubs. Total vegetation ground cover is 15-30%. The grasses tend to occur in patches where pockets of soil have accumulated. Characteristic species include *Bouteloua eriopoda, Gutierrezia sarothrae, Krascheninnikovia lanata, Atriplex canescens*, and *Sphaeralcea* sp. Other associated species are *Aristida purpurea var. fendleriana, Coleogyne ramosissima, Pleuraphis rigida (= Hilaria rigida), Scleropogon brevifolius, Lycium andersonii, Achnatherum hymenoides (= Oryzopsis hymenoides)*, and *Dasyochloa pulchella (= Erioneuron pulchellum)*. Found on silty loams derived from Kaibab Limestone.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (13-Nov-1997). This rare grassland association is only found in level swales on the top of the Grand Wash Cliffs in the southwestern Grand Canyon National Park where pockets of silty loam soils derived from Kaibab Limestone accumulate. Level areas with soil are rare at this elevation in this region. Stands are located in a remote part of the park so impacts from visitors are inconsequential. The plant species in this association are highly palatable to livestock. Because of this, they are vulnerable to overgrazing if the livestock are not properly managed. This is not a concern in the park because livestock grazing is not permitted. This grassland association has few exotic plant species and the good condition of the stands should be maintained. Further inventory may locate additional sites outside the park.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This association needs to be reviewed against several new Grand Canyon types. It probably should be archived.
Global Similar Associations:
- *Atriplex canescens* Shrubland (CEGL001281)
- *Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland (CEGL002690)

- *Krascheninnikovia lanata / Pleuraphis jamesii* Dwarf-shrubland (CEGL001322)

Global Related Concepts:
- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Association (Warren et al. 1982) **=**
- *Gutierrezia sarothrae-Ceratoides lanata-Atriplex canescens/Bouteloua eriopoda* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:V.C.2.a. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Global Range: This association is only found on the top of the Grand Wash Cliffs (elevation 1430-1580 m) in the southwestern Grand Canyon National Park where pockets of soil have accumulated on level swales. Level areas are rare at this elevation. Further inventory may locate additional sites outside the park, especially on the Hualapi Indian Reservation.
Nations: US
States/Provinces: AZ:S2
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon?)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

***Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland**

Winterfat / Needle-and-Thread Dwarf-shrubland
Winterfat / Needle-and-Thread Dwarf-shrub Prairie
Identifier: CEGL001327

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Shrubland & Steppe (G310)
Association	*Krascheninnikovia lanata / Hesperostipa comata* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This association is known from the Colorado Plateau in northwestern Colorado and eastern and southeastern Utah and the northwestern Great Plains in northeastern Montana. It has also been reported from Washington and may occur in Saskatchewan. In the Colorado Plateau stands occur on colluvial slopes at around 2000 m elevation and a canyon bottom at 1780 m elevation. Soils are moderately deep and sandy. In northeastern Montana, it is a minor type that occurs on the periphery of badlands and breaks usually on alluvial flats and gently sloping footslopes. Vegetation is characterized by an open to moderate (10-60% cover) dwarf-shrub layer dominated by *Krascheninnikovia lanata* with an open to moderate herbaceous layer dominated by *Hesperostipa comata*. On the Colorado Plateau, other shrubs occurring with minimal cover include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Hesperostipa comata*; other grasses, such as *Bromus tectorum, Poa secunda, Poa fendleriana*, and *Achnatherum hymenoides*, may occur with few forbs. In the northwestern Great Plains, constant associates are *Artemisia frigida, Bouteloua gracilis*, and *Carex filifolia* with *Atriplex nuttallii, Artemisia tridentata, Gutierrezia sarothrae, Koeleria macrantha*, and *Poa secunda*. Forbs such as *Phlox hoodii, Plantago patagonica*, and *Sphaeralcea coccinea* are inconspicuous and contribute little cover. Introduced species *Bromus japonicus, Bromus tectorum*, and *Melilotus officinalis* are often present but not abundant.

ENVIRONMENTAL DESCRIPTION

Global Environment: This association is known from the Colorado Plateau in northwestern Colorado and eastern

Utah and the northwestern Great Plains in northeastern Montana. It has also been reported from Washington and may occur in Saskatchewan. In the Colorado Plateau, stands occur on colluvial slopes at around 2000 m elevation. Exposed soil covers most of the unvegetated surface with low to moderate litter cover. Biological soil crusts have up to 13% cover. Soils include sandy loam and silty clay loam. In northeastern Montana, it is a minor type that occurs on the periphery of badlands and breaks usually on alluvial flats and gently sloping footslopes.

VEGETATION DESCRIPTION

Global Vegetation: This association is characterized by an open to moderately dense (10-60% cover) dwarf-shrub layer dominated by *Krascheninnikovia lanata* with an open to moderate herbaceous layer dominated by *Hesperostipa comata*. On the Colorado Plateau, other shrubs occurring with minimal cover include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus*, and *Gutierrezia sarothrae*. The herbaceous layer is dominated by *Hesperostipa comata*. Other grasses present include *Bromus tectorum, Poa secunda, Poa fendleriana, Bouteloua gracilis*, and *Achnatherum hymenoides* with few forbs such as *Delphinium andersonii, Helianthus annuus, Mentzelia albicaulis, Plantago patagonica, Oenothera albicaulis*, and *Sphaeralcea coccinea*. In the northwestern Great Plains, DeVelice et al. (1995) reported constant associates as *Artemisia frigida, Bouteloua gracilis*, and *Carex filifolia*. Other common taxa include *Atriplex nuttallii, Artemisia tridentata, Gutierrezia sarothrae, Koeleria macrantha, Nassella viridula, Poa secunda*, and *Pseudoroegneria spicata*. Scattered forbs such as *Phlox hoodii, Plantago patagonica*, and *Sphaeralcea coccinea* are typically present and contribute little cover. Introduced species *Bromus japonicus, Bromus tectorum*, and *Melilotus officinalis* are often present but not abundant.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shurb	*Krascheninnikovia lanata*
Herb (field)	Graminoid	*Hesperostipa comata*

CHARACTERISTIC SPECIES

Global: *Hesperostipa comata*, *Krascheninnikovia lanata*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus japonicus* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High), *Melilotus officinalis* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (1-Feb-1996). This association is reported from small, widely scattered occurrences over a large part of the interior West.

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Global Comments: This associations is closely related to *Krascheninnikovia lanata* / *Pleuraphis jamesii* Dwarf-shrubland (CEGL001322) in the Colorado Plateau. DeVelice et al. (1995) suggested a putative *Krascheninnikovia lanata* / *Pseudoroegneria spicata* plant association that would represent the late-seral stage of this type in the northwestern Great Plains. Stands in the Colorado Plateau and northwestern Great Plains have significant differences in associated species. More data and analysis are needed to determine if they should be classified together.
Global Similar Associations:

- *Krascheninnikovia lanata* / *Achnatherum hymenoides* Dwarf-shrubland (CEGL001323)
- *Krascheninnikovia lanata* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001321)
- *Krascheninnikovia lanata* / *Phlox* spp. Dwarf-shrubland (CEGL001325)
- *Krascheninnikovia lanata* / *Pleuraphis jamesii* Dwarf-shrubland (CEGL001322)
- *Krascheninnikovia lanata* / *Poa secunda* Dwarf-shrubland (CEGL001326)
- *Krascheninnikovia lanata* Dwarf-shrubland (CEGL001320)

Global Related Concepts:

- *Ceratoides lanata* / *Stipa comata* Community Type (DeVelice et al. 1995) =
- *Ceratoides lanata*/*Stipa comata* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: This association is known from the Colorado Plateau in northwestern Colorado and eastern and southeastern Utah . It has also been reported from northeastern Montana (DeVelice et al. 1991), Utah and Washington, and may occur in Saskatchewan, Canada.
Nations: CA?, US
States/Provinces: AZ, CO:SU, MT:S3, SK?, UT, WA:S1, WY
TNC Ecoregions: 6:C, 9:C, 19:C, 26:C
USFS Ecoregions (1994/95): 313A:CC, 331D:CC, 331E:CC, 331F:C?, 331G:CC, 342I:??, M331E:CC
Federal Lands: NPS (Canyonlands, Dinosaur, Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles, mod. K.A. Schulz
References: Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Coles et al. 2008a, DeVelice et al. 1991, DeVelice et al. 1995, Driscoll et al. 1984, MTNHP 2002b, Reid and Hall 2010, WNDD unpubl. data, Western Ecology Working Group n.d.

***Krascheninnikovia lanata* Dwarf-shrubland**

Winterfat Dwarf-shrubland
Identifier: CEGL001320

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Shrubland & Steppe (G310)
Association	*Krascheninnikovia lanata* Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This association is known from Colorado Plateau west into to the Great Basin and northern Mojave Desert and east into the northern panhandle of Texas and is likely to be more widespread in similar habitats in the southwestern Great Plains. It is an alkaline dwarf-shrub association that occurs primarily on sandsheets, slopes and plains often on eolian deposits near canyon walls and in alkaline flats in and around playas and along washes. Sites are flat to steep (up to 40% slope) and occur between 800 and 1770 m (2620-5800 feet) elevation. Soils are rapidly drained loamy sands or sandy loams derived from alluvium from a variety of parent materials and sandstones that have eroded and been redeposited by wind and water. It occurs on low to high levels of soil salinity and alkalinity. Total vegetation cover ranges from 5 to 45% and is characterized by the dwarf-shrub *Krascheninnikovia lanata* with cover between 5 and 30%. In southern Nevada, scattered *Ambrosia dumosa*, *Atriplex polycarpa, Larrea tridentata, Lycium andersonii, Sphaeralcea ambigua*, and *Suaeda moquinii (= Suaeda fruticosa)* may be present. The herbaceous layer is poorly developed but may contain tufts of the grass *Achnatherum hymenoides*. Forbs commonly present include *Eriogonum* spp., *Opuntia polyacantha, Oenothera pallida, Plantago patagonica*, and *Sphaeralcea parvifolia*. Biological soil crusts may provide up to 45% cover. Introduced annuals *Bromus tectorum, Bromus rubens*, and *Salsola tragus* may be abundant on some sites.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This winterfat dwarf-shrubland association occurs in the Western Grand Canyon at 1350 to 1425 m (4450-4625 feet) elevation. It occurs on plateaus, in broad valley bottoms, and on large terraces or step-in-slopes of sideslopes. It occurs on essentially flat slopes with slight north or east exposures. Soils are characteristically silty, and bare soil (65-80%) overwhelmingly dominates the ground cover.
Global Environment: This association is known from the Colorado Plateau west into the Great Basin and northern Mojave Desert and in the panhandle of Texas. It is an alkaline dwarf-shrub association that occurs primarily on sandsheets, slopes and plains often on eolian deposits near canyon walls and in alkaline flats in and around playas

and along washes. Sites are gentle to steep (up to 40% slope) and occur between 800 and 1770 m (2620-5800) feet elevation. Soils are rapidly drained loamy sands from alluvium derived from a mixture of rocks such as granodiorite, quartzite, latite, limestone and basalt in southern Nevada (Faden 1977), and sandy loams derived from Navajo and Entrada sandstones in southeastern Utah that have eroded and been redeposited by wind and water. It occurs on low to high levels of soil salinity and alkalinity.

In Texas, this community occurs on shallow soils on ridges and on footslopes along the Canadian River. In general, the soils are redbed-derived and shallow in nature. It would seem that this shrub is able to grow on a variety of soils but prefers the more shallow, rocky areas. It is often found growing in association with other shrubs but may grow alone in small colonies. When this community is found, it is never extensive and rarely occupies more than a third of an acre. There is usually some evidence of deer browsing on this species, and in areas where it is accessible, domestic livestock will browse it as well.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees and tall shrubs are entirely absent from this dwarf-shrub vegetation type; however, scattered short shrubs such as *Atriplex canescens* (1%) and *Yucca baccata* (1%) occasionally occur in some stands. A well-defined dwarf-shrub layer of *Krascheninnikovia lanata* (12-20%) characterizes this association, while *Gutierrezia* spp. (up to 5%) are also common. Native bunch grasses, including *Achnatherum hymenoides*, *Hesperostipa comata*, and *Pleuraphis jamesii*, sporadically occur in the relatively sparse graminoid component of the understory (3%). *Layia glandulosa* and *Sphaeralcea ambigua* are the most common forbs (5%), while *Eriastrum diffusum*, *Mentzelia albicaulis*, and *Ipomopsis polycladon* occur in some stands, all at low individual covers.

Global Vegetation: On the Colorado Plateau, total vegetation cover ranges from 5 to 45% and is characterized by the dwarf-shrub *Krascheninnikovia lanata* with cover between 5 and 30%. In southern Nevada, scattered *Ambrosia dumosa, Atriplex polycarpa, Larrea tridentata, Lycium andersonii, Sphaeralcea ambigua*, and *Suaeda moquinii (= Suaeda fruticosa)* may be present (Faden 1977). The herbaceous layer is poorly developed but may contain tufts of the grass *Achnatherum hymenoides*. Forbs commonly present include *Eriogonum* spp., *Opuntia polyacantha, Oenothera pallida, Plantago patagonica*, and *Sphaeralcea parvifolia*. Biological soil crusts provide up to 45% cover. Introduced annuals *Bromus tectorum, Bromus rubens*, and *Salsola tragus* may be abundant on some sites.

In Texas, this small community is dominated by *Krascheninnikovia lanata*, with some other short shrubs also being present in lesser amounts. Associated shrubs present in the community include *Dalea formosa, Mimosa borealis, Atriplex canescens*, and occasionally small *Prosopis glandulosa*. The community gives the appearance of being droughty and forbs are few. *Tetraneuris scaposa, Gutierrezia sarothrae, Chaetopappa ericoides (= Leucelene ericoides), Paronychia jamesii*, and *Eriogonum longifolium* are the most common. The most common grasses are *Aristida purpurea, Hesperostipa neomexicana (= Stipa neomexicana), Bouteloua gracilis*, and *Bouteloua curtipendula*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Succulent shrub	*Yucca baccata*
Herb (field)	Dwarf-shurb	*Krascheninnikovia lanata*
Herb (field)	Forb	*Eriastrum diffusum*
Herb (field)	Graminoid	*Achnatherum speciosum, Hesperostipa comata, Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shurb	*Krascheninnikovia lanata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Krascheninnikovia lanata*

Global: *Krascheninnikovia lanata*, *Plantago patagonica*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Salsola tragus* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: This is a broadly defined association that includes stands from the Colorado Plateau, Great Basin and northern Mojave Desert characterized by the dominance of *Krascheninnikovia lanata* without a notable herbaceous layer. The herbaceous layer is typically absent or sparse or dominated by introduced species such as *Bromus tectorum* or *Salsola tragus*. This is a very-small-patch association as presently defined from Lake Meredith National Recreation Area, Texas. The concept will need further review to determine if it is a viable association or should be considered as patches within a broader association.
Global Similar Associations:
- *Krascheninnikovia lanata* / *Hesperostipa comata* Dwarf-shrubland (CEGL001327)
- *Krascheninnikovia lanata* / *Poa secunda* Dwarf-shrubland (CEGL001326)

Global Related Concepts:
- *Ceratoides lanata* (Bourgeron and Engelking 1994) =
- *Eurotia lanata* Community (Faden 1977) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Winterfat Community (Mitchell et al. 1966) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon; it was sampled in Toroweap Valley and to the east of Toroweap Point.
Global Range: This association is known from the Colorado Plateau west into the Great Basin and northern Mojave Desert.
Nations: US
States/Provinces: AZ, CA?, CO, NV:S5, TX, UT
TNC Ecoregions: 11:C, 17:C, 19:C, 28:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 315B:CC, 322A:CC, 341B:CC, 341D:CC, 342B:CC
Federal Lands: NPS (Alibates, Arches, Canyonlands, Capitol Reef, Grand Canyon, Great Basin, Lake Meredith, Petrified Forest)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.03579, GRCA.03587.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz and J. Drake
References: Bourgeron and Engelking 1994, Clark et al. 2009, Coles et al. 2009a, Driscoll et al. 1984, Faden 1977, Fenton et al. 2007, Mitchell et al. 1966, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Schulz and Hall 2011, Thomas et al. 2009a, Western Ecology Working Group n.d.

***Opuntia polyacantha / Pleuraphis jamesii* Shrubland**

Panhandle Prickly-pear / James' Galleta Shrubland
Identifier: CEGL002299

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dry Shrubland & Grassland (M171)
Group	Intermountain Semi-Desert Shrubland & Steppe (G310)

Association *Opuntia polyacantha / Pleuraphis jamesii* Shrubland

ELEMENT CONCEPT

Global Summary: This low-succulent association occurs on hot, dry, relatively undisturbed sites on benches, valley floors, and slopes in the northern Colorado Plateau. Stands occur on gentle to steep (4-72%) slopes between 1457 and 1628 m (4780-5340 feet) elevation. Substrates may be fine- or coarse-textured soils derived from eolian sand, alluvium and colluvium. Total vegetation cover is between 15 and 30% and is characterized by patches of *Opuntia polyacantha*, with clumps of *Pleuraphis jamesii* between the shrubs. Other drought-tolerant shrubs may occur in the canopy with low cover, including *Artemisia tridentata ssp. wyomingensis, Atriplex confertifolia, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra* spp., *Gutierrezia sarothrae, Grayia spinosa*, and *Sarcobatus vermiculatus*. The herbaceous layer is dominated by grasses, with *Achnatherum hymenoides* and *Hesperostipa comata* often present in addition to *Pleuraphis jamesii*. *Juniperus osteosperma* trees are scattered throughout the community but do not form a stratum. Cryptogams are absent in gravelly sites but may have up to 25% cover in sandy sites.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association typically occurs on sideslopes or localized plateaus in the eastern portion of the Inner Canyon. It usually occurs at 1050 to 1175 m (3400-3875 feet) elevation, but can be found as high as 1325 m (4350 feet). It is primarily found on fairly gentle gradients (9-12 degrees), but is also occasionally found on more gentle slopes (5 degrees), and occurs across all aspects. Soils are rapidly-drained sandy loams that typically lie above sandstone or shale. Gravel (50%), rocks (17%), bare soil or sand (16%), and litter (10%) are major components of the ground cover.

Global Environment: These prickly-pear dwarf-shrublands tend to be characteristic of rocky sites that are too dry for most vegetation. Sites include small ridges in canyons, benches, midslopes, toeslopes, alluvial fans, stream terraces, valley floors, plains and flats in the northern Colorado Plateau. Stands occur on gentle to steep (4-72%) slopes with are oriented to eastern and southern aspects between 1457 and 1628 m (4780-5340 feet) elevation. The unvegetated surface has moderate to high cover of bare soil and large and small rocks. Litter is variable but can be as high as 45%. Cryptogamic cover can approach 20%. Soils may be fine- or coarse-textured and range from rapidly drained sand or sandy loams, to somewhat poorly drained silty loams or sandy clays derived from eolian sand, alluvium and colluvium. Parent materials are variable and include sandstone, shale, Precambrian gneiss, and deposits of eolian, sheetwash, and rockfall material.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 20-25% in this association which is characterized by the codominance of the dwarf-shrub *Opuntia polyacantha* (7-10%) and the perennial grass *Pleuraphis jamesii* (4-6%). Tall shrubs do not occur. *Ephedra torreyana* (3-5%) dominates a fairly well-developed short-shrub layer (7%), which also commonly supports *Encelia farinosa* (1%), *Lycium andersonii* (1%), and *Atriplex canescens* (1%). Along with *Opuntia polyacantha, Echinocereus engelmannii* (up to 1%) is also common in the dwarf-shrub layer. The *Pleuraphis jamesii*-dominated graminoid layer (5-10%) also frequently includes *Dasyochloa pulchella* (1%) and the exotic *Bromus rubens* (up to 1%). *Sphaeralcea grossulariifolia* (1%) frequently occurs in a fairly sparse forb layer (3%), while *Erodium cicutarium* (1%), *Calochortus flexuosus* (up to 1%), and *Eriogonum inflatum* (1%) also sometimes occur. Based upon the 5 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 22 species per 400-square-meter plot.

Global Vegetation: This succulent-dominated dwarf-shrubland is characteristic of rocky sites that are too dry for most vegetation. Total vegetation cover tends to be somewhat sparse, between 13 and 30%. This association is characterized by an open, patchy canopy of *Opuntia polyacantha*, with between 2 and 25% cover, and low to moderate cover of the bunchgrass *Pleuraphis jamesii*, usually with between 2 and 10% cover. The shrub layer is low in cover and may be diverse, with scattered short and dwarf-shrubs such as *Artemisia tridentata ssp. wyomingensis, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Ephedra viridis, Ephedra torreyana, Eriogonum microthecum, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata, Opuntia phaeacantha, Sarcobatus vermiculatus*, or *Sclerocactus whipplei*, but none will have higher cover than *Opuntia polyacantha*, and usually have much less. *Juniperus osteosperma* trees may be scattered through the community but do not form a stratum. The herbaceous layer is sparse or contributes low cover, usually less than 10% total cover. Graminoids associates may include *Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus, Vulpia octoflora*, and the exotic annual *Bromus tectorum*. Forb cover is sparse and variable. Forbs may include *Astragalus nuttallianus, Cryptantha*

flava, Hymenopappus filifolius, Lappula occidentalis, Lepidium densiflorum, Lepidium montanum, Sphaeralcea coccinea, Sphaeralcea leptophylla, Streptanthella longirostris, and the exotic annual *Salsola tragus*. Biological soil crusts may be absent or range up to 25% cover.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Dwarf-shurb	*Opuntia polyacantha*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Succulent shrub	*Opuntia polyacantha*
Herb (field)	Graminoid	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex canescens*, *Calochortus flexuosus*, *Dasyochloa pulchella*, *Ephedra torreyana*, *Eriogonum inflatum*, *Lycium andersonii*, *Opuntia polyacantha*, *Pleuraphis jamesii*, *Sphaeralcea grossulariifolia*
Global: *Achnatherum hymenoides*, *Astragalus nuttallianus*, *Atriplex canescens*, *Chrysothamnus viscidiflorus*, *Hesperostipa comata*, *Opuntia polyacantha*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Sclerocactus whipplei* (G1G3); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High), *Salsola tragus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Jan-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777) is also dominated by *Pleuraphis jamesii* and supports *Ephedra torreyana* and *Opuntia polyacantha*; however, it is a strictly herbaceous type that supports much more *Pleuraphis jamesii* cover and much less shrub cover (*Opuntia polyacantha* and *Ephedra torreyana*) than is typical of *Opuntia polyacantha* / *Pleuraphis jamesii* Shrubland (CEGL002299).
Global Comments: A number of cactus dwarf-shrublands have been identified in the northern Colorado Plateau through the NPS vegetation mapping program. A careful analysis of the aggregate data is necessary to determine which types are consistent.
Global Similar Associations:

- *Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland (CEGL002690)
- *Opuntia (fragilis, polyacantha, phaeacantha)* Shrubland (CEGL004009)
- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777) is also dominated by *Pleuraphis jamesii* and supports *Ephedra torreyana* and *Opuntia polyacantha*, but it is a strictly herbaceous type that supports much more grass cover and much less shrub cover.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the eastern portion of the Inner Canyon, where it was sampled from Unkar Creek, Red Canyon, Cardenas Creek, the Tabernacle, and Ottoman Amphitheater.
Global Range: This association occurs on xeric sites in the northern Colorado Plateau of Colorado and Utah and is likely more widespread.

Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Canyonlands, Colorado, Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (5 plots): GRCA.01549, GRCA.03025, GRCA.03031, GRCA.03550, GRCA.04617.
Local Description Authors: R. Meszaros
Global Description Authors: J. Coles, mod. K.A. Schulz
References: Reid and Hall 2010, Von Loh et al. 2007, Western Ecology Working Group n.d.

M170. Great Basin & Intermountain Dwarf Sage Shrubland & Steppe
G308. Intermountain Low & Black Sagebrush Shrubland & Steppe

Artemisia bigelovii - Ephedra (*viridis, torreyana*) Talus Shrubland

Bigelow's Sagebrush - (Mormon-tea, Torrey's Joint-fir) Talus Shrubland
Identifier: CEGL003755

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dwarf Sage Shrubland & Steppe (M170)
Group	Intermountain Low & Black Sagebrush Shrubland & Steppe (G308)
Association	*Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland

ELEMENT CONCEPT

Global Summary: This mixed colluvial slope shrubland is known from Arches and Canyonlands national parks and Glen Canyon National Recreation Area in eastern Utah and likely is more widespread throughout the canyonlands of the Colorado Plateau. This sparse mixed shrubland occurs on the colluvial deposits that form the lower slopes of canyons and valleys and on mesatops, steep canyonsides, benches, hills and escarpments. Most stands are on steep slopes (2-80%) between 1193 and 1673 m elevation and tend to occur on warmer exposures. Most of the unvegetated surface is covered by large rocks, gravel and bare soil. The substrate is complex and variable and often consists of an underlying shale covered by fragments of sandstone fallen from cliffs above. Soils are rapidly drained stony sandy loams, loamy sands, and clay loams. The vegetation is characterized by a sparse mixed short-shrub canopy scattered among boulders, which often are larger than the vegetation. Total vegetation cover ranges from 2 to 25% but is usually less than 15%. *Artemisia bigelovii* is always present but may not be dominant. As many as 15 species of shrubs may be associated with this community, none with more than a few percent cover, including *Atriplex canescens, Atriplex confertifolia, Brickellia grandiflora, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Echinocereus triglochidiatus, Ericameria nauseosa, Eriogonum corymbosum*, and *Gutierrezia sarothrae*. *Rhus trilobata* and *Fraxinus anomala* are generally absent but may be present with very low relative cover. Only scattered herbaceous species are present, providing sparse cover. Common graminoids include *Achnatherum hymenoides, Aristida purpurea*, and *Pleuraphis jamesii*. Forbs occasionally present include *Chamaesyce fendleri, Eriogonum inflatum, Lepidium montanum*, and *Stanleya pinnata*. Biological soil crusts are absent or provide sparse cover. *Juniperus osteosperma* sapling or dwarf-trees are often present with too little cover to constitute a stratum.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sagebrush shrubland association occurs on exposed, high-level, talus slopes that occur just below the canyon rim. It typically occurs along horizontal bands of broken Kaibab limestone and is constrained by sheer Kaibab limestone cliffs below. It occurs at roughly 1725 m (5650 feet) elevation on fairly steep slopes (35 degrees), often with eastern aspects. Substrates are somewhat unstable and are typically composed of rapidly-drained sandy loams. Exposed rocks (30%) and gravel (55%) overwhelmingly dominate the ground cover, while litter (10%) and bare soil (3%) are quite sparse. This community is essentially confined to talus slopes in rimrock environments.

Global Environment: This sparse mixed shrubland occurs on the colluvial deposits that form the lower slopes of canyons and valleys and on mesatops, steep canyonsides, benches, hills and escarpments. Stands are on gentle to more typically steep slopes (2-80%) between 1193 and 1673 m elevation and tend to occur on warmer exposures. Most of the unvegetated surface is covered by large rocks, gravel and bare soil with sparse cover of litter, downed wood and cryptogamic soil crust. The substrate is complex and variable and often consists of an underlying shale covered by fragments of sandstone fallen from cliffs above. Soils vary in texture and parent materials. Most are rapidly drained, stony or sandy loam, loamy sand and clay loam in texture and are derived from Cedar Mesa sandstone, Chinle shale, Moenkopi shale and Honaker Trail Formation.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 10-15% in this community. It is characteristically sparse as boulders, rocks, and gravel are more prevalent than vegetation. The stunted tree or tall shrub *Pinus edulis* (1%) punctuates the otherwise stark talus slopes on which this community occurs. *Ephedra viridis* (1-2%) dominates the short-shrub stratum (6%), while *Nolina microcarpa, Eriogonum corymbosum*, and *Shepherdia rotundifolia* are all common at low covers. *Artemisia bigelovii* (3-4%) and scattered *Ephedra torreyana* (to 1%) dominate the dwarf-shrub layer and often occur growing amongst boulders. *Achnatherum* sp. is a very common bunchgrass in this community and occurs relatively abundantly (3%) here. Forb cover is typically quite sparse (up to 1%) and is comprised of trace covers of various species, including *Artemisia ludoviciana, Chaetopappa ericoides, Psilostrophe sparsiflora*, and *Xylorhiza tortifolia*.
Global Vegetation: Total vegetation cover ranges from 2 to 25% but is usually less than 15%. It is a mix of xeric shrubs, among which *Artemisia bigelovii* and *Ephedra torreyana* or *Ephedra viridis* are conspicuous, although not always dominant. Many other shrub species are usually present, including *Atriplex canescens, Atriplex confertifolia, Brickellia grandiflora, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Echinocereus triglochidiatus, Ericameria nauseosa, Eriogonum corymbosum*, and *Gutierrezia sarothrae*. *Rhus trilobata* and *Fraxinus anomala* are absent or have no more than trace cover. The herbaceous layer may include many species or few species but is always sparse. *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Chamaesyce fendleri, Eriogonum inflatum, Lepidium montanum*, and *Stanleya pinnata* are the most consistent species. Biological soil crust formation is rare on active slopes, but may be provide sparse cover on gentle slopes. *Juniperus osteosperma* sapling or dwarf-trees are often present with too little cover to constitute a stratum.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Needle-leaved shrub	*Pinus edulis*
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra viridis*
Short shrub/sapling	Succulent shrub	*Nolina microcarpa*
Herb (field)	Dwarf-shurb	*Artemisia bigelovii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii, Ephedra torreyana, Ephedra viridis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia bigelovii*, *Artemisia ludoviciana*, *Ephedra torreyana*, *Ephedra viridis*, *Eriogonum corymbosum*, *Pinus edulis*, *Shepherdia rotundifolia*, *Xylorhiza tortifolia*
Global: *Artemisia bigelovii*, *Ephedra viridis*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Shepherdia rotundifolia* (G3G4)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (13-Mar-2006).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland (CEGL002328) also occurs on steep, eroded talus slopes and can host a somewhat similar composition of shrub species, including *Ephedra viridis, Eriogonum corymbosum*, and *Artemisia bigelovii*. It typically occurs well into the canyon, as opposed to just below the rim, and supports a notable amount of *Pinus edulis* and *Juniperus osteosperma*, as opposed to the very low cover of *Pinus edulis* present in *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755).
Global Comments: This colluvial slope shrubland association is broadly defined by low cover of common shrub species. The colluvial slope appears to be a defining characteristic as *Artemisia bigelovii, Ephedra torreyana, Ephedra viridis*, and *Gutierrezia sarothrae* are also common on mesatops and ridges. Additional classification work is needed to clarify these colluvial slope types from similar sparsely vegetated types.
Global Similar Associations:

- *Artemisia bigelovii* Shrubland (CEGL000276)
- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801)
- *Ephedra torreyana - Artemisia bigelovii* Sparse Vegetation (CEGL002350)
- *Pinus edulis - Juniperus osteosperma* / Mixed Shrubs Talus Woodland (CEGL002328) also occurs on steep, eroded talus slopes and can share a somewhat similar composition of shrub species, but supports a notable amount of *Pinus edulis* and *Juniperus osteosperma*.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from both the Inner Canyon and the Western Grand Canyon. It was sampled from SB Point.
Global Range: This association is known from Arches and Canyonlands national parks and Glen Canyon National Recreation Area and likely is widespread throughout the canyonlands of the Colorado Plateau in eastern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC
Federal Lands: NPS (Arches, Canyonlands, Glen Canyon, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (1 plot): GRCA.02079.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Coles et al. 2009a, Reid and Hall 2010, Western Ecology Working Group n.d.

***Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation**

Bigelow's Sagebrush / Blue Grama Dwarf-shrub Herbaceous Vegetation
Identifier: CEGL001742

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dwarf Sage Shrubland & Steppe (M170)
Group	Intermountain Low & Black Sagebrush Shrubland & Steppe (G308)
Association	*Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This dwarf-shrub steppe is found near canyon rims and mesatops and along escarpments in southeastern Colorado and the Colorado Plateau in southern Arizona and south to the Oscura Mountains in northern portions of the Tularosa Basin of southern New Mexico. Stands often occur on shallow soil deposits surrounded by bedrock and cliff faces, but also are found on flat to gentle slopes on hillslopes and mesatops at 1545-1830 m (5100-6040 feet) elevation on all aspects. Soils are typically coarse-textured loams derived from

colluvium and residuum from sandstone and limestone or other parent materials. The vegetation is dominated by a moderately dense graminoid layer of the perennial shortgrass *Bouteloua gracilis* with an open (10-25% cover) dwarf-shrub layer characterized by *Artemisia bigelovii*. *Gutierrezia sarothrae* is commonly present and may codominate some stands. Occasional *Pinus edulis* or *Juniperus* spp. tree may be present. Other dwarf-shrubs and shrubs present with low cover may include *Atriplex confertifolia, Opuntia imbricata, Opuntia polyacantha var. polyacantha, Opuntia whipplei*, and *Yucca glauca*. Associated herbaceous species include grasses, such as *Achnatherum hymenoides, Aristida purpurea var. fendleriana (= Aristida fendleriana), Bouteloua curtipendula, Hesperostipa neomexicana, Muhlenbergia torreyi, Pleuraphis jamesii, Poa fendleriana, Sporobolus airoides, Sporobolus cryptandrus*, and the forbs *Arenaria hookeri, Astragalus lentiginosus, Chaetopappa ericoides, Eriogonum jamesii*, and *Petradoria pumila*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sagebrush dwarf-shrub herbaceous association occurs on the plateau of the South Rim at approximately 1825 to 2100 m (6000-6900 feet) elevation. It occurs in swales, depressions, localized lowlands, and other openings in pinyon-juniper woodlands. Slopes are typically flat (up to 2 degrees), and aspects are typically south- or east-facing. Soils are usually composed of well-drained sandy loams, and when exposed, bedrock is commonly limestone. Bare soil (15%) and gravel (25%), as well as varying amounts of litter and rocks, are common components of the ground cover. This community type often occurs in areas that have experienced grazing or other disturbances, and seems to be somewhat restricted to such sites on the eastern side of the South Rim area.

Global Environment: This dwarf-shrub steppe is found near canyon rims and mesatops and along escarpments in southeastern Colorado and the Colorado Plateau in southern Arizona and south to the Oscura Mountains in northern portions of the Tularosa Basin of southern New Mexico. Stands often occur on shallow soil deposits surrounded by bedrock and cliff faces, but also are found on flat to gentle slopes on hillslopes and mesatops at 1545-1830 m (5100-6040 feet) elevation on all aspects. Soils are typically coarse-textured loams derived from colluvium and residuum from sandstone and limestone or other parent materials.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This shrub-herbaceous community lacks any trees or tall shrubs; however, scattered *Pinus edulis* and *Juniperus osteosperma* occasionally encroach from adjacent woodlands. Total shrub cover averages 25-30% and is codominated by the dwarf-shrubs *Gutierrezia sarothrae* (8-10%) and *Artemisia bigelovii* (12%). Various associated shrub species, including *Yucca baccata, Purshia stansburiana, Fallugia paradoxa, Atriplex canescens, Krascheninnikovia lanata*, and *Opuntia polyacantha*, often occur sporadically at relatively low covers. *Bouteloua gracilis* (10-20%) overwhelmingly dominates the significant graminoid stratum, while *Achnatherum lettermanii* (6%) and *Achnatherum hymenoides* (2%) also frequently occur. Forb diversity and cover (1%) are both quite low in this community, but species such as *Chaetopappa ericoides* and *Sphaeralcea parvifolia* occasionally occur. Based upon the 3 stand sampled, this association hosts below-average species diversity among Grand Canyon plant communities, with 13 species per 400-square-meter plot.

Global Vegetation: This association is dominated by a moderately dense graminoid layer of the perennial shortgrass *Bouteloua gracilis* with an open (10-25% cover) dwarf-shrub layer characterized by *Artemisia bigelovii*. *Gutierrezia sarothrae* is commonly present and may codominate some stands. Occasional *Pinus edulis* or *Juniperus* spp. tree may be present. Other dwarf-shrubs and shrubs present with low cover may include *Atriplex confertifolia, Opuntia imbricata, Opuntia polyacantha var. polyacantha, Opuntia whipplei*, and *Yucca glauca*. Associated herbaceous species include grasses, such as *Achnatherum hymenoides, Aristida purpurea var. fendleriana (= Aristida fendleriana), Bouteloua curtipendula, Hesperostipa neomexicana, Muhlenbergia torreyi, Pleuraphis jamesii, Poa fendleriana, Sporobolus airoides, Sporobolus cryptandrus*, and the forbs *Arenaria hookeri, Astragalus lentiginosus, Chaetopappa ericoides, Eriogonum jamesii*, and *Petradoria pumila*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Gutierrezia sarothrae*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*

Herb (field)	Forb	*Chaetopappa ericoides, Sphaeralcea parvifolia*
Herb (field)	Graminoid	*Achnatherum lettermanii, Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*
Herb (field)	Graminoid	*Bouteloua gracilis, Hesperostipa neomexicana*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum lettermanii*, *Artemisia bigelovii*, *Atriplex canescens*, *Bouteloua gracilis*, *Gutierrezia sarothrae*, *Krascheninnikovia lanata*, *Sphaeralcea parvifolia*
Global: *Artemisia bigelovii*, *Bouteloua gracilis*, *Gutierrezia sarothrae*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)
Global: Other: *Opuntia polyacantha* (G5), *Pleuraphis jamesii* (G5)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: *Artemisia bigelovii* Shrubland (CEGL000276) is also dominated by *Artemisia bigelovii*; however, *Gutierrezia sarothrae* only occurs at trace covers. *Bouteloua gracilis* occurs in this community as well, but only at 4-8% cover as opposed to 10-20% cover in *Artemisia bigelovii* / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001742). Additionally, *Artemisia bigelovii* Shrubland typically occurs in large openings on the plateau and along rocky outcrops, mostly near the rim, not in smaller, low-level swales or depressions within pinyon-juniper woodlands.
Global Comments: Additional classification work is needed to clarify differences between this shrub herbaceous association and similar shrubland associations in the *Artemisia bigelovii* Shrubland Alliance (A.1103).
Global Similar Associations:
- *Artemisia bigelovii* / *Achnatherum hymenoides* Shrubland (CEGL000990)
- *Artemisia bigelovii* / *Bouteloua eriopoda* Dwarf-shrub Herbaceous Vegetation (CEGL001741)
- *Artemisia bigelovii* Shrubland (CEGL000276) is also dominated by *Artemisia bigelovii*, but only trace amounts of *Gutierrezia sarothrae*and lesser amounts of *Bouteloua gracilis* occur.

Global Related Concepts:
- *Artemisia bigelovii* / *Bouteloua gracilis* Plant Community (Shaw et al. 1989) =
- *Artemisia bigelovii*/*Bouteloua gracilis* (Bourgeron and Engelking 1994) =
- *Bouteloua gracilis - Artemisia bigelovii* Plant Association (Muldavin et al. 2000b) =
- *Bouteloua gracilis - Artemisia bigelovii* PA (Muldavin and Mehlhop 1992) =
- DRISCOLL FORMATION CODE:V.C.2.e. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim. It was sampled from near Cape Solitude, the plateau east of Palisades of the Desert, and from the Coconino Plateau south of Desert View.
Global Range: This dwarf-shrub association is found from canyon rims and mesatops in southeastern Colorado to the Colorado Plateau in northwestern New Mexico and northern Arizona, in southern Utah, and in the Oscura Mountains at the northern end of the Tularosa Basin of southern New Mexico.
Nations: US
States/Provinces: AZ, CO, NM

TNC Ecoregions: 19:C, 24:C, 27:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 321A:CC, 331I:CC
Federal Lands: DOD (Pinon Canyon, White Sands Missile Range); NPS (Canyon de Chelly, Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.02239, GRCA.03218, GRCA.03220.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin and Mehlhop 1992, Muldavin et al. 2000b, Reid and Hall 2010, Shaw et al. 1989, Thomas et al. 2010, Western Ecology Working Group n.d.

Artemisia bigelovii Shrubland

Bigelow's Sagebrush Shrubland
Identifier: CEGL000276

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Dwarf Sage Shrubland & Steppe (M170)
Group	Intermountain Low & Black Sagebrush Shrubland & Steppe (G308)
Association	*Artemisia bigelovii* Shrubland

ELEMENT CONCEPT

Global Summary: This association occurs most commonly on ledgy slopes, canyon rims and ridges in the east-central part of the Colorado Plateau (southeastern Utah and northern Arizona). Slopes are gentle and elevations range from 1552 to 1900 m (5090-6234 feet). Substrates include alluvial and eolian deposits that have weathered into coarse loamy sands. These soils are often thin and overlie sandstone bedrock. The vegetation is dominated by *Artemisia bigelovii*, but other shrub species are always present, including *Atriplex confertifolia, Ephedra torreyana, Gutierrezia sarothrae, Purshia stansburiana*, and *Yucca harrimaniae*. The total cover of the associated shrubs may exceed that of *Artemisia bigelovii*. The herbaceous understory is sparse, rarely exceeding 5-10% cover, and variable from stand to stand. *Pleuraphis jamesii* is often present in the otherwise graminoid-poor understory; other herbaceous species may include *Arenaria fendleri, Calochortus flexuosus, Chaenactis stevioides, Oenothera pallida*, and *Rumex hymenosepalus*. Cryptobiotic soil crusts may have high cover. Scattered individuals of *Juniperus osteosperma* may be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sagebrush association occurs mainly on the South Rim and plateaus of the Western Grand Canyon at approximately 1725 to 1850 m (5650-6100 feet) elevation. It occurs on flat to gentle slopes (1-6 degrees) of the high-level plateau, often in close proximity to the rim, mostly on northern or eastern exposures. This association often occurs in areas dominated by shallow, chipped limestone substrates. Soils are well-drained or rapidly-drained silt or sand loams; when unobscured, the underlying geologic parent material is often limestone. Gravel (50%) overwhelmingly dominates the ground cover, while some litter (20-25%) is often also present. This association seems to favor exposed, windy rimrock habitats, but also extends inland from these environments. A single anomalous site was sampled in the Inner Canyon at 1300 m on a relatively steep sideslope.
Global Environment: This short shrubland association occurs most often on ledgy slopes, canyon rims and ridges and less often on valley floors in the east-central part of the Colorado Plateau (southeastern Utah and northern Arizona). Slopes are gentle and elevations range from 1552 to 1900 m (5090-6234 feet). Substrates include alluvial and eolian deposits derived from sandstones and shales that have weathered into coarse loamy sands. These soils are often thin and overlie sandstone bedrock. A high percentage of the unvegetated surface may be covered by cryptobiotic soil crusts.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees are essentially lacking from this shrubland association; however, stunted *Pinus edulis* (1%) and *Juniperus osteosperma* (1-2%) sometimes occur. Total shrub cover averages 20-25%,

but can be somewhat higher in denser stands. A near monoculture of *Artemisia bigelovii* (15-20%) dominates the shrub layer, while associated species such as *Ephedra viridis* (2%), *Yucca baccata* (2%), *Gutierrezia sarothrae* (2%), and *Opuntia polyacantha* (trace) are common at low covers. The graminoid component of this community is somewhat variable; some stands are essentially devoid of grass cover, while others support a fairly well-developed grass understory (sometimes up to 10%). Often one of the native bunch grasses *Pleuraphis jamesii* or *Bouteloua gracilis* are present at modest covers (5-6%), while *Elymus elymoides* and/or *Poa fendleriana* sometimes occur at low covers. Forb cover (1%) is extremely sparse, and species composition varies widely among stands. Based upon the 7 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with only 12 species per 400-square-meter plot.

Global Vegetation: This association occurs primarily in sites where the coarse sandy soils are thin and overlie sandstone bedrock. The total vegetation cover, therefore, is generally somewhat sparse, rarely exceeding 25%. The shrub layer is dominated by *Artemisia bigelovii*, but other shrub species are always present, including *Atriplex confertifolia, Ephedra torreyana, Gutierrezia sarothrae, Purshia stansburiana*, and *Yucca harrimaniae*. The total cover of the associated shrubs may exceed that of *Artemisia bigelovii*. The herbaceous understory is sparse, rarely exceeding 5-10% cover, and variable from stand to stand. *Pleuraphis jamesii* is often present in the otherwise graminoid-poor understory; other herbaceous species may include *Arenaria fendleri, Calochortus flexuosus, Chaenactis stevioides, Oenothera pallida*, and *Rumex hymenosepalus*. Scattered individuals of *Juniperus osteosperma* may be present, but total tree cover is usually less than 5%, and there is little chance that trees will take over the community because of the lack of suitable sites for establishment of deep-rooted species such as juniper.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Dwarf-shrub	*Artemisia bigelovii*
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia bigelovii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia bigelovii*, *Ephedra viridis*, *Opuntia polyacantha*
Global: *Artemisia bigelovii*, *Atriplex confertifolia*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (7-Jan-2003).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: While *Artemisia bigelovii* is also the dominant shrub species in *Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001742), it typically occurs at somewhat lower covers (12%). *Bouteloua gracilis* forms a characteristically dense graminoid understory which is much better developed than in *Artemisia bigelovii* Shrubland (CEGL000276). This community typically occurs in localized lowlands, far from the rim; while *Artemisia bigelovii* Shrubland occurs on the high-level plateau near the rim, in areas dominated by chipped limestone substrates.
Global Comments: A closely related association, *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755), occurs on colluvial slopes, sometimes below the rim habitats that support *Artemisia bigelovii* Shru-

bland (CEGL000276). It is possible that these associations should be combined.
Global Similar Associations:
- *Artemisia bigelovii - Ephedra (viridis, torreyana)* Talus Shrubland (CEGL003755)
- *Artemisia bigelovii / Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation (CEGL001742) is also dominated by *Artemisia bigelovii* but with a characteristically dense graminoid understory of *Bouteloua gracilis*.

Global Related Concepts:
- *Artemisia bigelovii* Shrubland (Thomas et al. 2003b) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, where it was sampled near Cape Solitude and east of Palisades of the Desert; from the Western Grand Canyon, where it was sampled on the Kanab Plateau to the west of Kanab Creek; and from the Inner Canyon, where it was sampled from Wall Creek, a tributary of Bright Angel Creek.
Global Range: This association has been documented from northern Arizona and adjacent parts of southeastern Utah.
Nations: US
States/Provinces: AZ, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 341B:CC
Federal Lands: NPS (Capitol Reef, Grand Canyon, Hovenweep)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (7 plots): GRCA.02062, GRCA.02063, GRCA.02066, GRCA.02067, GRCA.02238, GRCA.02613, GRCA.03219.
Local Description Authors: K. Christie
Global Description Authors: J. Coles
References: Clark et al. 2009, Reid and Hall 2010, Romme et al. 1993, Thomas et al. 2003b, Von Loh et al. 2008, Western Ecology Working Group n.d.

M169. Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe
G303. Intermountain Dry Tall Sagebrush Shrubland

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland

Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland
Identifier: CEGL002699

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe (M169)
Group	Intermountain Dry Tall Sagebrush Shrubland (G303)
Association	*Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland

ELEMENT CONCEPT

Global Summary: This association is common throughout the Colorado Plateau and likely occurs on disturbed sites throughout the range of basin big sagebrush in the western U.S. Stands occur in small to moderate-sized patches on alluvial terraces, floodplains, and point bars, mostly below 2000 m (6560 feet) elevation. *Artemisia tridentata ssp. tridentata* shrubs are always present, often with a lesser component of *Ericameria nauseosa, Atriplex canescens*, or *Chrysothamnus viscidiflorus*. *Bromus tectorum* dominates the occasionally sparse herbaceous layer, frequently accompanied by other weedy exotic or annual grasses and forbs. Individuals or small patches of native grasses and forbs may occur, including *Leymus cinereus, Achnatherum hymenoides*, and *Sporobolus cryptandrus*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This big sagebrush shrubland association occurs in flat, shallow valley bottoms on the plateau in Grand Canyon-Parashant National Monument. It occurs from 1875 to 1900 m (6175-6250

feet) elevation in wide open areas within a matrix of mature *Pinus ponderosa*. Soils are clay or silty-clay, moderately well-drained, and obscure the underlying geology. Ground cover is dominated by bare soil (71%) and litter (24%). This vegetation type often occurs in areas that have experienced disturbance, often through grazing.

Global Environment: This association occurs on alluvial terraces, flats and fans or valley floors throughout the Colorado Plateau and extends into the Great Basin. Most stands occur on level to gently sloping sites below 2000 m (6560 feet) elevation, but elevations range from 1130-2045 m. Soils are variable and include sandy loams, silt loams, and clay loams, depending on the size of the stream and the geology of the area. Parent materials is frequently alluvium but includes sandstones, shale, limestone, eolian deposits and Precambrian gneiss. The unvegetated surface often has high cover of litter and bare soil with low cover of rocks. Cryptobiotic soil crusts are often extensive (up to 15% in some stands).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is surrounded by *Pinus ponderosa* woodlands; however, individual trees or tall shrubs rarely occur within this open, shrub-dominated association. Total shrub cover typically averages 25-30%, most of which is comprised of the short shrubs *Artemisia tridentata* (20-30%) and *Ericameria nauseosa* (5%). The dwarf-shrub *Gutierrezia sarothrae* (1%) is also regularly present. Graminoids such as *Elymus elymoides* (2%), *Bromus tectorum* (1%), and *Bouteloua gracilis* (0-1%) are common in the understory. *Agrostis* sp. (5%) occasionally occurs as well. A well-established forb layer (5-10%) exists in which *Convolvulus arvensis* (2%), *Chamaesyce albomarginata* (1%), *Erigeron* sp. (0-1%), and *Oenothera caespitosa* (0-1%) occur most frequently. Although it is only seen sporadically, *Helianthus ciliaris* occurs with relatively high cover (11%). Based upon the 3 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

Global Vegetation: This big sagebrush association is widespread on floodplains and terraces within the Colorado Plateau that have been subject to grazing. *Artemisia tridentata ssp. tridentata* is always present in the sparse to dense shrub canopy (10-70% cover) with cover of sagebrush between 5 and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present but is likely to be present in the vicinity. *Artemisia tridentata ssp. wyomingensis* may be present in some stands. Other shrubs that occur in this community consistently include *Atriplex canescens, Chrysothamnus viscidiflorus*, and *Sarcobatus vermiculatus*. Less common shrubs are *Artemisia nova, Brickellia microphylla, Ephedra viridis, Gutierrezia sarothrae, Opuntia* spp., or *Tetradymia canescens*. In some stands there may be scattered trees of *Pinus edulis, Juniperus osteosperma, Juniperus scopulorum*, and *Populus angustifolia*. The herbaceous layer reflects a long history of disturbance and is dominated by exotic annual *Bromus* species, especially *Bromus tectorum*. Other common exotic herbaceous species include *Bromus rigidus, Ceratocephala testiculata (= Ranunculus testiculatus), Erodium cicutarium, Lappula occidentalis, Lactuca serriola*, and *Sisymbrium altissimum*. Because it is dominated by annual species, the total herbaceous cover varies depending on seasonal precipitation. Remnant native herbaceous vegetation may include scattered individuals or patches of *Achnatherum hymenoides, Descurainia pinnata, Elymus elymoides, Hesperostipa comata, Heterotheca villosa, Leptodactylon watsonii, Oenothera caespitosa, Senecio spartioides, Stenotus acaulis*, and others. Exotic perennial species such as *Acroptilon repens, Agropyron cristatum, Bromus inermis, Cardaria draba*, and *Carduus nutans ssp. macrolepis* may also be present because of the disturbed nature of this community.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Elymus elymoides*

Global

Stratum	Lifeform	Species
Tall shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata ssp. tridentata*
Herb (field)	Graminoid	*Bromus tectorum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Bouteloua gracilis*, *Bromus tectorum*, *Chamaesyce albomarginata*, *Convolvulus arvensis*, *Elymus elymoides*, *Ericameria nauseosa*, *Gutierrezia sarothrae*, *Helianthus ciliaris*, *Oenothera caespitosa*, *Penstemon linarioides*, *Tragopogon dubius*
Global: *Artemisia tridentata* ssp. *tridentata*, *Bromus tectorum*, *Ericameria nauseosa*, *Sporobolus cryptandrus*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Penstemon linarioides* (state-vulnerable, G5); **Invasive/Exotic**: *Bromus tectorum* (exotic, High), *Convolvulus arvensis* (exotic, Medium/Low), *Lactuca serriola* (exotic, Low/Insignificant), *Tragopogon dubius* (exotic, Medium/Low), *Verbascum thapsus* (exotic, Medium)
Global: Invasive/Exotic: *Acroptilon repens* (invasive/exotic, High/Medium), *Agropyron cristatum* (invasive/exotic, Medium/Low), *Bromus inermis* (invasive/exotic, High/Medium), *Bromus rigidus* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High), *Cardaria draba* (invasive/exotic), *Carduus nutans* ssp. *macrolepis* (invasive/exotic), *Ceratocephala testiculata* (invasive/exotic), *Erodium cicutarium* (invasive/exotic, Medium/Low), *Lactuca serriola* (invasive/exotic, Low/Insignificant), *Salsola tragus* (invasive/exotic), *Sisymbrium altissimum* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001).

CLASSIFICATION

Status: Standard
Classification Confidence: 1 - Strong
Grand Canyon National Park Comments: *Artemisia tridentata - Purshia stansburiana* Shrubland (CEPS009534) is also dominated by *Artemisia tridentata* and has similar covers of *Gutierrezia sarothrae* and *Bromus tectorum*. However, *Ericameria nauseosa* is not present here, while it is codominant in *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699).
Global Comments: This semi-natural association is likely much more widespread across the western U.S. but is not often sampled.
Global Similar Associations:
- *Artemisia tridentata - Purshia stansburiana* Shrubland [Park Special] (CEPS009534)
- *Artemisia tridentata / Ericameria nauseosa* Shrubland (CEGL000998)
- *Artemisia tridentata ssp. wyomingensis* / Disturbed Understory Semi-natural Shrubland (CEGL002083)
- *Populus fremontii / Ericameria nauseosa* Woodland (CEGL002465)

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau near Mount Dellenbaugh and Yellow John Mountain.
Global Range: This association is widespread in southern Utah and western Colorado and likely occurs on disturbed sites throughout the range of basin big sagebrush in the western U.S.
Nations: US
States/Provinces: AZ, CO, NV, UT
TNC Ecoregions: 9:C, 11:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341A:CC, 341B:CC, M331E:CC, M341:C
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Grand Canyon-Parashant, Great Basin, Hovenweep, Mesa Verde, Natural Bridges, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (3 plots): GRCA.04155, GRCA.04162, GRCA.04163.
Local Description Authors: R. Meszaros
Global Description Authors: J. Coles, mod. K.A. Schulz
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2008c, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Reid and Hall 2010, Romme et al. 1993, Schulz and Hall 2011, Thomas et al. 2009b, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d.

Artemisia tridentata - Ephedra spp. Shrubland

Big Sagebrush - Joint-fir species Shrubland
Identifier: CEGL001003

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe (M169)
Group	Intermountain Dry Tall Sagebrush Shrubland (G303)
Association	*Artemisia tridentata - Ephedra* spp. Shrubland

ELEMENT CONCEPT

Global Summary: This big sagebrush shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from Death Valley in California and in Nevada and Oregon. More survey and classification work are needed to fully characterize this type. It predominantly occurs on sideslopes, although it also rarely occurs in drainage channels and on cinder cones. It mostly occurs from approximately 1350 to 1725 m (4400-5650 feet) elevation but can occur at up to 1850 m (6050 feet) on some sites. It is typically found on moderately steep (20 degrees), limestone, basalt, or shale slopes. Soils are mostly rapidly-drained silty loams that occasionally contain clay or sand. Ground cover tends to be dominated by gravel and rocks. This vegetation type often forms large expanses across appropriate habitats. Stands sometimes contain occasional trees or tall shrubs, but these individuals are rarely common enough to constitute a defined vegetation layer. A short-shrub stratum dominated by *Artemisia tridentata* and *Ephedra* spp. characterizes this association. Three species of *Ephedra* are common, with *Ephedra fasciculata* and *Ephedra viridis* occurring most frequently. *Ephedra nevadensis* also occurs; however, its presence is rare. *Yucca baccata* also commonly occurs as a short shrub. The dwarf-shrub layer is typically dominated by *Gutierrezia sarothrae*, while *Thamnosma montana* also occasionally occurs. *Elymus elymoides, Bromus rubens, Achnatherum hymenoides, Achnatherum speciosum, Pleuraphis jamesii*, and *Bromus tectorum* are all common in the fairly well-developed graminoid layer. A variety of different forbs occur in the understory; however, forb composition varies considerably among stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This big sagebrush shrubland association predominantly occurs on sideslopes in the Western Grand Canyon, although it also rarely occurs in drainage channels and on cinder cones. It mostly occurs from approximately 1350 to 1725 m (4400-5650 feet) elevation but can occur at up to 1850 m (6050 feet) on some sites. It is typically found on moderately steep (20 degrees), limestone, basalt, or shale slopes. Soils are mostly rapidly-drained silty loams that occasionally contain clay or sand. Ground cover tends to be dominated by gravel (54%) and rocks (21%), with lesser amounts of litter (11%) and bare soil (7%). A single stand was sampled from Grand Canyon-Parashant National Monument from a similar environment. This vegetation type often forms large expanses across appropriate habitats.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 25-30% in this association. Stands are sometimes punctuated by the occasional tree or tall shrub, but these individuals are rarely common enough to constitute a defined vegetation layer. A short-shrub stratum dominated by *Artemisia tridentata* (15-20%) and *Ephedra* spp. (6%) characterizes this association. Three species of *Ephedra* are common, with *Ephedra fasciculata* (2%) and *Ephedra viridis* (2%) occurring most frequently. *Ephedra nevadensis* (2%) also occurs; however, its presence is rare. *Yucca baccata* (2%) also commonly occurs as a short shrub. The dwarf-shrub layer is typically dominated by *Gutierrezia sarothrae* (3%), while *Thamnosma montana* (2%) also occasionally occurs. *Elymus elymoides* (0-1%), *Bromus rubens* (0-1%), *Achnatherum hymenoides* (0-1%), *Achnatherum speciosum* (2%), *Pleuraphis jamesii* (3%), and *Bromus tectorum* are all common in the fairly well-developed graminoid layer (5%). A variety of different forbs (3%) occur in the understory; however, forb composition varies considerably among stands. Based upon the 12 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum hymenoides*, *Achnatherum speciosum*, *Artemisia tridentata*, *Bromus rubens*, *Bromus tectorum*, *Elymus elymoides*, *Ephedra fasciculata*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Pleuraphis jamesii*, *Sphaeralcea ambigua*, *Thamnosma montana*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus diandrus* (exotic), *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Ephedra fasciculata* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Artemisia tridentata - Purshia stansburiana* Shrubland (CEPS009534) has a similar cover of *Artemisia tridentata* and *Ephedra viridis*, but also has a consistent *Purshia stansburiana* component which *Artemisia tridentata - Ephedra* spp. Shrubland (CEGL001003) lacks.
Global Similar Associations:
- *Artemisia tridentata - Purshia stansburiana* Shrubland [Park Special] (CEPS009534) has a similar cover of *Artemisia tridentata* and *Ephedra viridis* but also has a consistent *Purshia stansburiana* component.

Global Related Concepts:
- 152.1121 *Artemisia tridentata - Gutierrezia sarothrae - Ephedra viridis* Association (Warren et al. 1982) **=**
- *Artemisia tridentata-Ephedra viridis* (Bourgeron and Engelking 1994) **=**
- *Artemisia tridentata* Association (Peterson 1984) **=**
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) **>**
- Sagebrush Zone (Kurzius 1981) **><**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is chiefly known from the Western Grand Canyon, where it was sampled from Monument Point, in and around Toroweap Valley and Vulcan's Throne, Cottonwood Canyon, near Schmutz Spring, Twin Springs Canyon, near Burnt Canyon Point, and to the northeast of Fishtail Mesa. A single stand was sampled from Grand Canyon-Parashant National Monument between Toroweap Valley and Whitmore Canyon.
Global Range: This association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. It is also reported from Death Valley in California and in Nevada and Oregon. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ:S3, CA, NV:S5, OR:S1
TNC Ecoregions: 6:C, 11:C, 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341:C, 342B:CC
Federal Lands: NPS (Death Valley, Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (12 plots): GRCA.02578, GRCA.02583, GRCA.02589, GRCA.02593, GRCA.02638, GRCA.03049, GRCA.03589,

GRCA.03618, GRCA.03621, GRCA.04068, GRCA.04598, GRCA.04687.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Kagan et al. 2004, Kurzius 1981, Peterson 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

Artemisia tridentata - Purshia stansburiana Shrubland [Park Special]

Big Sagebrush - Stansbury's Cliffrose Shrubland
Identifier: CEPS009534

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe (M169)
Group	Intermountain Dry Tall Sagebrush Shrubland (G303)
Association	*Artemisia tridentata - Purshia stansburiana* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This big sagebrush shrubland association predominantly occurs on plateaus of the Western Grand Canyon and Grand Canyon-Parashant National Monument. It occurs from approximately 1725 to 1850 m (5700-6100 feet) elevation, usually in close proximity to the edge of the canyon rim. It is typically found on flat, upper slopes, but occasionally occurs near the top of low-gradient sideslopes (5-10 degrees). Soils are well-drained silty or sandy loams that occasionally contain clay and typically obscure the limestone bedrock below. The ground cover tends to be dominated by gravel (30%), litter (30%) and rocks (17%), with lesser amounts of bare soil (12%) and bedrock (2%). A single stand was sampled from a similar, although higher elevation (2025 m [6600 feet]) on the South Rim.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is shrub-dominated, but stands often contain a sparse tree layer made up of *Pinus monophylla* (1%), *Pinus edulis* (2%), and *Juniperus osteosperma* (2%). Total shrub cover is moderately dense and typically averages 35-40%. The short shrub *Artemisia tridentata* (10-20%) and the tall shrub *Purshia stansburiana* (5-10%) codominate and characterize this community. *Gutierrezia sarothrae* (4-6%) and *Yucca baccata* (3%) are also fairly constant members of the short-shrub layer, although they can occupy other strata based on site conditions. The cacti *Opuntia whipplei (= Cylindropuntia whipplei)* (1%) and *Opuntia phaeacantha* (3%) are sometimes seen in the dwarf-shrub layer. *Bromus tectorum* (3%) typically dominates the graminoid layer and is almost always found growing in the shade beneath *Artemisia tridentata*. Other grasses such as *Bouteloua gracilis* (8%) and *Achnatherum speciosum* (5%) occur much less frequently, but both can appear with relatively high cover. *Sanvitalia abertii* (2%), *Sphaeralcea ambigua* (1%), *Chaetopappa ericoides* (1%), and *Draba cuneifolia* (1%) occasionally occur in what is usually a sparse forb layer. Based upon the 7 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 19 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Pinus monophylla*
Tall shrub/sapling	Broad-leaved evergreen shrub	*Purshia stansburiana*
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Forb	*Sanvitalia abertii*
Herb (field)	Graminoid	*Bromus tectorum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum hymenoides*, *Artemisia tridentata*, *Bromus tectorum*, *Ephedra viridis*, *Gutierrezia sarothrae*, *Juniperus osteosperma*, *Opuntia phaeacantha*, *Opuntia whipplei*, *Pinus monophylla*, *Purshia stansburiana*, *Sanvitalia abertii*, *Sphaeralcea ambigua*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: *Artemisia tridentata - Ephedra* spp. Shrubland (CEGL001003) has similar cover of *Artemisia tridentata, Ephedra viridis*, and *Yucca baccata*, but lacks the consistent *Purshia stansburiana* component that characterizes *Artemisia tridentata - Purshia stansburiana* Shrubland (CEPS009534). *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699) is also dominated by *Artemisia tridentata* and has similar covers of *Gutierrezia sarothrae* and *Bromus tectorum*. However, this association also supports *Ericameria nauseosa* as a codominant in the short-shrub stratum and lacks *Purshia stansburiana*.
Global Similar Associations:

- *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland (CEGL002699) is also dominated by *Artemisia tridentata* and has similar covers of *Gutierrezia sarothrae* and *Bromus tectorum* but also supports *Ericameria nauseosa* as a codominant in the short-shrub stratum and lacks *Purshia stansburiana*.
- *Artemisia tridentata - Ephedra* spp. Shrubland (CEGL001003) has similar cover of *Artemisia tridentata, Ephedra viridis*, and *Yucca baccata* but lacks a consistent *Purshia stansburiana* component.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, the Western Grand Canyon, and also from the South Rim. In Grand Canyon-Parashant, it was sampled from Twin Point above the Sanup Plateau, and from Burnt Canyon Point; in the Western Grand Canyon, it was sampled from an unnamed point above and to the west of the mouth of Kanab Creek, and from Tuckup Point above Willow Spring; and on the South Rim, it was sampled from Yuma Point.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (7 plots): GRCA.02064, GRCA.02226, GRCA.03055, GRCA.04067, GRCA.04190, GRCA.04191, GRCA.04223.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Artemisia tridentata / Bouteloua gracilis Shrubland

Big Sagebrush / Blue Grama Shrubland
Identifier: CEGL000995

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe (M169)
Group	Intermountain Dry Tall Sagebrush Shrubland (G303)
Association	*Artemisia tridentata / Bouteloua gracilis* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland has only been described from the plateaus and mesas of Grand Canyon and Zion national parks in northwestern Arizona and southwestern Utah, but it is more widespread and likely occurs

in New Mexico and Nevada. Sites range from valley bottoms and drainages to rolling hills, mesa tops and terraces. Substrates are alluvial soils derived from limestone or volcanic flows or sandy-textured soil derived from sandstone or sandy limestone. Stands have an open, short-shrub canopy (less than 1 m tall) that is dominated by the evergreen microphyllous shrub *Artemisia tridentata* usually with greater than 20% cover. Other common shrubs and dwarf-shrubs may include *Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Atriplex canescens, Krascheninnikovia lanata*, or *Ephedra viridis*. The sparse herbaceous layer is dominated by the short perennial bunchgrass *Bouteloua gracilis* with *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii*, or *Sporobolus cryptandrus* often present. Forbs are sparse. Scattered *Juniperus osteosperma* trees and succulents such as *Opuntia* spp. may also be present.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This big sagebrush shrubland association occurs on high-level plateaus and low-level valley bottoms in all of the sub-regions of Grand Canyon National Park besides the Inner Canyon. It typically occurs at 1800 to 1950 m (5900-6400 feet) elevation, on flat slopes (up to 2 degrees), across all aspects. Soils are moderately well-drained and characteristically silty; some stands occur in more loam-based soils, and others occur in more clay-based soils. Bare soil (55%), litter (25%), and gravel (12%) are dominant components of the ground cover. This vegetation type often occurs in large-scale openings within ponderosa pine or pinyon-juniper woodland communities. It sometimes occurs in areas that have experienced historical stand-replacing fires which have converted these woodlands into shrublands. Grazing evidence is present in many stands. A single stand was sampled from a similar plateau environment on the Powell Plateau of the North Rim.
Global Environment: This shrubland has only been described from the plateaus and mesas of Grand Canyon and Zion national parks in northwestern Arizona and southwestern Utah, but it is more widespread and likely occurs in New Mexico and Nevada. Elevations range from 1370-2040 m. Sites range from valley bottoms and drainages to rolling hills, mesa tops and terraces. Substrates include sandy-textured soils derived from sandstone or sandy limestone and moderately deep, fine-textured, alkaline, calcareous, alluvial soils derived from limestone or volcanic flows.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees are typically lacking from this shrubland association, but scattered *Pinus* spp. or *Juniperus osteosperma* individuals occasionally encroach from adjacent woodland communities. Total shrub cover typically averages 35-40%, but can vary from 20% in sparser stands up to 50% in denser stands. A monoculture of *Artemisia tridentata* (35-40%) characterizes the shrub component of this association; however, the dwarf-shrub *Gutierrezia sarothrae* (1%) occurs in almost all stands as well. *Bouteloua gracilis* (usually 10-12%, and rarely up to 40% cover) dominates the typically well-developed graminoid layer. *Elymus elymoides* (3%) is also very common and can even be codominant on some stands (up to 12% cover). Various different species occur in the somewhat lacking forb stratum (2%).
Global Vegetation: This shrubland is characterized by an open, short-shrub canopy (less than 2 m tall) that is dominated by the evergreen microphyllous shrub *Artemisia tridentata* usually with greater than 20% cover. Other common shrubs and dwarf-shrubs may include *Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Atriplex canescens, Ephedra viridis, Krascheninnikovia lanata*, or *Tetradymia canescens*. The sparse herbaceous layer is dominated by the short perennial bunchgrass *Bouteloua gracilis* with *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii*, or *Sporobolus cryptandrus* often present. Forbs are sparse but may include species of *Castilleja, Eriogonum, Lupinus*, and *Penstemon*. Scattered *Juniperus osteosperma* trees and succulents such as *Opuntia* spp. may also be present.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua gracilis*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Short shrub/sapling	Dwarf-shurb	*Gutierrezia sarothrae*
Herb (field)	Graminoid	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Bouteloua gracilis*

Global: *Artemisia tridentata*, *Bouteloua gracilis*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Convolvulus arvensis* (exotic, Medium/Low), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Portulaca oleracea* (exotic), *Tragopogon dubius* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (17-Dec-1999). Although, this shrubland has only been describe from six locations in Grand Canyon National Park, Arizona, it is likely a widespread type that occurs elsewhere in the Colorado Plateau such as New Mexico and possibly Nevada. Stands in the park are protected from livestock grazing, but may be sensitive to overbrowsing by wildlife. Outside the park, excessive use by livestock or wildlife degrade stands. Fortunately, *Artemisia tridentata* and *Bouteloua gracilis* are fairly resilient to overgrazing. Increased fire frequency caused by abundance of fine fuels from introduced annual grasses such as *Bromus rubens* or *Bromus tectorum* may threaten these shrublands. More survey and classification work are needed to verify potential range distribution.

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Artemisia tridentata* Shrubland (CEGL000991) also supports a short-shrub stratum that is strongly dominated by *Artemisia tridentata*; however, the graminoid understory is almost totally absent.
Global Comments: On Fishtail Mesa, cover of *Artemisia bigelovii* was lumped with *Artemisia tridentata* in plot summary tables as "*Artemisia*" by Jameson et al. (1962) and Rowlands and Brian (1996). It is not clear if these shrub species co-occurred within the plot sites or not.
Global Similar Associations:

- *Artemisia tridentata* Shrubland (CEGL000991) also supports a short-shrub stratum that is strongly dominated by *Artemisia tridentata*, but a graminoid understory is almost totally absent.

Global Related Concepts:

- 152.1111 *Artemisia tridentata - Gutierrezia sarothrae - Bouteloua gracilis* (Warren et al. 1982) **=**
- *Artemisia tridentata/Bouteloua gracilis* (Bourgeron and Engelking 1994) **=**
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) **>**
- Shrub Type (Jameson et al. 1962) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from throughout Grand Canyon National Park in all sub-regions besides the Inner Canyon. On the South Rim, it was sampled from near Cedar Mountain and on the plateau southwest of Hermits Rest; on the North Rim, it was sampled from Powell Plateau; in the Western Grand Canyon, it was sampled from Tuckup Point; and in Grand Canyon-Parashant National Monument, it was sampled from the Shivwits Plateau in the vicinity of Lake Flat.
Global Range: This association is described from Zion and Grand Canyon national parks in southwestern Utah and northwestern Arizona. It is likely widespread across the Colorado Plateau and also may occur in New Mexico and Nevada.
Nations: US
States/Provinces: AZ:S3, UT

TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, M341C:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (10 plots): GRCA.02054, GRCA.02116, GRCA.03050, GRCA.03053, GRCA.03207, GRCA.04151, GRCA.04165, GRCA.04167, GRCA.04229, GRCA.04230.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Bunting 1987, Cogan et al. 2004, Driscoll et al. 1984, Everett 1987, Jameson et al. 1962, Reid and Hall 2010, Rowlands and Brian 1996, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979

***Artemisia tridentata* Shrubland**

Big Sagebrush Shrubland
Identifier: CEGL000991

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Tall Sagebrush Shrubland & Steppe (M169)
Group	Intermountain Dry Tall Sagebrush Shrubland (G303)
Association	*Artemisia tridentata* Shrubland

ELEMENT CONCEPT

Global Summary: This broadly defined sagebrush shrubland is described from eastern California, Nevada, and Utah, but likely occurs throughout much of the western U.S. Elevations range from 1340-2225 m. Landforms include dunes, basins and slopes. Substrates are variable; soil texture ranges from sand to clay. This association is used to describe *Artemisia tridentata*-dominated shrublands where the subspecies is not known and the herbaceous layer is generally sparse. The herbaceous layer may be limited by substrate or disturbance. Stands in Utah and California had moderate cover (25-50%) of *Artemisia tridentata* often with scattered individuals of *Ericameria nauseosa (= Chrysothamnus nauseosus), Sarcobatus vermiculatus, Grayia spinosa, Gutierrezia sarothrae*, or *Opuntia polyacantha*. If present, the herbaceous layer typically consists of low cover of graminoids such as *Distichlis spicata* and *Elymus elymoides*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This big sagebrush shrubland association predominantly occurs on plateaus and in wide valley bottoms in the Western Grand Canyon, Grand Canyon-Parashant National Monument, and on western portion of the South Rim. It occurs from approximately 1700 to 1975 m (5600-6500 feet) elevation, but has been found as low as 1375 m (4525 feet). Stands are typically found on flat, low or high levels, but they occasionally occur on gently sloping gradients (8 degrees). Soils are well-drained and composed of either sandy loam or silty clay. Geology is commonly obscured by widespread bare soil. The ground cover tends to be dominated by bare soil (55%), litter (18%) and gravel (15%), with small amounts of wood (2%) and rocks (1%). This vegetation type can cover expansive swathes of the plateau, particularly in western portions of the park.
Global Environment: This broadly defined sagebrush shrubland is reported from the Great Basin and Uinta Basin but is likely more widespread. Elevations range from 1340-2225 m. Landforms include dunes, basins and slopes. Substrates are variable; soil texture ranges from sand to clay.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This association is dominated by a near monoculture of the short shrub *Artemisia tridentata* (30-40%). *Pinus monophylla* or *Pinus edulis* / *Juniperus osteosperma* woodlands are often found adjacent to this community, and occasionally scattered pinyon or juniper trees encroach into these open shrublands. *Gutierrezia sarothrae* (4%) is occasionally present in the short- or dwarf-shrub layers and, besides *Artemisia tridentata*, is the only other significant source of cover. Overall, this community has a sparse to sometimes absent understory.

A very sparse graminoid layer exists in some stands, with *Elymus elymoides* (1%) occurring most frequently. *Bouteloua gracilis* (1%) and *Sporobolus cryptandrus* (1%) also occur, but much less commonly. Forbs such as *Astragalus* sp. (trace cover), *Chamaesyce albomarginata* (1%), and *Descurainia* sp. (1%) sporadically occur. Based upon the 10 stands sampled, this association hosts extremely low species diversity among plant communities in Grand Canyon, with only 8 species per 400-square-meter plot.

Global Vegetation: This broadly defined association is used to describe *Artemisia tridentata*-dominated shrublands where the subspecies is not known and the herbaceous layer is generally sparse. The herbaceous layer may be limited by substrate or disturbance. Stands in Utah and California had a moderately dense short-shrub layer (25-70%) dominated by *Artemisia tridentata*. Associated shrub species may codominate, but more typically occur as scattered individuals including *Ericameria nauseosa (= Chrysothamnus nauseosus), Sarcobatus vermiculatus, Grayia spinosa, Gutierrezia sarothrae*, or *Opuntia polyacantha*. If present, the herbaceous layer typically consists of low cover of graminoids such as *Distichlis spicata* and *Elymus elymoides*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*
Herb (field)	Graminoid	*Elymus elymoides*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Artemisia tridentata*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Artemisia tridentata*, *Elymus elymoides*, *Gutierrezia sarothrae*
Global: *Artemisia tridentata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Convolvulus arvensis* (exotic, Medium/Low), *Eragrostis cilianensis* (exotic, Medium/Insignificant), *Lactuca serriola* (exotic, Low/Insignificant), *Marrubium vulgare* (exotic, Medium/Low), *Sisymbrium altissimum* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5? (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Grand Canyon National Park Comments: There are several other associations at Grand Canyon that are dominated by *Artemisia tridentata*, but this association is distinctive among these by its near monoculture of *Artemisia tridentata* and lack of other shrub or understory species.
Global Comments: This is a broadly defined, low-confidence association that could be split into several associations with more information. There are many associations defined for all subspecies of *Artemisia tridentata*. Leary and Peterson (1984) identified *Artemisia tridentata* in their stands to *ssp. tridentata*; however, their stands were almost pure *Artemisia tridentata* with little else to classify into a less general association.
Global Similar Associations:

- *Artemisia tridentata* / *Bouteloua gracilis* Shrubland (CEGL000995)
- *Artemisia tridentata* / *Elymus elymoides* Shrubland (CEGL001001)
- *Artemisia tridentata ssp. tridentata* / *Distichlis spicata* Shrubland (CEGL001000) This is one of many similar *Artemisia tridentata* associations without variety of *Artemisia tridentata* specified.

Global Related Concepts:

- *Artemisia tridentata* (Bourgeron and Engelking 1994) =
- *Artemisia tridentata* Association (Leary and Peterson 1984) <

- *Artemisia tridentata* Shrubland (Von Loh 2000) **=**
- *Artemisia tridentata* Vegetation Zone VIII (Ralston 1969) **<**
- DRISCOLL FORMATION CODE:III.A.2.b. (Driscoll et al. 1984) **>**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, Grand Canyon-Parashant National Monument), and from the South Rim. In the Western Grand Canyon, it was sampled from the Kanab Plateau and Toroweap Valley; in Grand Canyon-Parashant, it was sampled from the Shivwits Plateau near Mount Dellenbaugh and near Twin Creek Canyon; and on the South Rim, it was sampled from Pasture Wash.
Global Range: This sagebrush shrubland is reported from eastern California, Nevada, and Utah, but likely occurs throughout much of the Intermountain West.
Nations: US
States/Provinces: AZ, CA:S5, NV:S5, UT
TNC Ecoregions: 6:C, 10:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 341C:CC, 342B:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (10 plots): GRCA.02068, GRCA.02073, GRCA.02080, GRCA.03203, GRCA.03581, GRCA.03593, GRCA.04106, GRCA.04125, GRCA.04168, GRCA.04198.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Leary and Peterson 1984, Ralston 1969, Reid and Hall 2010, Von Loh 2000, Von Loh et al. 2002, Western Ecology Working Group n.d.

M095. Great Basin & Intermountain Xero-Riparian Scrub
G559. Cool Semi-Desert Shrub & Herb Wash-Arroyo

Ericameria nauseosa Desert Wash Shrubland

Rubber Rabbitbrush Desert Wash Shrubland
Identifier: CEGL002261

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin & Intermountain Xero-Riparian Scrub (M095)
Group	Cool Semi-Desert Shrub & Herb Wash-Arroyo (G559)
Association	*Ericameria nauseosa* Desert Wash Shrubland

ELEMENT CONCEPT

Global Summary: This association is found in or near temporary watercourses on point bars, basin floors, and low stream terraces in western Colorado and eastern Utah. Stands have been found between 1189 and 2104 m (3900-6900 feet) elevation. Sites are flat to gently sloping (<3 degrees) and of any aspect. The unvegetated surface is mostly bare soil, sand, and/or loose rocks. There is usually little litter, but sometimes woody debris can be deposited by floods. Parent materials are variable, but sandstone, shale, and gneiss are most common on sampled stands. Soils are rapidly drained to well-drained sands or sandy loams. This shrubland association has sparse to moderate total vegetation cover (1-65%). This association is characterized by an open short-shrub layer distributed in linear rows along the intermittent drainages. *Ericameria nauseosa* is the dominant shrub with 1-15% cover. Other shrubs are typically present but contribute little cover. These include *Artemisia tridentata*, *Atriplex canescens*, *Atriplex confertifolia*, *Ephedra viridis*, *Fraxinus anomala*, *Gutierrezia sarothrae*, *Purshia stansburiana*, *Quercus havardii*, and *Sarcobatus vermiculatus*. The herbaceous stratum has sparse to moderate cover. The exotic *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides*, *Descurainia pinnata*, *Elymus elymoides*, *Glycyrrhiza lepidota*, *Hesperostipa comata*, *Hordeum jubatum*, and *Pleuraphis jamesii*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This association is found in or adjacent to temporary watercourses on point bars, basin floors, and low stream terraces. Stands have been found between 1189 and 2104 m (3900-6900 feet) elevation. Sites are flat to gently sloping (<3 degrees) and of any aspect. The unvegetated surface is mostly bare soil, sand, and/or loose rocks. There is usually little litter, but sometimes woody debris can be deposited by floods. Parent materials are variable, but sandstone, shale, and gneiss are most common on sampled stands. Soils are rapidly drained to well-drained sands, sandy loams or silt loams derived from alluvium. Biological soil crusts may be present but do not provide much cover.

VEGETATION DESCRIPTION

Global Vegetation: This shrubland association has sparse to moderate total vegetation cover (1-65%). This association is characterized by an open to moderately dense short-shrub layer distributed in linear rows along the intermittent drainages. Ericameria nauseosa is the dominant shrub with 1-15% cover. In sparse or patchy stands, *Ericameria nauseosa* acts as an indicator species. Other shrubs are typically present, but contribute little cover. These include *Artemisia tridentata*, *Atriplex canescens*, *Atriplex confertifolia*, *Ephedra viridis*, *Fraxinus anomala*, *Gutierrezia sarothrae*, *Purshia stansburiana*, *Quercus havardii*, and *Sarcobatus vermiculatus*. The herbaceous stratum has sparse to moderate cover. The exotic *Bromus tectorum* is often abundant. Other herbaceous species commonly found are *Achnatherum hymenoides*, *Descurainia pinnata*, *Elymus elymoides*, *Glycyrrhiza lepidota*, *Hesperostipa comata*, *Hordeum jubatum*, and *Pleuraphis jamesii*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*

CHARACTERISTIC SPECIES

Global: *Ericameria nauseosa*

OTHER NOTEWORTHY SPECIES

Global: Vulnerable: *Parryella filifolia* (G3G4), *Shepherdia rotundifolia* (G3G4); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High); **Other**: *Quercus havardii* var. *tuckeri* (G4T3?Q)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (10-Jan-2005).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: In sparse or patchy stands, *Ericameria nauseosa* acts as an indicator species.
Global Similar Associations:

- *Ericameria nauseosa* / *Sporobolus airoides* Shrubland (CEGL002918)
- *Ericameria nauseosa* Shrubland (CEGL002713)
- *Fallugia paradoxa* Colorado Plateau Desert Wash Shrubland (CEGL002357)

ELEMENT DISTRIBUTION

Global Range: This association has been found in western Colorado and eastern Utah. It is likely found in other places of the arid western U.S.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 9:C, 10:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 313D:CC, 341B:CC, M331E:CC
Federal Lands: NPS (Arches, Canyonlands, Capitol Reef, Colorado, Dinosaur, Glen Canyon, Grand Canyon, Petrified Forest)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Drake, mod. J. Coles and K.A. Schulz
References: Clark et al. 2009, Coles et al. 2008a, Coles et al. 2009a, Reid and Hall 2010, Romme et al. 1993, Thomas et al. 2009a, Von Loh et al. 2007, Western Ecology Working Group n.d.

M093. Great Basin Saltbrush Scrub
G300. Intermountain Shadscale - Saltbush Scrub

Atriplex canescens / *Calycoseris parryi* Shrubland

Fourwing Saltbush / Yellow Tackstem Shrubland
Identifier: CEGL001284

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex canescens* / *Calycoseris parryi* Shrubland

ELEMENT CONCEPT

Global Summary: This association is warm desertscrub found on nearly level alluvial plains adjacent to the Colorado River, elevation 700-800 m. The common shrubs are *Atriplex canescens, Prosopis glandulosa* and *Suaeda moquinii (= Suaeda torreyana)*. The cacti *Opuntia erinacea* and *Opuntia basilaris* are common in this shrubland. Common ephemeral species include *Calycoseris parryi, Chaenactis stevioides, Erodium texanum*, and the Eurasian weed *Bromus rubens*. Near the river the *Prosopis glandulosa* density and size increase to form a thicket that resembles a mesquite 'bosque.' The soil is distinctive, a silty loam derived from the Grand Canyon series.

CONSERVATION STATUS RANK

Global Rank & Reasons: G2 (13-Nov-1997). This association is very rare being restricted to alluvial terraces along the south side of the Colorado River from one location in the eastern part of Grand Canyon National Park. Potential habitat outside the park along the Little Colorado River has not been surveyed. Effects from boating recreationalists on the "mesquite bosque" vegetation near the river is not known. Additionally, there is a hiking trail through the shrubland.

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: This association was added to the NVC based on Warren et al. (1982). Recent work in Grand Canyon National Park failed to identify any plots meeting this concept, but the association may well occur in the park or further west in Lake Mead National Recreation Area.
Global Similar Associations:

- *Atriplex canescens* / *Sporobolus airoides* Shrubland (CEGL001291)
- *Atriplex canescens* Shrubland (CEGL001281)

Global Related Concepts:

- 153. 1731 *Atriplex canescens - Opuntia erinacea - Prosopis glandulosa* Association (Warren et al. 1982) =
- *Atriplex canescens/Calycoseris parryi* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: This association is only found in the eastern part of the Grand Canyon on alluvial terraces on the south side of the Colorado River between Tanner Canyon and Cardenas Creek. It may occur in unsurveyed areas outside the park such as along the Little Colorado River on the Navajo Reservation.
Nations: US
States/Provinces: AZ:S2, NV?

TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 341:?
Federal Lands: NPS (Grand Canyon?)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Warren et al. 1982, Western Ecology Working Group n.d.

Atriplex canescens / *Muhlenbergia porteri* Shrubland

Fourwing Saltbush / Bush Muhly Shrubland
Identifier: CEGL005385

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex canescens* / *Muhlenbergia porteri* Shrubland

ELEMENT CONCEPT

Global Summary: This saltbush shrubland association is currently known from Salinas Pueblo Missions National Monument and White Sands Missile Range in New Mexico and Grand Canyon National Park in Arizona. The information below is based on data collected there and will be updated when additional inventory data are available. At Salinas Pueblo Missions, this association is reported from 1980 m (6490 feet) in elevation on a gentle, southwest-facing slope of a low hill. The substrate is derived from limestone of the Permian San Andres Formation. The ground surface is characterized by exposed soil and litter. The reported site is in close proximity to pueblo ruins, and soils appear to have been disturbed. At Grand Canyon, it occurs on fairly steep, mid and upper sideslopes at 1575 to 1625 m (5200-5300 feet) elevation, but likely also occurs outside of this elevational range. It is typically found on southeast- to southwest-facing, moderate to steep gradients (22-35 degrees). Soils are well- to rapidly-drained silty loams. This desert shrubland is dominated by *Atriplex canescens* with a luxuriant grass understory dominated by *Muhlenbergia porteri*, which can reach 40% total cover underneath shrubs and in the intershrub spaces. At Grand Canyon, *Juniperus osteosperma* trees occasionally occur, but tall shrubs are absent. The short-shrub layer also includes *Ephedra fasciculata, Aloysia wrightii, Coleogyne ramosissima, Opuntia bigelovii*, and *Yucca baccata*. The dwarf-shrub layer is poorly-developed and is typically represented only by *Gutierrezia sarothrae* or *Gutierrezia microcephala*. *Bromus rubens* often accompanies *Muhlenbergia porteri* in the graminoid understory, while other native bunch grasses such as *Achnatherum speciosum, Bouteloua curtipendula, Hesperostipa comata*, and *Tridens muticus* occasionally occur. At Salinas Pueblo Missions, *Bouteloua gracilis* and *Sporobolus contractus* are also common associates. A ruderal vegetation phase is indicated by the presence of *Erysimum capitatum, Marrubium vulgare, Phacelia integrifolia*, *Portulaca oleracea*, and *Solanum jamesii*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on fairly steep, mid and upper sideslopes in the Western Grand Canyon. It was observed at 1575 to 1625 m (5200-5300 feet) elevation, but likely also occurs outside of this elevational range. It is typically found on southeast- to southwest-facing, moderate to steep gradients (22-35 degrees). Soils are well- to rapidly-drained silty loams that typically obscure the underlying geology. Gravel (50%) and rocks (30%) strongly dominate the ground cover; however, a significant amount of litter (16%) is found in most stands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the codominance of the short shrub *Atriplex canescens* (4%) and the perennial grass *Muhlenbergia porteri* (3%). The tree *Juniperus osteosperma* (2%) occasionally punctuates this shrub-dominated community; however, tall shrubs are absent. Along with *Atriplex canescens*, the short-shrub layer (10%) also invariably includes

Ephedra fasciculata (1%), *Aloysia wrightii* (1%), *Coleogyne ramosissima* (1%), *Opuntia bigelovii (= Cylindropuntia bigelovii)* (1%), and *Yucca baccata* (2%). The dwarf-shrub layer is poorly-developed and is typically represented only by *Gutierrezia sarothrae* or *Gutierrezia microcephala* (1%). *Bromus rubens* (2%) often accompanies *Muhlenbergia porteri* in the graminoid understory (6%), while other native bunch grasses such as *Achnatherum speciosum, Bouteloua curtipendula, Hesperostipa comata*, and *Tridens muticus* occasionally occur at about 1% cover each. *Sphaeralcea ambigua* (1%) is common in the otherwise variable forb layer (3%). Based upon the 2 stands sampled, this association hosts above-average species diversity with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tree canopy	Needle-leaved tree	*Juniperus osteosperma*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Forb	*Sphaeralcea ambigua*
Herb (field)	Graminoid	*Muhlenbergia porteri*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aloysia wrightii*, *Atriplex canescens*, *Coleogyne ramosissima*, *Ephedra fasciculata*, *Juniperus osteosperma*, *Muhlenbergia porteri*, *Opuntia bigelovii*, *Sphaeralcea ambigua*, *Yucca baccata*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)
Global: Vulnerable: *Ephedra fasciculata* (G3?), *Opuntia bigelovii* (G3?)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (12-May-2009).

CLASSIFICATION

Status: Standard
Grand Canyon National Park Comments: *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (CEGL001288) is also dominated by *Atriplex canescens* and supports both *Yucca baccata* and *Gutierrezia sarothrae*; however, it is codominated by *Pleuraphis jamesii* (and not *Muhlenbergia porteri*, as is the case in *Atriplex canescens* / *Muhlenbergia porteri* Shrubland (CEGL005385).
Global Similar Associations:

- *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (CEGL001288) is also dominated by *Atriplex canescens* and supports both *Yucca baccata* and *Gutierrezia sarothrae*, but it is codominated by *Pleuraphis jamesii* rather than *Muhlenbergia porteri*.

Global Related Concepts:

- *Atriplex canescens* / *Muhlenbergia porteri* Plant Association (Muldavin et al. 2000b) =
- *Atriplex canescens* / *Muhlenbergia porteri* Plant Association (Muldavin et al. 1998d) =

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled below and to the south of the Sanup Plateau, near 220-Mile Canyon.
Global Range: This association is known from White Sands Missile Range and Salinas Pueblo Missions National Monument in New Mexico and Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ, NM
TNC Ecoregions: 19:C, 21:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, M313B:CC
Federal Lands: DOD (White Sands Missile Range); NPS (Grand Canyon, Salinas Pueblo Missions); USFWS (Sevilleta)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01646, GRCA.01650.
Local Description Authors: R. Meszaros
Global Description Authors: K.S. King after A. Kennedy and E. Muldavin, mod. M.J. Russo
References: Muldavin et al. 1998d, Muldavin et al. 2000b, Muldavin et al. 2011c, Reid and Hall 2010, Western Ecology Working Group n.d.

Atriplex canescens / *Pleuraphis jamesii* Shrubland

Fourwing Saltbush / James' Galleta Shrubland
Identifier: CEGL001288

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex canescens* / *Pleuraphis jamesii* Shrubland

ELEMENT CONCEPT

Global Summary: This broadly defined shrubland association has been reported from the Colorado Plateau and Uinta Basin and may occur in the Chihuahuan Desert and eastern California. As defined, this association occurs on two distinct types of landforms: alluvial flats and stream terraces with fine-textured, alkaline or saline silty clay loam soils, or on upland flats covered by eolian sand deposits. The vegetation is characterized by a sparse to moderately dense shrub layer (10-40% cover) dominated by *Atriplex canescens* with *Pleuraphis jamesii* dominating the herbaceous layer. Associated shrubs include *Ericameria nauseosa*, *Ephedra torreyana, Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Gutierrezia sarothrae, Artemisia bigelovii*, or *Opuntia polyacantha*, depending on topographic position and substrate. Other graminoids include *Achnatherum hymenoides* and *Sporobolus cryptandrus* on sandy sites, and *Bouteloua gracilis* and *Sporobolus airoides* on fine-textured soil. Forbs generally have low cover and may include *Sphaeralcea grossulariifolia* and *Chenopodium* spp. Introduced or weedy species, such as *Bromus tectorum, Descurainia pinnata*, and *Salsola kali*, are common on some sites.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on plateaus, sideslopes, and in drainages on the South Rim and in the Western Grand Canyon. It typically occurs at 1250 to 1825 m (4100-5950 feet) elevation, and seems to favor less extreme east- and west-facing aspects. It is typically found on flat or very gentle gradients (1-6 degrees). Soils are well- to rapidly-drained silty or sandy loams derived from various parent materials. Bare soil (62%) dominates ground cover, while some gravel (11%) and a relatively large amount of cryptogamic soil crust (7%) are found in most stands.
Global Environment: This shrubland association occurs in the Colorado Plateau and Uinta Basin of eastern Utah and western Colorado and may occur in the Chihuahuan Desert and eastern California. Elevation ranges from 300-1900 m. It occurs on two distinct types of landforms: upland sites such as sandsheets with coarse-textured soils, or lowland sites such as alluvial flats and stream terraces with fine-textured soils. Water tends to pond temporarily in both kinds of sites following heavy rainstorms or spring floods; thus salts tend to accumulate in the soils. Sites are generally level to gently sloping or may be in nearly undetectable shallow depressions. The upland soils are somewhat shallow eolian sands or sandy loams. Lowland sites typically have deep, alkaline, saline silty clay loams derived from alluvium. These substrates are generally less saline and occur higher in the floodplain than *Atriplex canescens* / *Sporobolus airoides*- or *Atriplex confertifolia*-dominated shrublands that prefer saline bottomland sites.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is codominated by the short shrub *Atriplex canescens* (8-10%) and the perennial grass *Pleuraphis jamesii* (3-4%). Tall shrubs are essentially absent. Along with *Atriplex canescens*, the short-shrub layer also occasionally includes *Ephedra torreyana* (3%) and *Yucca baccata* (1%). A fairly weak dwarf-shrub layer (3%) exists, in which *Gutierrezia sarothrae* (up to 2%) and *Opuntia polyacantha* (1%) occur most frequently. *Opuntia phaeacantha* and *Krascheninnikovia lanata* may also

occur in some stands. The *Pleuraphis jamesii*-dominated graminoid layer (6%) also supports *Bromus tectorum* (1%), *Achnatherum hymenoides* (2%), and *Bouteloua gracilis* (1%). The forb understory is somewhat variable; *Sphaeralcea ambigua* (1%) occurs in the majority of stands, while the exotic *Salsola tragus* can occur at significant cover (up to 15%) on disturbed sites. Based upon the 5 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.
Global Vegetation: This broadly defined shrubland association is characterized by a sparse to moderately dense canopy (10-40% cover) of shrubs dominated by *Atriplex canescens*, with a sparse to moderate graminoid layer that is dominated by *Pleuraphis jamesii*. Many stands have the appearance of a shrubby grassland and may form a mosaic with *Ericameria nauseosa, Sarcobatus vermiculatus* or *Atriplex confertifolia* shrublands. Associated shrubs may include *Ephedra torreyana, Grayia spinosa*, several species of *Opuntia*, *Chrysothamnus viscidiflorus, Krascheninnikovia lanata, Gutierrezia sarothrae*, and *Artemisia bigelovii*. Other graminoids include *Achnatherum hymenoides* and *Sporobolus cryptandrus* on sandy sites, and *Bouteloua gracilis* and *Sporobolus airoides* on fine-textured soils of lowland sites. Forbs generally have low cover and may include *Astragalus nuttallianus, Cryptantha crassisepala, Descurainia pinnata, Mentzelia albicaulis, Phacelia crenulata, Sphaeralcea grossulariifolia*, and *Chenopodium* spp. Introduced species such as *Bromus tectorum, Erodium cicutarium*, and *Salsola kali* are common on some sites. In many sites, the herbaceous layer is sparse because of a history of grazing or other disturbance.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Chrysothamnus viscidiflorus, Ericameria nauseosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Short shrub/sapling	Dwarf-shurb	*Gutierrezia sarothrae, Krascheninnikovia lanata*
Herb (field)	Graminoid	*Achnatherum hymenoides, Bouteloua gracilis, Pleuraphis jamesii, Sporobolus airoides, Sporobolus cryptandrus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Achnatherum hymenoides*, *Atriplex canescens*, *Ephedra torreyana*, *Gutierrezia sarothrae*, *Opuntia phaeacantha*, *Opuntia polyacantha*, *Pleuraphis jamesii*, *Salsola tragus*, *Sphaeralcea ambigua*, *Yucca baccata*
Global: *Atriplex canescens*, *Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic), *Salsola tragus* (exotic)
Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Salsola kali* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G3G4 (1-Feb-1996).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: *Atriplex canescens* / *Muhlenbergia porteri* Shrubland (CEGL005385) is also dominated by *Atriplex canescens* and supports both *Yucca baccata* and *Gutierrezia sarothrae*; however, *Muhlen-*

bergia porteri (and not *Pleuraphis jamesii*) comprises the majority of the codominant graminoid understory in this community type.

Global Comments: As this association is currently defined, it is characterized only by the codominance of *Atriplex canescens* and *Pleuraphis jamesii*. Its relation to several similar associations is also unclear. Most of the information available suggests that the sparse shrub canopy is more typical and that this association should not be classified as a shrubland (Miller et al. 1977, Francis 1986, Von Loh 2000). Because it has a wide distribution (from southern Great Plains to the Mojave Desert), stands occur in diverse habitats (clayey bottomland to sand dunes) and vary from a sparse to moderate shrub canopy. It is likely that, when more information becomes available and the needed classification work is completed, this association will be subdivided.

The diagnostic species require warm sites with somewhat alkaline soils, so this association should be relatively widespread throughout the Colorado Plateau and western Great Plains. That it is not may reflect spotty sampling of the region, or it may indicate that this association has been mostly altered by grazing. This association may represent a form of *Atriplex canescens* / *Sporobolus airoides* Shrubland (CEGL001291) that has been degraded by domestic livestock grazing. The concept of *Atriplex canescens* / *Sporobolus airoides* Shrubland includes *Pleuraphis jamesii* in the herbaceous layer. In addition, the species lists for related and equivalent communities cited in the References section include both *Pleuraphis jamesii* and *Sporobolus airoides* in the herbaceous layer. It is possible that these associations (CEGL001288 and CEGL001291) should be combined, as it appears they are distinguished primarily by which of the two grasses is dominant. It is possible that summer-long grazing has reduced or eliminated *Sporobolus airoides* from many stands in the Colorado Plateau, leaving *Pleuraphis jamesii* and *Bouteloua gracilis* as more grazing-resistant species. Distinguishing these two associations because of different intensities of historic grazing may not be ecologically valid.

Global Similar Associations:

- *Atriplex canescens* / *Achnatherum hymenoides* Shrubland (CEGL001289) is similar to sandy site stands of this association.
- *Atriplex canescens* / *Bouteloua gracilis* Shrubland (CEGL001283) is similar to clayey bottomland and alluvial flats stands of this association.
- *Atriplex canescens* / *Muhlenbergia porteri* Shrubland (CEGL005385) is also dominated by *Atriplex canescens* and supports both *Yucca baccata* and *Gutierrezia sarothrae*, but *Muhlenbergia porteri* rather than *Pleuraphis jamesii* codominates the graminoid understory.
- *Atriplex canescens* / *Sporobolus airoides* Shrubland (CEGL001291) is similar to clayey bottomland and alluvial flats stands of this association.
- *Atriplex canescens* Shrubland (CEGL001281)
- *Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation (CEGL005801)
- *Pleuraphis jamesii* Herbaceous Vegetation (CEGL001777)

Global Related Concepts:

- *Atriplex canescens* / *Hilaria jamesii* Plant Community (Francis 1986) =
- *Atriplex canescens* / *Pleuraphis jamesii* Shrubland (Von Loh 2000) =
- *Atriplex canescens*/*Hilaria jamesii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >
- Greasewood-saltbush map symbol (BLM 1979a) ?
- Mapping symbol 313.11 Atca - Bogr - Hija - Spai (Miller et al. 1977) ><
- Mesquite-Saltbush Series (Diamond 1993) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the South Rim, where it was sampled to the east of Palisades of the Desert and near Cape Solitude; and from the Western Grand Canyon, where it was sampled from Toroweap Valley and Tuckup Canyon.

Global Range: This association has been documented from the Colorado Plateau (Four Corners region) of southeastern Utah and southwestern Colorado. It is to be expected in adjacent northern Arizona and New Mexico, and probably occurs in the Chihuahuan Desert and eastern California. Because the habitat and the diagnostic species are relatively common in this region, the association should be widespread; grazing by sheep and cattle may have eliminated most stands. The sites used in this description have also been grazed heavily and show high cover by disturbance-tolerant herbaceous species.

Nations: US

States/Provinces: AZ:S2, CA?, CO:SU, NM?, TX:S4, UT:S3S4, WY
TNC Ecoregions: 10:C, 19:C, 24:C, 27:C, 28:?, 29:?
USFS Ecoregions (1994/95): 313A:CC, 313B:CC, 313D:CC, 315:C, 321:C, 331I:??, 341B:CC, 341C:CC
Federal Lands: NPS (Canyonlands, Capitol Reef, Grand Canyon, Hovenweep, Petrified Forest); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (5 plots): GRCA.02237, GRCA.02579, GRCA.03222, GRCA.04608, GRCA.04615.
Local Description Authors: R. Meszaros
Global Description Authors: K.A. Schulz, mod. J. Coles
References: BLM 1979a, BLM 1979b, Bourgeron and Engelking 1994, CONHP 2010, CONHP unpubl. data 2003, Clark et al. 2009, Diamond 1993, Driscoll et al. 1984, Francis 1986, Miller et al. 1977, Reid and Hall 2010, Romme et al. 1993, Shute and West 1978, Soil Conservation Service 1978, Thomas et al. 2009a, U.S. Bureau of Reclamation 1976, Von Loh 2000, Von Loh et al. 2002, Von Loh et al. 2008, WNDD unpubl. data, Western Ecology Working Group n.d.

Atriplex canescens Shrubland

Fourwing Saltbush Shrubland
Identifier: CEGL001281

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex canescens* Shrubland

ELEMENT CONCEPT

Global Summary: This shrubland association is known from the Great Basin north into the southern Columbia Basin and east into Wyoming and the Colorado Plateau. It is common at middle elevations on alluvial fans and toeslopes in deep, sandy soils but will occur at lower elevations along alluvial benches where soils are often finer-textured and possibly saline/alkaline. Parent materials are variable. The vegetation is characterized by a sparse to moderately dense short-shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare (= Eriogonum kearneyi), Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum*, or *Psorothamnus* spp. *Artemisia bigelovii, Artemisia tridentata*, and *Ephedra viridis, Krascheninnikovia lanata*, or *Purshia stansburiana* may be present but are not codominants. The herbaceous layer includes low cover of species such as *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii*, and *Sporobolus cryptandrus*. Introduced species, especially *Bromus tectorum, Bromus diandrus*, and *Salsola kali*, are common on disturbed sites and can create an herbaceous layer much denser than on undisturbed sites. Winter annual forb cover is variable depending on annual precipitation.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This fourwing saltbush shrubland association occurs in the eastern-most portion of the South Rim, between the rim of the main canyon and the eastern boundary of the park. It occurs at the lowest elevations of the South Rim, at 1775 to 1825 m (5825-6000 feet) elevation, on flat to gentle slopes of the plateau, or in the bottom of small, localized drainage channels. This plant community seems to favor east-facing slopes and occurs in rapidly-drained or well-drained, limestone-derived loam soils. Bare soil (40-76%) and gravel (up to 20%) predominate the ground cover, while litter (up to 15%) is fairly sparse.
Global Environment: This widespread shrubland association occurs throughout much of the western U.S. and is found on bajadas, low stream terraces, valley floors and toeslopes. Sites are flat to gently sloping with any aspect. It is commonly found on deep, sandy soils at middle elevations (1235-2256 m [4050-7400 feet]) on the Colorado Plateau, but will occur at lower elevations (down to 610 m [2000 feet]) along alluvial benches where soils are often finer-textured and possibly saline/alkaline (Beatley 1976) in the Great Basin region. The unvegetated surface is predominantly bare soil and/or sand. Larger rocks and organic material are rare. Parent materials include volcanic tuff, shale and sandstone. At lower elevations, it may occur as a mosaic with *Lycium pallidum - Grayia spinosa*- or

Atriplex confertifolia-dominated shrublands.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: A somewhat sparse (5-10%) shrub layer of *Atriplex canescens* characterizes this association, and it often occurs within a larger matrix of grassland and sparse shrubland vegetation types. Other scattered shrubs, such as *Ephedra torreyana*, *Artemisia bigelovii, Gutierrezia sarothrae*, and *Krascheninnikovia lanata*, may occurs at very low covers (up to 1%). This community sometimes supports a well-developed graminoid understory, and other times grasses are essentially absent. When present, *Pleuraphis jamesii* (4%), *Bouteloua gracilis* (2%), and *Achnatherum* spp. (9%) are common members of the graminoid component. Forb composition is somewhat variable among stands; however, *Sphaeralcea parvifolia* (up to 3%) and weedy species such as *Salsola tragus* (up to 15% cover), *Amaranthus* sp. (1%), and *Portulaca oleracea* (1%) may occur. Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with only 10 species per 400-square-meter plot.

Global Vegetation: This broadly defined association is characterized by a sparse to moderately dense shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Total vegetation cover ranges from sparse to moderate (5-56% cover). Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare (= Eriogonum kearneyi), Ericameria nauseosa, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum, Psorothamnus fremontii*, or *Psorothamnus polydenius*. *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Krascheninnikovia lanata*, or *Purshia stansburiana* may be present but are not codominants. *Artemisia filifolia* may be present to subdominant in a few stands. The typically sparse herbaceous layer includes low cover of semi-arid grasses such as *Achnatherum hymenoides (= Oryzopsis hymenoides), Aristida purpurea, Elymus elymoides, Pleuraphis jamesii (= Hilaria jamesii)*, and *Sporobolus cryptandrus*. Common forb species on sandy sites include *Cymopterus ripleyi, Dalea searlsiae, Lesquerella ludoviciana*, and *Oenothera pallida*, and on disturbed sites *Cryptantha crassisepala, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis, Lepidium montanum, Plantago patagonica*, and *Rumex hymenosepalus* may be present. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus diandrus, Salsola kali*, and *Tribulus terrestris* can be common on disturbed sites and may form a moderately dense herbaceous stratum.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*
Herb (field)	Graminoid	*Pleuraphis jamesii*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Atriplex canescens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex canescens*, *Bouteloua gracilis*, *Pleuraphis jamesii*
Global: *Atriplex canescens*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus tectorum* (exotic, High), *Portulaca oleracea* (exotic), *Salsola tragus* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate

Global Similar Associations:
- *Artemisia tridentata - Atriplex canescens - Sarcobatus vermiculatus / (Achnatherum hymenoides)* Shrubland (CEGL001355)
- *Atriplex canescens - Artemisia tridentata* Shrubland (CEGL001282)
- *Atriplex canescens - Ephedra viridis* Talus Shrubland (CEGL001287)
- *Atriplex canescens - Krascheninnikovia lanata* Shrubland (CEGL001285)
- *Atriplex canescens / Achnatherum hymenoides* Shrubland (CEGL001289)
- *Atriplex canescens / Calycoseris parryi* Shrubland (CEGL001284)
- *Atriplex canescens / Pleuraphis jamesii* Shrubland (CEGL001288)
- *Atriplex canescens / Purshia stansburiana* Shrubland (CEGL001286)
- *Atriplex canescens / Sporobolus airoides* Shrubland (CEGL001291)
- *Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda* Shrub Herbaceous Vegetation (CEGL001733)
- *Prosopis glandulosa / Atriplex canescens* Shrubland (CEGL001382)

Global Related Concepts:
- *Atriplex canescens* (Bourgeron and Engelking 1994) **=**
- *Atriplex canescens* Association (Beatley 1976) **>**
- *Atriplex canescens* Sparse Plant Association (Muldavin et al. 1998d) **=**
- *Atriplex* ssp. Shrubland Alliance (Ostler et al. 2000) **>**
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) **>**
- Fourwing Saltbush/Sparse Undergrowth PA (Muldavin et al. 2000b) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the eastern portion of the South Rim. It was sampled from near Cape Solitude and on the plateau east of Palisades of the Desert.
Global Range: This shrubland association may occur throughout much of the interior western U.S. It is known from the southern Columbia Basin and Great Basin east into Wyoming and the Colorado Plateau.
Nations: US
States/Provinces: AZ, CA:S3, CO, NM, NV:S5, UT, WY:S3?
TNC Ecoregions: 6:C, 10:C, 11:C, 18:C, 19:C, 24:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, 342B:CC, 342G:C?
Federal Lands: DOD (White Sands Missile Range); NPS (Arches, Canyonlands, Capitol Reef, Chaco Culture, Colorado, Glen Canyon, Grand Canyon, Hubbell Trading Post, Pipe Spring, Zion); USFWS (Sevilleta)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 field data (6 plots): GRCA.02576, GRCA.03036, GRCA.03551, GRCA.03553, GRCA.03580, GRCA.03596.
Local Description Authors: K. Christie
Global Description Authors: K.A. Schulz, mod. J. Drake, J. Coles, G. Kittel
References: Beatley 1976, Bourgeron and Engelking 1994, Clark et al. 2009, Cogan et al. 2004, Coles et al. 2008b, Coles et al. 2009a, Driscoll et al. 1984, Howard 2003, Muldavin et al. 1998d, Muldavin et al. 2000b, Ostler et al. 2000, Peterson 2008, Reid and Hall 2010, Romme et al. 1993, Salas and Bolen 2010b, Salas et al. 2011, Von Loh et al. 2007, Western Ecology Working Group n.d.

Atriplex confertifolia - Lycium andersonii Shrubland

Shadscale - Water Jacket Shrubland
Identifier: CEGL001308

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex confertifolia - Lycium andersonii* Shrubland

ELEMENT CONCEPT

Global Summary: This xeromorphic shrubland association has been described locally from areas of rolling 'badlands' terrain in the eastern part of Grand Canyon National Park in northwestern Arizona. Elevation ranges from 950-1460 m. This vegetation is an unusual mixture of Mojavean and Colorado Plateau species, and may be unique to the Grand Canyon. Similar vegetation has also been reported from California and may also occur in southern Nevada. It is not known if this association represents the same vegetation type as the stands reported from California. Sites occur on all aspects and although slopes are moderate to gentle (<40%), the substrates are unstable and prone to surface movement. Substrates are shallow, gravelly, poorly developed soil derived from silt- and mud-stone shale. Stands have an open, short woody canopy (0.5-2 m tall) that is dominated by the facultatively deciduous shrub, *Atriplex confertifolia*, or codominating with *Lycium andersonii*. Other common shrubs and dwarf-shrubs may include *Ephedra nevadensis, Ephedra torreyana, Acacia greggii, Encelia frutescens, Tiquilia latior*, and *Gutierrezia sarothrae*. Cacti are common and may include *Opuntia basilaris, Opuntia erinacea, Echinocereus engelmannii* and *Echinocactus polycephalus*. The sparse herbaceous layer is dominated by the introduced annual *Bromus rubens*.

CONSERVATION STATUS RANK

Global Rank & Reasons: G3 (20-Sep-2000). These shrublands are rare and have only been described from the eastern part of Grand Canyon National Park in Chuar and Kwagunt valleys, and Marble Canyon. They are restricted to unstable substrates derived from friable siltstone, mudstone, or shale. Similar stands are also reported from California, however, this vegetation has an unusual combination of Mojavean and Colorado Plateau species and may be endemic to Grand Canyon. More survey and classification work is needed to determine if this association represents the same vegetation type as the stands reported from California. If the vegetation is the same, then rank will need to be changed to G4 or G5.

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak
Global Comments: This association was not identified during recent classification work at Grand Canyon National Park. It may need to be archived and replaced with 1 or 2 newly defined associations. Further review is needed. Alternatively, it may well occur in the park but was not found during the plot data collection.
Global Related Concepts:

- *Atriplex confertifolia-Lycium andersonii* (Bourgeron and Engelking 1994) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Global Range: These open shrublands have been described from the eastern portion of Grand Canyon National Park in northwestern Arizona. Stands have been reported from California in the Mojave Desert, and may also occur in southern Nevada.
Nations: US
States/Provinces: AZ:S3, CA:S1?
TNC Ecoregions: 11:C, 17:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:??
Federal Lands: NPS (Grand Canyon?)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: K.A. Schulz
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Reid and Hall 2010, Sawyer and Keeler-Wolf 1995, Warren et al. 1982, Western Ecology Working Group n.d.

Atriplex confertifolia Great Basin Shrubland

Shadscale Great Basin Shrubland
Great Basin Shadscale Shrubland
Identifier: CEGL001294

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex confertifolia* Great Basin Shrubland

ELEMENT CONCEPT

Global Summary: This shrub association occurs in scattered stands on ridges, flats, alluvial fans, talus slopes and badlands throughout the Colorado Plateau and Great Basin, often in a matrix of other high desert shrublands. Sites tend to occur on level to gentle slopes between 1158 and 2194 m (3800-7200 feet) elevation. Soils tend to be alkaline, shallow, well-drained clay loams, sometimes with a high rock or gravel content. Parent materials are variable but generally include a high percentage of calcareous source rocks. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other species of shrubs may also be present, although they contribute little to the total canopy, including *Gutierrezia sarothrae, Krascheninnikovia lanata, Kochia americana, Picrothamnus desertorum, Acamptopappus shockleyi, Atriplex canescens, Ephedra nevadensis, Sarcobatus vermiculatus*, and *Ericameria nauseosa*. The herbaceous layer rarely has more than 5% total cover; species vary greatly by location, but common graminoids include *Elymus multisetus, Elymus elymoides, Leymus salinus, Poa secunda, Dasyochloa pulchella (= Erioneuron pulchellum)*, and *Pleuraphis jamesii*. Forbs are diverse but only contribute measurable cover in unusually wet years; *Chaenactis douglasii, Phacelia crenulata*, and *Mentzelia albicaulis* are widespread. Disturbed sites have high cover of *Bromus tectorum*.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This saltbush shrubland association occurs on sideslopes or rarely in drainages in Marble Canyon and the eastern Inner Canyon. It typically occurs at 950 to 1150 m (3150-3750 feet) elevation, but has been observed as high as 1275 m (4150 feet). It is typically found on east- to northeast-facing, moderate slopes (15-25 degrees), but can also occur on gentler slopes (4 degrees). Soils are rapidly-drained silty loams or sandy clays that typically lie on top of shale or limestone. Ground cover tends to be dominated by gravel (38%), bare soil (25%), and rocks (17%).

Global Environment: This shrub association occurs in scattered stands on ridges, flats, alluvial fans, talus slopes and badlands throughout the Colorado Plateau and Great Basin. Sites tend to occur on level to gentle slopes between 1158 and 2194 m (3800-7200 feet) elevation. Soils tend to be alkaline, shallow, well-drained and have clay loam textures, sometimes with a high rock and/or gravel content. Parent materials are variable but generally include a high percentage of calcareous source rocks.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is dominated by the dwarf-shrub *Atriplex confertifolia* (7-10%). Tall shrubs are absent, and the short-shrub layer is typically sparse, but usually includes *Ephedra torreyana* (2%). Along with *Atriplex confertifolia*, the dwarf-shrub layer also usually includes *Opuntia polyacantha* (1%), *Gutierrezia sarothrae* (1%), and *Opuntia basilaris* (1%). The exotic *Bromus rubens* (sometimes up to 15% cover) invariably occurs in the graminoid understory, while the native bunch grasses *Pleuraphis jamesii* (1%) and *Aristida purpurea* (1%) are also fairly common. A sparse forb layer (3%) is present in which *Eriogonum inflatum* (1%), *Erodium cicutarium* (2%), and *Malacothrix glabrata* (up to 1%) occur most frequently. Based upon the 4 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

Global Vegetation: This association often occurs in a matrix of other high desert shrublands. Total vegetation cover rarely exceeds 20% and is clearly dominated by *Atriplex confertifolia*. Many other species of shrubs may also be present, although they contribute little to the total canopy, including *Gutierrezia sarothrae, Krascheninnikovia lanata, Kochia americana, Picrothamnus desertorum, Acamptopappus shockleyi, Atriplex canescens, Ephedra nevadensis, Sarcobatus vermiculatus*, and *Ericameria nauseosa*. The herbaceous layer rarely has more than 5% total cover; species vary greatly by location, but common graminoids include *Elymus multisetus, Elymus elymoides, Leymus salinus, Poa secunda, Dasyochloa pulchella (= Erioneuron pulchellum)*, and *Pleuraphis jamesii*. Forbs are diverse but only contribute more than trace cover in unusually wet years; *Atriplex powellii, Sphaeralcea coccinea, Chaenactis douglasii, Phacelia crenulata*, and *Mentzelia albicaulis* and the exotic annual *Salsola tragus* are widespread. Disturbed sites have high cover of *Bromus tectorum*.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra torreyana*
Herb (field)	Dwarf-shurb	*Atriplex confertifolia*
Herb (field)	Graminoid	Bromus rubens

Global

Stratum	Lifeform	Species
hort shrub/sapling	Broad-leaved deciduous shrub	*Atriplex confertifolia*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Aristida purpurea*, *Atriplex confertifolia*, *Bromus rubens*, *Ephedra torreyana*, *Gutierrezia sarothrae*, *Opuntia basilaris*, *Opuntia polyacantha*, *Pleuraphis jamesii*
Global: *Atriplex confertifolia*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Acamptopappus shockleyi* (G3?); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High), *Salsola tragus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: G5 (23-Feb-1994).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Comments: This broadly defined association describes *Atriplex confertifolia* shrublands that have either a sparse understory or lack any diagnostic species in the understory. It also includes degraded stands that have an understory dominated by weedy species.
Global Similar Associations:
- *Atriplex confertifolia* / *Achnatherum hymenoides* Shrubland (CEGL001311)
- *Atriplex confertifolia* / *Kochia americana* Shrubland (CEGL001305)
- *Atriplex confertifolia* / *Pleuraphis jamesii* Shrubland (CEGL001304)
- *Atriplex confertifolia* Sparse Shrubland (CEGL003830)
- *Atriplex confertifolia* Wyoming Basins Shrubland (CEGL001293)

Global Related Concepts:
- *Atriplex confertifolia* (Community II) (Bourgeron and Engelking 1994) =
- *Atriplex confertifolia* Association (Peterson 1984) =
- *Atriplex confertifolia* Association (Leary and Peterson 1984) =
- *Atriplex confertifolia* Association (Beatley 1976) >
- *Atriplex confertifolia* Association (Blackburn et al. 1969c) =
- DRISCOLL FORMATION CODE:III.C.1.b. (Driscoll et al. 1984) >

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the eastern portion of the Inner Canyon, where it was sampled in Badger Canyon, Soap Creek, Lava-(Chuar) Canyon, and Tanner Canyon.
Global Range: This association has been documented from plots in western Colorado and southern Utah. It is also reported to occur in Nevada (Rickard and Beatley 1965, Blackburn et al. 1968a) and the Cottonwood Mountains in Death Valley National Park, California (Peterson 1984).
Nations: US
States/Provinces: AZ, CA?, CO, NV:S5, UT

TNC Ecoregions: 6:C, 9:C, 11:C, 17:C, 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 322A:CC, 341B:CC, 342B:CC, M331E:CC, M341C:CC
Federal Lands: NPS (Bryce Canyon, Canyonlands, Capitol Reef, Death Valley, Dinosaur, Grand Canyon, Great Basin)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (4 plots): GRCA.01014, GRCA.01542, GRCA.03038, GRCA.03045.
Local Description Authors: R. Meszaros
Global Description Authors: J. Coles, mod. G. Kittel
References: Beatley 1976, Blackburn et al. 1969c, Bourgeron and Engelking 1994, Bradley 1964, Clark et al. 2009, Coles et al. 2008a, Driscoll et al. 1984, Leary and Peterson 1984, Peterson 1984, Peterson 2008, Reid and Hall 2010, Rickard and Beatley 1965, Romme et al. 1993, Schulz and Hall 2011, Tendick et al. 2011b, Western Ecology Working Group n.d.

Atriplex obovata Talus Dwarf-shrubland

Mound Saltbush Talus Dwarf-shrubland
Identifier: CEGL001789

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Atriplex obovata* Talus Dwarf-shrubland

ELEMENT CONCEPT

Global Summary: This saltbush dwarf-shrubland association is currently described from Grand Canyon National Park in northern Arizona. More survey and classification work are needed to fully characterize this type. It occurs on talus sideslopes at 975 to 1150 m (3225-3775 feet) elevation, and is typically found on moderate to steep (15-40 degrees), south- or southeast-facing slopes. Soils are rapidly drained silty or sandy loams that usually overlie limestone or sandstone bedrock. Vegetation is characterized by the dominance of *Atriplex obovata* in the short-shrub stratum. Tall shrubs are absent. *Ephedra torreyana* also regularly occurs in the short-shrub layer. A fairly sparse dwarf-shrub layer exists, in which *Opuntia basilaris, Gutierrezia sarothrae*, and *Brickellia atractyloides* may sporadically occur. *Bromus rubens* and *Muhlenbergia porteri* are frequently present in a well-developed graminoid layer that is typically dominated by non-native annuals. *Dasyochloa pulchella* and *Sporobolus* sp. also commonly occur. *Cryptantha* sp., *Thymophylla pentachaeta, Machaeranthera pinnatifida, Lepidium* sp., and *Phacelia crenulata* are common components of the forb understory.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This saltbush dwarf-shrubland association occurs on talus sideslopes in the upper portion of Marble Canyon (Inner Canyon). It occurs at 975 to 1150 m (3225-3775 feet) elevation, and is typically found on moderate to steep (15-40 degrees), south- or southeast-facing slopes. Soils are rapidly drained silty or sandy loams that usually lie on top of limestone or sandstone bedrock. Rocks (54%), gravel (21%), and bedrock (9%) dominate the ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 10-15% in this association which is characterized by the dominance of *Atriplex obovata* (6-8%) in the short-shrub stratum. Tall shrubs are absent from this association. Along with *Atriplex obovata, Ephedra torreyana* (3-5%) regularly occurs in the short-shrub layer. A fairly sparse dwarf-shrub layer (2%) exists, in which *Opuntia basilaris, Gutierrezia sarothrae*, and *Brickellia atractyloides* may sporadically occur at low individual covers. *Bromus rubens* (5%) and *Muhlenbergia porteri* (1%) are frequently present in a well-developed graminoid layer that is typically dominated by non-native annuals. *Dasyochloa pulchella* (1%) and *Sporobolus* sp. (1%) also commonly occur. *Cryptantha* sp. (1%), *Thymophylla pentachaeta* (1%), *Machaeranthera pinnatifida* (2%), *Lepidium* sp. (1%), and *Phacelia crenulata* (1%) are common components of the

forb understory (6%). Based upon the 7 stands sampled, this association hosts average species diversity among plant communities in Grand Canyon, with 16 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Atriplex obovata*
Herb (field)	Graminoid	*Bromus rubens*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex obovata*, *Bromus rubens*, *Ephedra torreyana*, *Machaeranthera pinnatifida*, *Muhlenbergia porteri*, *Opuntia basilaris*, *Phacelia crenulata*, *Thymophylla pentachaeta*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (7-Jan-2003).

CLASSIFICATION

Status: Standard
Global Related Concepts:
- *Atriplex obovata* Dwarf-shrubland (Thomas et al. 2003b) **=**

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Marble Canyon region of the Inner Canyon. It was sampled in Marble Canyon and in its tributaries including Soap Creek, Badger Canyon, Rider Canyon, and from near 24-Mile Rapids.
Global Range: This shrubland association is currently known from Grand Canyon National Park in northern Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC, 313B:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (7 plots): GRCA.03035, GRCA.03037, GRCA.03040, GRCA.03042, GRCA.03044, GRCA.03047, GRCA.04552.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Thomas et al. 2003b, Western Ecology Working Group n.d.

Lycium pallidum Shrubland [Park Special]

Pale Desert-thorn Shrubland
Identifier: CEPS009537

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Great Basin Saltbrush Scrub (M093)
Group	Intermountain Shadscale - Saltbush Scrub (G300)
Association	*Lycium pallidum* Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association is known from various mid- and low-elevation habitats in the Inner Canyon. It can be fairly well-developed in sandy habitats near the old high-water line along the Colorado River corridor. Some evidence suggests that it occurs in close proximity to archeological midden sites.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 30% in this association which is characterized by the dominance of *Lycium pallidum* (15%) in the short-shrub layer. *Larrea tridentata* (15%) is occasionally codominant, and *Prosopis glandulosa* (3%) sometimes occurs as well; however, these associate tall shrubs are not present in all stands. Other scattered short shrubs such as *Encelia farinosa*, *Bebbia juncea*, and *Isocoma acradenia* occur in most stands at low individual covers (1-3%). Dwarf-shrubs are lacking, and graminoids (1%) and forbs (1%) are very sparse.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Thorn shrub	*Lycium pallidum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Encelia farinosa*, *Larrea tridentata*, *Lycium pallidum*, *Prosopis glandulosa*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Jul-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled along the Colorado River corridor.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on two (2) Grand Canyon Monitoring and Reseach Center (GCMRC)/United States Geological Survey (USGS) plots.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

M499. Western North American Ruderal & Planted Semi-Desert Scrub & Grassland
G600. Great Basin & Intermountain Ruderal Dry Shrubland & Grassland

Bromus tectorum Semi-natural Herbaceous Vegetation

Cheatgrass Semi-natural Herbaceous Vegetation
Cheatgrass Annual Grassland

Identifier: CEGL003019

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Western North American Ruderal & Planted Semi-Desert Scrub & Grassland (M499)
Group	Great Basin & Intermountain Ruderal Dry Shrubland & Grassland (G600)
Association	*Bromus tectorum* Semi-natural Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain West. It occurs most often after disturbance of a natural shrub- or grass-dominated community that results in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. *Bromus tectorum* typically dominates the community with over 80-90% of the total vegetation cover, making it difficult to determine what natural community was formerly present. This vegetation also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species such as *Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. It is distinct from the extensive annual *Bromus* communities found along the Pacific Coast typical of the Mediterranean or maritime climates.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This cheatgrass association mostly occurs on mid- to high-elevation plateaus, on the North Rim and in Grand Canyon-Parashant National Monument; but has also been found on moderately steep (23 degrees) slopes in the Inner Canyon. It occurs primarily from 1850 to 2425 m (6050-7950 feet) elevation, but has been observed as low as 900 m (3270 feet). Soils are usually well-drained silt or clay loams, but sand substrates can also occur. The ground cover tends to be dominated by litter (55%), gravel (11%), rocks (7%), wood (5%), and bare soil or sand (7%). The distribution of this community is driven primarily by disturbance regimes and not environmental conditions; therefore, it can be expected in various disturbed areas throughout the entire park.
Global Environment: This herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the Intermountain and southwestern U.S. Elevation ranges from sea level to 2200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community, resulting in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*, although invasion of undisturbed sites has also been reported (e.g., Evans et al. 2001). At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). In the Great Basin, *Bromus tectorum* grasslands have invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Short and dwarf-shrubs occasionally exist in this herbaceous community (up to 5% cover); however, there is little compositional consistency among stands. This association is characterized by a well-developed graminoid layer dominated by the exotic *Bromus tectorum* (30%). The perennial grasses *Poa fendleriana* (2%) and *Elymus elymoides* (1%) also occur with some regularity. *Bromus rubens* occurs sporadically, but when present has significant cover (10%). A variety of different forb species can occur (typically 4-6% cover), depending upon the habitat of the site.
Global Vegetation: This vegetation type is characterized by a sparse to dense, short, annual graminoid layer that is typically dominated by *Bromus tectorum* with over 80-90% of the total vegetation cover. Other Eurasian introduced annual species of *Bromus* which may alternatively dominate or codominate are *Bromus carinatus, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. Although there may be remnant species of the former native vegetation, the high cover of annual bromes makes it difficult to determine what natural community was formerly present. Weedy and exotic annual forbs may also have significant cover in some stands. Scattered shrubs and dwarf-shrubs, especially *Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra viridis, Gutierrezia sarothrae*, and *Opuntia polyacantha*, may be present with low cover. At Wind Cave National Park in South Dakota, this weedy non-native graminoid vegetation is usually dominated by several perennial and annual brome grasses, including *Bromus inermis, Bromus japonicus*, and *Bromus tectorum*. Cover is variable (H. Marriott pers. comm. 1999), and in drought years, *Bromus tectorum* may be sparse or absent.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bromus tectorum*

Global

Stratum	Lifeform	Species
Herb (field)	Graminoid	*Bromus carinatus, Bromus hordeaceus, Bromus japonicus, Bromus madritensis, Bromus rigidus, Bromus rubens, Bromus tectorum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Bromus rubens*, *Bromus tectorum*, *Elymus elymoides*, *Erigeron divergens*, *Poa fendleriana*, *Tragopogon dubius*
Global: *Bromus carinatus*, *Bromus hordeaceus*, *Bromus japonicus*, *Bromus madritensis*, *Bromus rigidus*, *Bromus rubens*, *Bromus tectorum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low), *Lactuca serriola* (exotic, Low/Insignificant), *Sisymbrium altissimum* (exotic), *Tragopogon dubius* (exotic, Medium/Low)
Global: Vulnerable: *Lupinus ammophilus* (G3G4); **Invasive/Exotic**: *Bromus carinatus* (weedy native), *Bromus hordeaceus* (invasive/exotic), *Bromus japonicus* (invasive/exotic), *Bromus madritensis* (invasive/exotic), *Bromus rigidus* (invasive/exotic), *Bromus rubens* (invasive/exotic), *Bromus tectorum* (invasive/exotic, High)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (1-Dec-1997).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Grand Canyon National Park Comments: This association is unique within the park. Many associations contain *Bromus tectorum*, but no other community is dominated by this invasive grass.
Global Comments: This alliance also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species. It is distinct from the annual *Bromus* communities found along the Pacific Coast with Mediterranean or maritime climates because it does not have the introduced annual oatgrass (*Avena barbata* and *Avena fatua*), or other species typical of the California annual grassland (Sawyer and Keeler-Wolf 1995).
Global Similar Associations:
- *Juniperus osteosperma* / *Bromus tectorum* Semi-natural Woodland (CEGL002817)

Global Related Concepts:
- *Bromus tectorum* zootic climax (Daubenmire 1975) =
- Cheatgrass series (Sawyer and Keeler-Wolf 1995) <

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled near President Harding Rapid; from the North Rim, where it was sampled from the plateau near Outlet Canyon; and from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau near the head of Burnt Canyon. It can be expected to occur in various areas throughout Grand Canyon National Park.
Global Range: This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S.
Nations: US
States/Provinces: AZ, CA, CO, ID, NV, SD, UT
TNC Ecoregions: 6:C, 9:C, 10:C, 11:C, 13:C, 18:C, 19:C, 20:C, 21:C
USFS Ecoregions (1994/95): 262A:CC, 313A:CC, 341A:CC, 341B:CC, 341C:CC, 342D:CC, M261:C, M313A:CC,

M331E:CC, M331G:CC, M341C:CC
Federal Lands: NPS (Arches, Black Canyon of the Gunnison, Canyon de Chelly, Canyonlands?, Capitol Reef, Colorado, Craters of the Moon, Curecanti, Dinosaur, Glen Canyon, Golden Spike, Grand Canyon, Grand Canyon-Parashant, Great Basin, Hovenweep, Mesa Verde, Walnut Canyon, Wind Cave, Zion); USFWS (Ouray)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.03100, GRCA.03536, GRCA.04122.
Local Description Authors: R. Meszaros
Global Description Authors: D. Faber-Langendoen, mod. K. Schulz and J. Coles
References: Beatley 1976, Bell et al. 2009, Clark et al. 2009, Cogan et al. 1999, Cogan et al. 2004, Coles et al. 2008a, Coles et al. 2009a, Coles et al. 2010, Coles et al. 2011, Daubenmire 1975, Englund 2004, Evans et al. 2001, FEIS 2001, Hansen et al. 2004a, Karl et al. 1999, Marriott pers. comm., Naumann pers. comm., Peterson 2008, Redente et al. 1992, Reid and Hall 2010, Romme et al. 1993, Sawyer and Keeler-Wolf 1995, Schulz and Hall 2011, Tendick et al. 2010, Thomas et al. 2009b, Thomas et al. 2010, Von Loh et al. 2002, Von Loh et al. 2007, Von Loh et al. 2008, Western Ecology Working Group n.d., Young and Evans 1973, Young and Evans 1978

Erodium cicutarium Semi-natural Annual Herbaceous Vegetation

Redstem Stork's-bill Semi-natural Annual Herbaceous Vegetation
Identifier: CEGL002085

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Western North American Ruderal & Planted Semi-Desert Scrub & Grassland (M499)
Group	Great Basin & Intermountain Ruderal Dry Shrubland & Grassland (G600)
Association	*Erodium cicutarium* Semi-natural Annual Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This small-patch annual exotic herbaceous association occurs on ridges and valley bottoms in highly disturbed sites in the Colorado Plateau. Sites occupied by this association are generally associated with severe disturbance, such as annual grazing by sheep and/or cattle, mining or a very hot fire. Elevations range from 1692 to 2306 m (5550-7565 feet), and sites occur on level to moderate slopes with south to west exposures. Soils are generally sandy and derived from eolian or alluvial deposits. Cryptobiotic crusts may cover much of the unvegetated surface in sites that have not been grazed recently. Total vegetation cover is sparse to moderate (16-40%), depending on the amount of winter/spring precipitation and the time of year a site is sampled. The exotic annual forb *Erodium cicutarium* provides most of the vegetative cover, but other weedy and exotic species are also generally present, including *Bromus tectorum, Descurainia pinnata, Sisymbrium altissimum, Carduus nutans*, and *Tragopogon dubius*. A few scattered shrubs typical of sandy alkaline conditions may be present, including *Atriplex canescens, Opuntia polyacantha, Ephedra viridis, Lycium pallidum*, and *Quercus gambelii*.

ENVIRONMENTAL DESCRIPTION

Global Environment: This small-patch annual herbaceous association occurs on ridges and valley bottoms in highly disturbed sites in the Colorado Plateau. Elevations range from 1692 to 2306 m (5550-7565 feet), and sites occur on level to moderate slopes with south to west exposures. Soils are generally sandy and derived from eolian or alluvial deposits. Cryptobiotic crusts may cover much of the unvegetated surface in sites that have not been grazed in a number of years; in grazed sites, bare ground and rocks cover most of the surface.

VEGETATION DESCRIPTION

Global Vegetation: This annual herbaceous association indicates sites that have experienced severe or chronic disturbance. Total vegetation cover in this annual herbaceous type is sparse to moderate (16-40%), depending on the amount of winter/spring precipitation and the time of year a site is sampled. The exotic annual forb *Erodium cicutarium* provides most of the vegetative cover, but other weedy and exotic species are also generally present, including *Bromus tectorum, Descurainia pinnata, Sisymbrium altissimum, Carduus nutans*, and *Tragopogon dubius*. A few scattered shrubs may be present, including *Opuntia polyacantha, Ephedra viridis, Lycium pallidum, Atriplex*

canescens, and *Quercus gambelii*.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Forb	*Erodium cicutarium*

CHARACTERISTIC SPECIES

Global: *Erodium cicutarium*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Bromus tectorum* (invasive/exotic, High), *Carduus nutans* (invasive/exotic, High/Low), *Erodium cicutarium* (invasive/exotic, Medium/Low), *Sisymbrium altissimum* (invasive/exotic), *Tragopogon dubius* (invasive/exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (invasive) (14-Dec-2004).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate
Global Related Concepts:
- *Erodium cicutarium* Semi-natural Annual Herbaceous Vegetation (Wagner et al. 1978) =

ELEMENT DISTRIBUTION

Global Range: This association is of limited extent in northern Arizona, southeastern Utah, and western Colorado. It has been documented from western Colorado and southeastern Utah and has been observed, but not sampled, on the floor of Canyon del Muerto and Canyon de Chelly at Canyon de Chelly National Monument.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, M331G:CC
Federal Lands: NPS (Black Canyon of the Gunnison, Canyon de Chelly, Grand Canyon, Hovenweep)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: J. Coles
References: Bentley and Talbot 1948, Coles et al. 2010, Felger 1990, Reid and Hall 2010, Thomas et al. 2010, Von Loh et al. 2008, Wagner et al. 1978, Western Ecology Working Group n.d.

***Salsola* spp. Semi-natural Herbaceous Vegetation**

Russian-thistle species Semi-natural Herbaceous Vegetation
Identifier: CEGL004004

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Western North American Ruderal & Planted Semi-Desert Scrub & Grassland (M499)
Group	Great Basin & Intermountain Ruderal Dry Shrubland & Grassland (G600)
Association	*Salsola* spp. Semi-natural Herbaceous Vegetation

ELEMENT CONCEPT

Global Summary: This herbaceous association is known from Canyonlands National Park and Great Sand Dunes National Monument and occurs on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat

to steep slopes (0-25 degrees) between 1195 and 2297 m elevation. Sand or bare soil cover most of the unvegetated surface, although some sites have moderate cover of litter representing the previous crop of annual weeds. Biological soil crusts provide sparse to moderate cover depending on whether the site is being grazed. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium. Vegetation is dominated by exotic annual weedy species, especially *Salsola tragus*. Scattered native shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata, Ericameria nauseosa, Opuntia polyacantha, Opuntia phaeacantha var. major, Sarcobatus vermiculatus*, and *Sclerocactus whipplei*. Remnant native herbaceous species contribute little cover but are usually present; *Sporobolus cryptandrus, Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus airoides, Cryptantha* sp., *Sphaeralcea coccinea, Plantago patagonica, Cleome lutea, Ambrosia acanthicarpa, Eriogonum inflatum*, and *Lappula occidentalis* were recorded in the sample plots. *Bromus tectorum* generally has significant cover. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

ENVIRONMENTAL DESCRIPTION

Global Environment: This herbaceous association is known from Canyonlands National Park and Great Sand Dunes National Monument and occurs on floodplains, canyon bottoms, playas, and on active sand dunes. Sites are on flat to steep slopes (0-25 degrees) between 1195 and 2297 m elevation. Sand or bare soil cover most of the unvegetated surface, although some sites have moderate cover of litter representing the previous crop of annual weeds. Biological soil crusts provide sparse to moderate cover depending on whether the site is being grazed. Soils are moderately well-drained to rapidly drained sands, silt loams, or clays derived from alluvium.

VEGETATION DESCRIPTION

Global Vegetation: Vegetation is dominated by exotic annual weedy species, especially *Salsola tragus*. Scattered native shrubs may be present, including *Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Krascheninnikovia lanata, Ericameria nauseosa, Opuntia polyacantha, Opuntia phaeacantha var. major, Sarcobatus vermiculatus*, and *Sclerocactus whipplei*. Remnant native herbaceous species contribute little cover but are usually present; *Sporobolus cryptandrus, Achnatherum hymenoides, Pleuraphis jamesii, Sporobolus airoides, Cryptantha* sp., *Sphaeralcea coccinea, Plantago patagonica, Cleome lutea, Ambrosia acanthicarpa, Eriogonum inflatum*, and *Lappula occidentalis* were recorded in the sample plots. *Bromus tectorum* generally has significant cover. Some areas with fine-textured soils lack biological soil crusts, but sandy sites can have as much as 60% cover.

MOST ABUNDANT SPECIES

Global

Stratum	Lifeform	Species
Herb (field)	Forb	*Salsola tragus*

CHARACTERISTIC SPECIES

Global: *Salsola tragus*

OTHER NOTEWORTHY SPECIES

Global: Invasive/Exotic: *Salsola tragus* (invasive/exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNA (ruderal) (14-Jul-2006).

CLASSIFICATION

Status: Standard
Classification Confidence: 3 - Weak

ELEMENT DISTRIBUTION

Global Range: This herbaceous association is known from Canyonlands National Park in Utah and Great Sand Dunes National Monument in Colorado.
Nations: US

States/Provinces: AZ, CO, NV, UT
TNC Ecoregions: 19:C, 20:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M331F:CC
Federal Lands: NPS (Canyonlands, Grand Canyon-Parashant, Grand Canyon?, Great Sand Dunes)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors: M.E. Hall
References: Peterson 2008, Reid and Hall 2010, Salas et al. 2010b, Western Ecology Working Group n.d.

Sphaeralcea ambigua Herbaceous Vegetation [Park Special]

Apricot Globemallow Herbaceous Vegetation
Identifier: CEPS009532

USNVC CLASSIFICATION

Division	Western North American Cool Semi-Desert Scrub & Grassland (3.B.1.Ne)
Macrogroup	Western North American Ruderal & Planted Semi-Desert Scrub & Grassland (M499)
Group	Great Basin & Intermountain Ruderal Dry Shrubland & Grassland (G600)
Association	*Sphaeralcea ambigua* Herbaceous Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association occurs on the plateau of the Western Grand Canyon and Grand Canyon-Parashant National Monument in areas that have experienced shrub and tree mortality due to fire, drought, and/or grazing. A die-off of native woody species has resulted in openings in the vegetation, in which this herbaceous association has become established. It occurs on various localized landforms, including plateaus, valley bottoms, and sideslopes. It typically occurs at 1400 to 1875 m (4600-6150 feet) elevation on gentle slopes (1 to 5 degrees), with west- and southwest-facing aspects. Soils are normally moderately well-drained and may be composed of either silt or sand. Bare soil (25-95%), gravel (up to 50%), rocks (up to 25%), and some litter (up to 30%) are common components of ground cover.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Trees and taller shrubs are essentially absent from this herbaceous vegetation type; however, dead standing trees often occur in recently-burned areas. A few scattered short-shrub species sometimes occur in post-burn stands, but always at low covers. The dwarf-shrub *Gutierrezia sarothrae* commonly occurs at low cover (1-2%). This association is characterized by a well-developed herbaceous layer (24%) that is dominated by *Sphaeralcea ambigua*. The amount of *Sphaeralcea ambigua* varies depending upon a stand's physical environment. In burned areas, there is typically less *Sphaeralcea ambigua* (sometimes less than 5%), while in unburned valley bottoms, there may be a dense cover of up to 20% *Sphaeralcea ambigua*. Burned sites often host other herbaceous species, including *Erigeron divergens* (12%), *Heliomeris multiflora* (6%), and *Penstemon linarioides* (6%). Graminoids are extremely sparse (1%), although *Elymus elymoides* and *Sporobolus cryptandrus* occur commonly at very low covers. Based upon the 3 stands sampled, this association hosts above-average species diversity among plant communities in Grand Canyon, with 24 species per 400-square-meter plot. One classification plot hosted 44 different species.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Herb (field)	Dwarf-shrub	*Gutierrezia sarothrae*
Herb (field)	Forb	*Sphaeralcea ambigua*
Herb (field)	Graminoid	*Elymus elymoides*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Gutierrezia sarothrae*, *Sphaeralcea ambigua*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Amaranthus blitoides* (exotic), *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Portulaca oleracea* (exotic), *Salsola tragus* (exotic), *Sisymbrium altissimum* (exotic), *Taraxacum officinale* (exotic)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (2-Jul-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Western Grand Canyon, where it was sampled from Toroweap Valley, and from Grand Canyon-Parashant National Monument, where it was sampled from the Shivwits Plateau.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.02577, GRCA.04094, GRCA.04186.
Local Description Authors: K. Christie
Global Description Authors:
References: Western Ecology Working Group n.d.

6. Rock Vegetation

6.B.2. Temperate & Boreal Cliff, Scree & Other Rock Vegetation
6.B.2.Nb. Western North American Temperate Cliff, Scree & Rock Vegetation

M112. Southwestern North American Wet Cliff Vegetation
G545. Colorado Plateau Hanging Garden Seep

Betula occidentalis Desert Spring Shrubland [Park Special]

Water Birch Desert Spring Shrubland
Identifier: CEPS009680

USNVC CLASSIFICATION

Division	Western North American Temperate Cliff, Scree & Rock Vegetation (6.B.2.Nb)
Macrogroup	Southwestern North American Wet Cliff Vegetation (M112)
Group	Colorado Plateau Hanging Garden Seep (G545)
Association	*Betula occidentalis* Desert Spring Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US

States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Celtis laevigata / *Cladium* spp. Saturated Seep Shrubland [Park Special]

Sugarberry / Sawgrass species Saturated Seep Shrubland
Identifier: CEPS009681

USNVC CLASSIFICATION

Division	Western North American Temperate Cliff, Scree & Rock Vegetation (6.B.2.Nb)
Macrogroup	Southwestern North American Wet Cliff Vegetation (M112)
Group	Colorado Plateau Hanging Garden Seep (G545)
Association	*Celtis laevigata* / *Cladium* sp. Saturated Seep Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Cercis orbiculata Seep Shrubland [Park Special]

California Redbud Seep Shrubland
Identifier: CEPS009682

USNVC CLASSIFICATION

Division	Western North American Temperate Cliff, Scree & Rock Vegetation (6.B.2.Nb)
Macrogroup	Southwestern North American Wet Cliff Vegetation (M112)
Group	Colorado Plateau Hanging Garden Seep (G545)
Association	*Cercis orbiculata* Seep Shrubland [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Cladium californicum Seep [Park Special]

California Sawgrass Seep
Identifier: CEPS009683

USNVC CLASSIFICATION

Division	Western North American Temperate Cliff, Scree & Rock Vegetation (6.B.2.Nb)
Macrogroup	Southwestern North American Wet Cliff Vegetation (M112)
Group	Colorado Plateau Hanging Garden Seep (G545)
Association	*Cladium californicum* Seep [Park Special]

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (11-Sep-2012).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Nations: US
States/Provinces: AZ
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

6.C.1. Warm Desert & Semi-Desert Cliff, Scree & Other Rock Vegetation
6.C.1.Na. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation

M117. North American Warm Semi-Desert Cliff, Scree & Rock Vegetation
G569. North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation

Peucephyllum schottii Sparse Vegetation [Park Special]

Schott's Pygmy-cedar Sparse Vegetation
Identifier: CEPS009525

USNVC CLASSIFICATION

Division	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (6.C.1.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Cliff, Scree & Pavement Sparse Vegetation (G569)
Association	*Peucephyllum schottii* Sparse Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sparse vegetation association occurs primarily on cliff walls in the far Western Grand Canyon. It has been observed from 400 to 425 m (1350-1375 feet) elevation, but presumably occurs within a somewhat wider elevational range. It is primarily found on southwest-facing cliffs or extremely steep rock escarpments (45-80 degrees). Soils are extremely sparse, but where they occur are rapidly drained sandy loams that lie above granite bedrock. Ground cover is strongly dominated by bedrock (97%), with low cover of rocks (2%) and gravel (1%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover typically averages 5% in this extremely sparse association which is characterized and dominated by the short shrub *Peucephyllum schottii* (2%). Tall shrubs are absent from this association. Along with *Peucephyllum schottii*, the short-shrub layer invariably includes *Acacia greggii* (1%), *Ephedra fasciculata* (1%), and *Ferocactus cylindraceus* (up to 1%). *Mammillaria grahamii* (trace cover) is frequently present in a very weak dwarf-shrub layer, while *Eriogonum wrightii* (1%) occurs occasionally. *Aristida purpurea* (trace cover) consistently occurs in an extremely sparse graminoid layer. *Argythamnia neomexicana* (1%) and *Tidestromia oblongifolia* (1%) occur from time to time in a very sparse forb layer. Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 11 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Peucephyllum schottii*
Herb (field)	Dwarf-shurb	*Eriogonum wrightii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Argythamnia neomexicana*, *Aristida purpurea*, *Ephedra fasciculata*, *Eriogonum wrightii*, *Ferocactus cylindraceus*, *Mammillaria grahamii*, *Peucephyllum schottii*, *Tidestromia oblongifolia*, *Tridens muticus*

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: This association is fairly unique within Grand Canyon National Park. No other community contains significant *Peucephyllum schottii* cover and occurs on near-vertical rockwalls.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the far Western Grand Canyon where it was sampled from Salt Creek and Lava Cliff Rapids (CRM 242).
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.02671, GRCA.03683.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

G675. North American Warm Semi-Desert Dunes & Sand Flats

Abronia elliptica Herbaceous Dune Vegetation [Park Special]

Fragrant White Sand-verbena Herbaceous Dune Vegetation
Identifier: CEPS009521

USNVC CLASSIFICATION

Division	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (6.C.1.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Dunes & Sand Flats (G675)
Association	*Abronia elliptica* Herbaceous Dune Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This herbaceous association typically occurs on sand dunes and beaches in the Inner Canyon next to the Colorado River. It is typically present at 625 to 650 m (2075-2125 feet) elevation, and is primarily found on gentle gradients (6-12 degrees) on southwest aspects. Soils are rapidly-drained sands that obscure the underlying geology. Sand (92%) overwhelmingly dominates ground cover. This association was sampled only from the dunes at the mouth of Fossil Canyon; it may be expected in other similar dune habitats.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: This community is dominated by and characterized by the sand-loving forb *Abronia elliptica* (4-5%). *Acacia greggii* (1%) occasionally punctuates this predominantly herbaceous community, while *Isocoma acradenia* (1%) commonly occurs in a weak short-shrub layer. Dwarf-shrubs are virtually non-existent, but *Opuntia polyacantha* (1%) does occur from time to time. *Sporobolus flexuosus* (3%), *Bouteloua barbata* (1%), and *Achnatherum hymenoides* (1%) all consistently occur in a relatively well-developed graminoid layer (6%). Along with *Abronia elliptica, Streptanthella longirostris* (up to 1%) and *Dicoria canescens* (trace cover) frequently occur in the forb stratum. Based upon the 2 stands sampled, this association hosts slightly above-average species diversity among plant communities in Grand Canyon, with 20 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Isocoma acradenia*
Herb (field)	Dwarf-shrub	*Opuntia polyacantha*
Herb (field)	Forb	*Abronia elliptica*
Herb (field)	Graminoid	*Sporobolus flexuosus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abronia elliptica*, *Acacia greggii*, *Achnatherum hymenoides*, *Dicoria canescens*, *Isocoma acradenia*, *Sporobolus flexuosus*, *Streptanthella longirostris*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: This association is unique within Grand Canyon National Park. No other community contains significant *Abronia elliptica* cover and occurs on dune habitats.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon, where it was sampled from the mouth of Fossil Canyon at the confluence with the Colorado River.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC

Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01507, GRCA.03514.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

Prosopis glandulosa var. *torreyana* Sand Dune Shrubland [Park Special]

Western Honey Mesquite Sand Dune Shrubland
Identifier: CEPS009526

USNVC CLASSIFICATION

Division	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (6.C.1.Na)
Macrogroup	North American Warm Semi-Desert Cliff, Scree & Rock Vegetation (M117)
Group	North American Warm Semi-Desert Dunes & Sand Flats (G675)
Association	*Prosopis glandulosa var. torreyana* Sand Dune Shrubland [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This shrubland association occurs on sand dunes and beaches along the Colorado River in the Inner Canyon. It was observed at 825 m (2700 feet) elevation, but may occur within a somewhat broader elevational range. It primarily occurs on flat to gentle slopes (up to 8 degrees). Soils are rapidly-drained, eolian sands that obscure the underlying bedrock. Ground cover is strongly dominated by sand (70%) with lesser amounts of litter (20%) and notable cover of cryptogamic soil crust (6%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 15-20% in this association which is dominated by the tall shrub *Prosopis glandulosa* (8-10%). Often *Prosopis glandulosa* grows in clumps or on hummocks in the sandy substrate. A relatively well-developed short-shrub layer exists in which *Suaeda moquinii* (5%) and *Atriplex canescens* (1%) invariably occur. Dwarf-shrubs are essentially absent from this community. *Schismus barbatus* (1%) and *Sporobolus cryptandrus* (trace) are the major components of the sparse graminoid layer (1%). *Abronia elliptica* (1%), *Streptanthella longirostris* (1%), and *Sphaeralcea ambigua* (1%) are regular members of a fairly simple forb understory (4%). Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 13 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Tall shrub/sapling	Thorn shrub	*Prosopis glandulosa*
Short shrub/sapling	Broad-leaved evergreen shrub	*Suaeda moquinii*
Herb (field)	Graminoid	*Schismus barbatus*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Abronia elliptica*, *Atriplex canescens*, *Prosopis glandulosa*, *Schismus barbatus*, *Sphaeralcea ambigua*, *Streptanthella longirostris*, *Suaeda moquinii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Salsola tragus* (exotic), *Schismus barbatus* (exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: *Prosopis glandulosa var. torreyana* Shrubland (CEGL001381) typically supports a much higher cover of *Prosopis glandulosa var. torreyana* (25%) and occurs on sideslopes and in drainage channels, as opposed to on sand dunes.
Global Similar Associations:

- *Prosopis glandulosa var. torreyana* Shrubland (CEGL001381) typically supports much higher cover of *Prosopis glandulosa var. torreyana* and occurs on sideslopes and in drainage channels, as opposed to on sand dunes.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon where it occurs on beaches along the Colorado River. It was sampled from near Comanche Creek and near Basalt Creek.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.02543, GRCA.04566.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

6.C.2. Cool Semi-Desert Cliff, Scree & Other Rock Vegetation
6.C.2.Na. North American Cool Semi-Desert Cliff, Scree & Rock Vegetation

M118. Intermountain Basin Cliff, Scree & Badland Sparse Vegetation
G570. Intermountain Basins Cliff, Scree & Badland Sparse Vegetation

Ephedra trifurca Badlands Shrubland

Longleaf Joint-fir Badlands Shrubland
Identifier: CEGL005116

USNVC CLASSIFICATION

Division	North American Cool Semi-Desert Cliff, Scree & Rock Vegetation (6.C.2.Na)
Macrogroup	Intermountain Basin Cliff, Scree & Badland Sparse Vegetation (M118)
Group	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Association	*Ephedra trifurca* Badlands Shrubland

ELEMENT CONCEPT

Global Summary: This joint-fir shrubland association is currently described from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey and classification work are needed to fully characterize this type. It typically occurs on rolling, hilly badlands at 550 to 600 m (1850-2000 feet) elevation, and is primarily found on very gentle gradients (0-3 degrees), typically on west-facing aspects. It sometimes occurs on much steeper slopes (25-30 degrees) as well. Soils are moderately- to rapidly-drained silty or sandy clays or loams that contain gypsum. The ground cover is strongly dominated by cryptogamic soil crusts (90%). Vegetation is characterized and dominated by the short shrub *Ephedra trifurca*. *Larrea tridentata* commonly occurs in a meager tall-shrub layer. The short-shrub layer usually also supports *Hymenoclea salsola*, *Psorothamnus fremontii*, and *Lycium andersonii*. A sparse dwarf-shrub layer of *Atriplex confertifolia* is typically present. *Vulpia octoflora* and sometimes *Schismus barbatus* are common components of the graminoid understory. *Camissonia brevipes, Cryptantha* spp., and *Sphaeralcea grossulariifolia* almost always occur, while *Geraea canescens, Mentzelia* sp., *Eriogonum inflatum*, and *Erodium cicutarium* occur sporadically in the forb layer.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This joint-fir shrubland association typically occurs on rolling, hilly badlands in Grand Canyon-Parashant National Monument. It occurs at 550 to 600 m (1850-2000 feet) elevation, and is primarily found on very gentle gradients (0-3 degrees), typically on west-facing aspects. It sometimes occurs on much steeper slopes (25-30 degrees) as well. Soils are moderately- to rapidly-drained silty or sandy clays or loams that contain gypsum. The ground cover is strongly dominated by cryptogamic soil crusts (90%) with relatively low amounts of litter (2%), bare soil (7%) and gravel (1%).

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 5-7% in this sparse shrubland association. This community is characterized and dominated by the short shrub *Ephedra trifurca* (2-4%). *Larrea tridentata* (1%) commonly occurs in a meager tall-shrub layer. Along with *Ephedra trifurca*, the short-shrub layer usually supports *Hymenoclea salsola* (1%), *Psorothamnus fremontii* (1%), and *Lycium andersonii* (1%). A sparse dwarf-shrub layer of *Atriplex confertifolia* (1%) is typically present. *Vulpia octoflora* (up to 1%) and sometimes *Schismus barbatus* (1%) are common components of the graminoid understory (1%). *Camissonia brevipes* (1%), *Cryptantha* spp. (up to 1%), and *Sphaeralcea grossulariifolia* (up to 1%) almost always occur, while *Geraea canescens* (1%), *Mentzelia* sp. (1%), *Eriogonum inflatum* (up to 1%), and *Erodium cicutarium* (trace) occur sporadically in the forb layer (3%). Based upon the 5 stands sampled, this association hosts slightly below-average species diversity among plant communities in Grand Canyon, with 15 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved evergreen shrub	*Ephedra trifurca*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Atriplex confertifolia*, *Camissonia brevipes*, *Ephedra trifurca*, *Eriogonum inflatum*, *Geraea canescens*, *Hymenoclea salsola*, *Larrea tridentata*, *Lycium andersonii*, *Psorothamnus fremontii*, *Schismus barbatus*, *Sphaeralcea grossulariifolia*, *Vulpia octoflora*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Vulnerable: *Camissonia brevipes* (state-critically imperiled, G4G5); **Invasive/ Exotic**: *Bromus rubens* (exotic), *Erodium cicutarium* (exotic, Medium/Low), *Schismus barbatus* (exotic, High/ Medium), *Sisymbrium irio* (exotic, Medium/Insignificant)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (23-Jun-2010).

CLASSIFICATION

Status: Nonstandard

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from Grand Canyon-Parashant National Monument, where it was sampled from Gyp Wash and Tassi Wash.
Global Range: This shrubland association is currently known from Grand Canyon National Park and Grand Canyon-Parashant National Monument in Arizona. More survey work is needed to fully document its global range.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon, Grand Canyon-Parashant)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (5 plots): GRCA.02519, GRCA.03526, GRCA.04518, GRCA.04521, GRCA.04523.
Local Description Authors: R. Meszaros
Global Description Authors: R. Meszaros
References: Reid and Hall 2010, Western Ecology Working Group n.d.

Eriogonum corymbosum Badlands Sparse Vegetation

Crispleaf Buckwheat Badlands Sparse Vegetation
Identifier: CEGL002979

USNVC CLASSIFICATION

Division	North American Cool Semi-Desert Cliff, Scree & Rock Vegetation (6.C.2.Na)
Macrogroup	Intermountain Basin Cliff, Scree & Badland Sparse Vegetation (M118)
Group	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Association	*Eriogonum corymbosum* Badlands Sparse Vegetation

ELEMENT CONCEPT

Global Summary: This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to steep slopes, occur between 1219 and 2670 m (4000-8760 feet) elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, up to 88%. Litter is sparse. Parent materials are Moenkopi, Morrison, Mancos, Tropic or Chinle shales and the Clarion Formation that erode to badlands deposits. Vegetation has difficulty taking hold on the highly erosive surface. Soils are rapidly drained clay loams or silty loams. Total vascular vegetation cover for this association rarely exceeds 20% and is usually closer to 10%. The vegetation is characterized by an open canopy of *Eriogonum corymbosum* that ranges in foliar cover from 5 to 20%. Associated shrubs include *Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Psorothamnus fremontii, Salvia dorrii, Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Xylorhiza glabriuscula*, and *Coleogyne ramosissima*. The herbaceous layer is low in species diversity and provides sparse cover. No species of graminoid or forb provides greater than 1% cover. Graminoids recorded include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. Forbs include *Astragalus kentrophyta, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea, Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum var. subnudum*, and *Cryptantha tenuis*. At Bryce Canyon, *Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands.

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This association occurs on sideslopes in the Inner Canyon and Western Grand Canyon at 1000 to 1825 m (3300-6000 feet) elevation. It can occur in various topographic positions and across all aspects, although it seems to favor more xeric exposures. It often inhabits sparsely vegetated or badland areas, and primarily occurs on moderate to steep slopes (up to 30 degrees) derived from various geologic parent materials including shale, sandstone, and limestone. Soils are typically silty and rapidly-drained. Bare soil (10-20%), gravel (up to 40%), and rocks (up to 30%) are the major components of the ground cover, while some stands support significant cover of cryptogamic soil crust.
Global Environment: This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to gentle to moderately steep, occur between 1219 and 2670 m (4000-8760 feet) elevation, and are oriented to all aspects. The unvegetated surface has high exposure of bare soil, up to 88%, although some slopes have a moderate cover of colluvial boulders. Litter is sparse. Parent materials are Moenkopi, Morrison, Mancos, Tropic or Chinle shales and Clarion Formation that erode to badlands deposits. Vegetation has difficulty taking hold on the highly erosive surface. Soils are rapidly drained sandy clays or silty clays.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Tree cover is entirely lacking in this shrubland association. *Ericameria nauseosa* (5%) and *Rhus trilobata* (1%) commonly occur in the short-shrub layer (7-10% cover), while various other species, including *Ephedra* spp., *Yucca baccata*, and *Atriplex canescens*, may also occur occasionally. The dwarf-shrub *Eriogonum corymbosum* (4-5%) characterizes this association and occurs in all stands. Scattered cacti, including *Opuntia polyacantha* and *Echinocereus triglochidiatus*, commonly occur at trace covers. Graminoid composition

is variable, and graminoid cover is typically quite low (up to 2%). Species such as *Pleuraphis jamesii, Sporobolus cryptandrus*, and *Achnatherum hymenoides* occur sporadically. *Sphaeralcea ambigua* (trace) is the only consistent component of the sparse forb layer (less than 1%). This association supports below-average species diversity among plant communities in Grand Canyon National Park, with 14 species per 400-square-meter plot.
Global Vegetation: Total vascular vegetation cover for this association rarely exceeds 20% and is often closer to 10%. The vegetation is characterized by an open canopy of *Eriogonum corymbosum* that ranges in foliar cover from 5 to 20%. Associated shrubs include *Amsonia tomentosa, Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Psorothamnus fremontii, Salvia dorrii, Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Xylorhiza glabriuscula*, and *Coleogyne ramosissima*. The herbaceous layer is low in species diversity and provides sparse cover. No species of graminoid or forb provides greater than 1% cover. Graminoids recorded include *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Hesperostipa comata, Leymus salinus*, and *Pleuraphis jamesii*. Forbs include *Astragalus kentrophyta, Lomatium minimum, Machaeranthera canescens, Sphaeralcea coccinea, Chamaesyce fendleri, Amsonia tomentosa, Thelesperma subnudum var. subnudum*, and *Cryptantha tenuis*. At Bryce Canyon, *Pinus edulis* and *Juniperus osteosperma* saplings provide sparse cover in some stands.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Ericameria nauseosa*
Herb (field)	Dwarf-shurb	*Eriogonum corymbosum*

Global

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Eriogonum corymbosum*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Ericameria nauseosa*, *Eriogonum corymbosum*
Global: *Atriplex confertifolia*, *Eriogonum corymbosum*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Bromus rubens* (exotic), *Bromus tectorum* (exotic, High), *Erodium cicutarium* (exotic, Medium/Low)
Global: Vulnerable: *Lomatium minimum* (G3); **Invasive/Exotic**: *Bromus tectorum* (invasive/exotic, High), *Halogeton glomeratus* (invasive/exotic, High/Medium)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (22-Jan-2002).

CLASSIFICATION

Status: Standard
Classification Confidence: 2 - Moderate

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon and Western Grand Canyon; it was sampled from Lava Creek/Chuar Valley, from below Tuckup Point near Willow Canyon, and from along the Tuckup trail between The Dome and Rocky Tuckup Point.
Global Range: This association has been described from southern and eastern Utah.
Nations: US
States/Provinces: AZ, CO, UT
TNC Ecoregions: 18:C, 19:C
USFS Ecoregions (1994/95): 313A:CC, 341B:CC, M341C:CC
Federal Lands: NPS (Arches, Bryce Canyon, Canyonlands, Capitol Reef, Glen Canyon, Grand Canyon, Mesa Verde, Zion)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2007 and 2008 field data (3 plots): GRCA.03056, GRCA.04563, GRCA.04606.
Local Description Authors: K. Christie
Global Description Authors: J. Coles, mod. G. Kittel
References: Clark et al. 2009, Cogan et al. 2004, Coles et al. 2009a, Reid and Hall 2010, Romme et al. 1993, Tendick et al. 2011b, Thomas et al. 2009b, Western Ecology Working Group n.d.

Psorothamnus fremontii - Acacia greggii [Shale] Sparse Vegetation [Park Special]

Fremont's Smokebush - Catclaw Acacia [Shale] Sparse Vegetation
Identifier: CEPS009527

USNVC CLASSIFICATION

Division	North American Cool Semi-Desert Cliff, Scree & Rock Vegetation (6.C.2.Na)
Macrogroup	Intermountain Basin Cliff, Scree & Badland Sparse Vegetation (M118)
Group	Intermountain Basins Cliff, Scree & Badland Sparse Vegetation (G570)
Association	*Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation [Park Special]

ENVIRONMENTAL DESCRIPTION

Grand Canyon National Park Environment: This sparse vegetation association typically occurs on barren sideslopes in the Inner Canyon. It was observed at 1025 to 1050 m (3375-3450 feet) elevation, but likely occurs within a somewhat broader elevational range. It is primarily found on steep (32-35 degrees) south-facing slopes. Soils are well- to rapidly-drained silts that lie on top of shale bedrock. Bare soil (50%), gravel (31%), and rocks (14%) dominate the ground cover in these somewhat barren environments.

VEGETATION DESCRIPTION

Grand Canyon National Park Vegetation: Total shrub cover averages 8-10% in this sparse community which is codominated by the short shrubs *Psorothamnus fremontii* (3-4%) and *Acacia greggii* (5-7%). Tall shrubs are non-existent. Along with *Acacia greggii* and *Psorothamnus fremontii*, *Encelia resinifera* (1%) can also occur in the short-shrub layer. Dwarf-shrubs and graminoids are absent from this community. *Erodium cicutarium, Camissonia* sp., *Cryptantha* sp., *Eriogonum inflatum*, and *Chaenactis* sp. are all consistently present at low individual covers in the forb understory (2%). This association characteristically lacks floristic diversity. Based upon the 2 stands sampled, this association hosts below-average species diversity among plant communities in Grand Canyon, with 11 species per 400-square-meter plot.

MOST ABUNDANT SPECIES

Grand Canyon National Park

Stratum	Lifeform	Species
Short shrub/sapling	Broad-leaved deciduous shrub	*Acacia greggii*
Short shrub/sapling	Thorn shrub	*Psorothamnus fremontii*

CHARACTERISTIC SPECIES

Grand Canyon National Park: *Acacia greggii*, *Psorothamnus fremontii*

OTHER NOTEWORTHY SPECIES

Grand Canyon National Park: Invasive/Exotic: *Erodium cicutarium* (exotic, Medium/Low)

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (24-Jun-2010).

CLASSIFICATION

Status: Nonstandard
Grand Canyon National Park Comments: *Psorothamnus fremontii* Shrubland (CEGL005154) is also dominated by

Psorothamnus fremontii and supports some *Acacia greggii*; however, *Acacia greggii* occurs much less frequently here than in *Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation (CEPS009527). Additionally, this community supports more species diversity.

Global Similar Associations:

- *Psorothamnus fremontii* Shrubland (CEGL005154) is also dominated by *Psorothamnus fremontii* and supports more species diversity, but *Acacia greggii* occurs much less frequently.

ELEMENT DISTRIBUTION

Grand Canyon National Park Range: This association is known from the Inner Canyon where it was sampled from Lava-(Chuar) Canyon.
Nations: US
States/Provinces: AZ
TNC Ecoregions: 19:C
USFS Ecoregions (1994/95): 313A:CC
Federal Lands: NPS (Grand Canyon)

ELEMENT SOURCES

Grand Canyon National Park Plots and Observation Points: This description is based on 2008 field data (2 plots): GRCA.01541, GRCA.03547.
Local Description Authors: R. Meszaros
Global Description Authors:
References: Western Ecology Working Group n.d.

ELEMENT SOURCES

Local Description Authors:
Global Description Authors:
References: Western Ecology Working Group n.d.

Bibliography for Grand Canyon National Park

ANHIC [Alberta Natural Heritage Information Centre]. No date. Community database files. Alberta Natural Heritage Information Centre, Parks and Protected Areas Division, Alberta Community Development, Edmonton.

Achuff, P. L., R. L. McNeil, M. L. Coleman, C. Wallis and C. Wershler. 2002a. Ecological land classification of Waterton Lakes National Park, Alberta. Volume I: Integrated resource description. Parks Canada, Waterton Lakes National Park, Alberta. 226 pp.

Alexander, B. G., Jr., E. L. Fitzhugh, F. Ronco, Jr., and J. A. Ludwig. 1987. A classification of forest habitat types of the northern portion of the Cibola National Forest, NM. General Technical Report RM-143. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 35 pp.

Alexander, B. G., Jr., F. Ronco, Jr., A. S. White, and J. A. Ludwig. 1984b. Douglas-fir habitat types of northern Arizona. General Technical Report RM-108. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 13 pp.

Alexander, B. G., Jr., F. Ronco, Jr., E. L. Fitzhugh, and J. A. Ludwig. 1984a. A classification of forest habitat types of the Lincoln National Forest, New Mexico. General Technical Report RM-104. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 29 pp.

Alexander, R. M. 1986. Classification of the forest vegetation of Wyoming. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Note RM-466. Fort Collins, CO. 10 pp.

Allard, D. J. 1990. Southeastern United States ecological community classification. Interim report, Version 1.2. The

Nature Conservancy, Southeast Regional Office, Chapel Hill, NC. 96 pp.

Annable, C. R. 1985. Vegetation and flora of the Funeral Mountains, Death Valley National Monument. California-Nevada Cooperative National Park Resources Studies Unit, National Park Service/University of Nevada Contribution 016/07. Las Vegas, NV. 188 pp.

Armstrong, J. D. 1969. Vegetation of the Virgin Mountains, Clark County, Nevada. Unpublished thesis, University of Nevada, Las Vegas. 104 pp.

Arno, S. F. 1980. Forest fire history in the northern Rockies. Journal of Forestry 78(8):460-465.

BIA [Bureau of Indian Affairs]. 1979. The secretarial land use plan for the addition to the Havasupai Indian Reservation. Unpublished draft Environmental Statement INT DES 79-42. Prepared by USDI Bureau of Indian Affairs, Phoenix Area Office with the assistance of Office of Arid Land Studies, University of Arizona, Tucson.

BLM [Bureau of Land Management]. 1979a. Pages 2-6 to 2-15 in: Grand Junction Resource Area grazing management-draft environmental statement.

BLM [Bureau of Land Management]. 1979b. Final environmental impact statement, proposed development of coal resources in Eastern Powder River, WY. 67 pp.

Baalman, R. J. 1965. Vegetation of the Salt Plains National Wildlife Refuge, Jet, Oklahoma. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.

Bader, E. H. 1932. The vegetation of the Mesa Verde National Park, Colorado. Unpublished thesis, University of Colorado, Boulder. 64 pp.

Bailey, R. 1997. Map: Ecoregions of North America (rev.). Washington, DC: USDA Forest Service in cooperation with The Nature Conservancy and the U.S. Geological Survey. 1:15,000,000.

Bailey, R. G. 1998. Ecoregion map of North America: Explanatory note. Miscellaneous Publication Number 1548, USDA Forest Service. 10 pp.

Baker, W. L. 1980a. Alpine vegetation of the Sangre De Cristo Mountains, New Mexico: Gradient analysis and classification. Unpublished thesis, University of North Carolina, Chapel Hill. 55 pp.

Baker, W. L. 1982a. Vegetation description in Colorado-where are the gaps? Journal of the Colorado-Wyoming Academy of Science 14(1):39 (Abstract).

Baker, W. L. 1982b. Natural vegetation of the Piceance Basin, Colorado. Appendix D, pages 1-113 in: J. S. Peterson and W. L. Baker, editors. Inventory of the Piceance Basin, Colorado. Unpublished report for the Bureau Land Management, Craig, CO.

Baker, W. L. 1983b. Some aspects of the presettlement vegetation of the Piceance Basin, Colorado. Great Basin Naturalist 43(4):687-699.

Baker, W. L. 1983c. Natural vegetation of part of northwestern Moffat County, Colorado. Unpublished report prepared for the State of Colorado Natural Areas Program, Department of Natural Resources, Denver by Colorado Natural Heritage Inventory, Denver.

Baker, W. L. 1984a. A preliminary classification of the natural vegetation of Colorado. Great Basin Naturalist 44(4):647-676.

Baker, W. L., and S. C. Kennedy. 1985. Presettlement vegetation of part of northwestern Moffat County, Colorado,

described from remnants. Great Basin Naturalist 45(4):747-777.

Balice, R. G., S. G. Ferran, and T. S. Foxx. 1997. Preliminary vegetation and land cover classification for the Los Alamos region. Report LA-UR-97-4627, Los Alamos National Laboratory, Los Alamos, NM.

Barber, M. Personal communication. Ecologist.

Barbour, M. G., and J. Major, editors. 1977. Terrestrial vegetation of California. John Wiley and Sons, New York. 1002 pp.

Barbour, M. G., and J. Major, editors. 1988. Terrestrial vegetation of California: New expanded edition. California Native Plant Society, Special Publication 9, Sacramento. 1030 pp.

Barbour, M. G., and W. D. Billings, editors. 1988. North American terrestrial vegetation. Cambridge University Press, New York. 434 pp.

Barclay, J. S. 1978. The effects of channelization on riparian vegetation and wildlife in south central Oklahoma. In: R. R. Johnson and J. F. McCormick, editors. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. U.S. Department of Agriculture, Forest Service, Washington, DC.

Barnes, F. J. 1987. Carbon and water relations across a pinyon-juniper habitat gradient. Unpublished dissertation, New Mexico State University, Las Cruces.

Barney, M. A., and N. C. Frischknecht. 1974. Vegetation changes following fire in the pinyon-juniper types of west-central Utah. Journal of Range Management 27(2):91-96.

Bassett, D., M. Larson, and W. Moir. 1987. Forest and woodland habitat types of Arizona south of the Mogollon Rim and southwestern New Mexico. Edition 2. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Bassett, R. L. 1987. Silvicultural systems for pinyon-juniper. Pages 273-278 in: R. L. Everett, compiler. Proceedings--pinyon-juniper conference: 1986 January 13-16; Reno, NV. General Technical Report INT-215. USDA Forest Service, Intermountain Research Station, Ogden, UT.

Baumann, T. G. 1978a. Winter ecology of bighorn sheep in the Mummy Range, Colorado. Unpublished thesis, Colorado State University, Fort Collins.

Beatley, J. C. 1976. Vascular plants of the Nevada Test Site and central-southern Nevada: Ecological and geographic distributions. Technical Information Center, Energy Research and Development Administration. TID-26881. Prepared for Division of Biomedical and Environmental Research. 297 pp.

Beavis, W. D., J. C. Owens, J. A. Ludwig, and E. W. Huddleston. 1982. Grassland communities of east-central New Mexico and density of the range caterpillar, *Hemileuca oliviae* (Lepidoptera: Saturnidae). Southwestern Naturalist 27(3):335-343.

Bell, J., D. Cogan, J. Erixson, and J. Von Loh. 2009. Vegetation inventory project report, Craters of the Moon National Monument and Preserve. Natural Resource Technical Report NPS/UCBN/NRTR-2009/277. National Park Service, Fort Collins, CO. 358 pp.

Bentley, J. R., and M. W. Talbot. 1948. Annual-plant vegetation of the California foothills as related to range management. Ecology 29:72-79.

Bierly, K. F. 1972. Meadow and fen vegetation in Big Meadows, Rocky Mountain National Park. Unpublished thesis, Colorado State University, Fort Collins. 102 pp.

Blackburn, W. H. 1967. Plant succession on selected habitat types in Nevada. Unpublished thesis, University of Nevada, Reno. 162 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968a. Vegetation and soils of the Mill Creek watershed. Nevada Agricultural Experiment Station Bulletin R-43. University of Nevada, Reno. 69 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968b. Vegetation and soils of the Crowley Creek watershed. Nevada Agricultural Experiment Station Bulletin R-42. Reno. 60 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968c. Vegetation and soils of the Duckwater watershed. Nevada Agricultural Experiment Station Bulletin R-40. University of Nevada, Reno. 76 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969a. Vegetation and soils of the Cow Creek watershed. Vegetation and soils of the Mill Creek watershed. In cooperation with USDI Bureau of Land Management. University of Nevada, College of Agriculture, Reno. 71 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969b. Vegetation and soils of the Coils Creek watershed. Nevada Agricultural Experiment Station Bulletin R-48. Reno. 81 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969c. Vegetation and soils of the Churchill Canyon watershed. Nevada Agricultural Experiment Station Bulletin R-45. Reno. 157 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969d. Vegetation and soils of the Pine and Mathews Canyon watersheds. Nevada Agricultural Experiment Station Bulletin R-46. Reno. 111 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1971. Vegetation and soils of the Rock Springs watershed. Nevada Agricultural Experiment Station Bulletin R-83. Reno. 116 pp.

Blackburn, W. H., R. E. Eckert, Jr., and P. T. Tueller. 1969e. Vegetation and soils of the Crane Springs watershed. Nevada Agricultural Experiment Station Bulletin R-55. Reno. 63 pp.

Blackburn, W. H., and P. T. Tueller. 1970. Pinyon and juniper invasion in black sagebrush communities in east-central Nevada. Ecology 51:841-848.

Blackhawk Coal Company. 1981. Vegetation resources. Chapter 9 Section 9.2, pages 9-1 through 9-27 in: Mining and Reclamation Plan for Willow Creek Mine, Blackhawk Coal Company. Utah Division of Oil, Gas & Mining Number ACT/007/002. Salt Lake City, UT.

Bolen, E. G. 1964. Plant ecology of spring-fed salt marshes in western Utah. Ecological Monographs 34(2):143-166.

Boles, P. H., and W. A. Dick-Peddie. 1983. Woody riparian vegetation patterns on a segment of the Mimbres River in southwestern New Mexico. Southwestern Naturalist 28:81-87.

Bond, H. E. 1959. Revegetation and disintegration of pocket gopher mounds on Black Mesa, Colorado. Unpublished thesis, Colorado State University, Fort Collins.

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1993b. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Unpublished report prepared for The Nature Conservancy by the Western Heritage Task Force, Boulder, CO. (Volume I and II).

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1995a. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Desert Plants 11(2-3):3-68.

Bourgeron, P. S., and L. D. Engelking, editors. 1994. A preliminary vegetation classification of the western United

States. Unpublished report. The Nature Conservancy, Western Heritage Task Force, Boulder, CO. 175 pp. plus appendix.

Bowns, J. E., and N. E. West. 1976. Blackbrush (*Coleogyne ramosissima* Torr.) on southwestern Utah rangelands. Utah Agricultural Experiment Station Research Report 27. Logan, UT. 27 pp.

Boyce, D. A. 1977. Vegetation of the South Fork of the White River Valley, Colorado. Unpublished dissertation, University of Colorado, Boulder. 312 pp.

Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. General Technical Report INT-287. USDA Forest Service, Intermountain Research Station, Ogden, UT. 128 pp.

Bradley, W. G. 1964. The vegetation of the desert game range with special reference to the desert bighorn. Pages 43-67 in: Transcripts of the Desert Bighorn Council. Las Vegas, NV.

Briggs, G. M., and J. A. MacMahon. 1983. Alpine and subalpine wetland plant communities of the Uinta Mountains, Utah. Great Basin Naturalist 43(4):523-530.

Britton, C. M., and H. A. Wright. 1983. Brush management with fire. Pages 61-68 in: K. C. McDaniel, editor. Proceedings--brush management symposium: 1983 February 16; Albuquerque, NM. Society for Range Management, Denver, CO.

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist 44(2):299-309.

Brotherson, J. D., and W. E. Evenson. 1982. Vegetation communities surrounding Utah Lake and its bays. Utah Lake Vegetation Studies. Unpublished report done for the Utah Division of Wildlife Resources and USDI Bureau of Reclamation, Provo, UT. 401 pp.

Brown, D. E., C. H. Lowe, and C. P. Pase. 1979. A digitized classification system for the biotic communities of North America with community (series) and association examples for the Southwest. Journal of the Arizona-Nevada Academy of Science 14:1-16.

Brown, D. E., editor. 1982. Biotic communities of the American Southwest-United States and Mexico. Desert Plants Special Issue 4(1-4):1-342.

Bruner, W. E. 1931. The vegetation of Oklahoma. Ecological Monographs 1:99-188.

Bundy, R. M., J. V. Baumgartner, M. S. Reid, P. S. Bourgeron, H. C. Humphries, and B. L. Donohue. 1996. Ecological classification of wetland plant associations in the Lahontan Valley, Nevada. Prepared for Stillwater National Wildlife Refuge and USDI Fish & Wildlife Service. 53 pp. not including inventories, tables and graphs.

Bunin, J. E. 1975a. Aspen forests of the west slope of the Park Range, north-central Colorado. Unpublished paper presented at the 1975 AIBS/ESA Meetings, 17-22 August 1975, Oregon State University, Corvallis. 22 pp.

Bunin, J. E. 1975c. The vegetation of the west slope of the Park Range, Colorado. Unpublished dissertation, University of Colorado, Boulder. 235 pp.

Bunin, J. E. 1985. Vegetation of the City of Boulder, Colorado open space lands. Report prepared for the City of Boulder, Real Estate/Open Space, Boulder, CO. 114 pp.

Bunting, S. C. 1987. Use of prescribed burning in juniper and pinyon-juniper woodlands. Pages 141-144 in: R. L. Everett, compiler. Proceedings--pinyon-juniper conference; 1986 January 13-16; Reno, NV. General Technical Report INT-215. USDA Forest Service, Intermountain Research Station, Ogden, UT.

Butler, J., D. Crawford, S. Menard, and T. Meyer. 2002. Lacreek National Wildlife Refuge, South Dakota. USGS-USFWS Vegetation Mapping Program. Final report. Technical Memorandum 8260-02-02, Remote Sensing and GIS Group, Technical Service Center, Bureau of Reclamation, Denver, CO.

Buttery, R. F. 1955. Range conditions and trends resulting from winter concentrations of elk in Rocky Mountain National Park, Colorado. Unpublished thesis. Colorado Agricultural and Mechanical College, Fort Collins. 117 pp.

CONHP [Colorado Natural Heritage Program]. 2003. Unpublished data. List of Elements and Elcodes converted and entered into Biotics Tracker 4.0. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

CONHP [Colorado Natural Heritage Program]. 2006-2010. Tracked natural plant communities. Colorado Natural Heritage Program, Colorado State University, Fort Collins. [http://www.cnhp.colostate.edu/tracking/communities.html].

CONHP [Colorado Natural Heritage Program]. No date. Unpublished data on file. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Callison, J., Jr., J. D. Brotherson, and J. E. Bowns. 1985. The effects of fire on the blackbrush (*Coleogyne ramosissima*) community of southwestern Utah. Journal of Range Management 38(6):535-538.

Cannon, H. L. 1960. The development of botanical methods of prospecting for uranium on the Colorado Plateau. USDI Geological Survey Bulletin 1085-A. Washington, DC. 50 pp.

Carmichael, R. S., O. D. Knipe, C. P. Pase, and W. W. Brady. 1978. Arizona chaparral: Plant associations and ecology. Research Paper RM-202. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 16 pp.

Carsey, K., D. Cooper, K. Decker, D. Culver, and G. Kittel. 2003b. Statewide wetlands classification and characterization: Wetland plant associations of Colorado. Prepared for Colorado Department of Natural Resources, Denver, by Colorado Natural Heritage Program, College of Natural Resources, Colorado State University, Fort Collins. 79 pp. [http://www.cnhp.colostate.edu/documents/2003/wetland_classification_final_report_2003.pdf]

Carsey, K., G. Kittel, K. Decker, D. J. Cooper, and D. Culver. 2003a. Field guide to the wetland and riparian plant associations of Colorado. Colorado Natural Heritage Program, Fort Collins, CO.

Cedar Creek Associates, Inc. 1987. Draft vegetation in formation for the Alton Coal Mining Project. Volume 6, Chapter 3, Appendix 3.6-B, pages 1-41 in: Mining & Reclamation Plan for Alton Mine, Utah International, Inc., Utah Division of Oil, Gas & Mining ACT/025/003.

Chappell, C., R. Crawford, J. Kagan, and P. J. Doran. 1997. A vegetation, land use, and habitat classification system for the terrestrial and aquatic ecosystems of Oregon and Washington. Unpublished report prepared for Wildlife habitat and species associations within Oregon and Washington landscapes: Building a common understanding for management. Prepared by Washington and Oregon Natural Heritage Programs, Olympia WA, and Portland, OR. 177 pp.

Christy, J. A. 2004. Native freshwater wetland plant associations of northwestern Oregon. Oregon Natural Heritage Information Center, Oregon State University, Portland, OR.

Christy, J. A., J. S. Kagan, and A. M. Wiedemann. 1998. Plant associations of the Oregon Dunes National Recreation Area - Siuslaw National Forest, Oregon. USDA Forest Service Technical Paper R6-NR-ECOL-TP-09-98, Pacific Northwest Region, Portland, OR. 196 pp.

Christy, J. A., and L. C. Cornelius. 1980. Katherine Ordway Sycan Marsh Preserve: Preliminary classification of plant communities. The Nature Conservancy, Oregon Field Office, Portland.

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Unpublished thesis, University of Northern Colorado, Greeley. 82 pp.

Clagg, H. B. 1975. Fire ecology in high-elevation forests in Colorado. Unpublished M.S. thesis, Colorado State University, Fort Collins. 137 pp.

Clark, D., M. Dela Cruz, T. Clark, J. Coles, S. Topp, A. Evenden, A. Wight, G. Wakefield, and J. Von Loh. 2009. Vegetation classification and mapping project report, Capitol Reef National Park. Natural Resource Report NPS/NCPN/NRTR--2009/187. National Park Service, Fort Collins, CO. 882 pp.

Clary, W. P. 1978. Arizona fescue mountain rangelands. Pages 205-207 in: D. N. Hyder, editor. Proceedings of the First International Rangeland Congress, Denver, CO, 14-18 August 1978. Society for Range Management, Denver.

Clary, W. P. 1992. Ecology and values of Gambel oak woodlands. Pages 87-95 in: Ecology and management of oak and associated woodlands. General Technical Report RM-218. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 224 pp.

Coenenberg, J. G., and E. J. Depuit. 1979. Baseline wildlife studies, Crow Coal Lease, southeastern Montana, 1975-1978. Montana Agricultural Experiment Station, Reclamation Research Unit, Bozeman, MT. 133 pp.

Cogan, D. 2007c. Vegetation classification and mapping project report, Lyndon B. Johnson National Historical Park. Natural Resource Technical Report NPS/SOPN/NRTR--2007/073. National Park Service, Johnson City, TX. 118 pp.

Cogan, D. 2007d. Vegetation classification and mapping project report, San Antonio Missions National Historical Park, National Park Service, Gulf Coast Network. Natural Resource Technical Report NPS/GULN/NRTR--2007/074. National Park Service, Fort Collins, CO. 114 pp.

Cogan, D., H. Marriott, J. Von Loh, and M. J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Wind Cave National Park, South Dakota. Technical Memorandum No. 8260-98-08. USDI Bureau of Reclamation Technical Services Center, Denver, CO. 225 pp.

Cogan, D., K. Varga, and G. Kittel. 2005. USGS-NPS Vegetation Mapping Program: Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway. Final Project Report 2002-2005 Vegetation Mapping Project. Technical Memorandum 8260-06-02. USDI Bureau of Reclamation, Denver, CO. 87 pp. plus Appendixes A-F.

Cogan, D., M. Reid, K. Schulz, and M. Pucherelli. 2004. Zion National Park, Utah 1999-2003. Vegetation Mapping Project. Technical Memorandum 8260-03-01. Remote Sensing and GIS Group Technical Service Center, Bureau of Reclamation, Denver, CO. Appendix F: Vegetation Association Descriptions for Zion.

Coles, J., A. Tendick, G. Manis, A. Wight, G. Wakefield, J. Von Loh, and A. Evenden. 2009a. Vegetation classification and mapping project report, Arches National Park. Natural Resource Technical Report NPS/NCPN/NRTR--2009/253. National Park Service, Fort Collins, CO. 544 pp.

Coles, J., A. Tendick, J. Von Loh, G. Bradshaw, G. Manis, A. Wight, G. Wakefield, and A. Evenden. 2010. Vegetation classification and mapping project report, Black Canyon of the Gunnison National Park. Natural Resource Technical Report NPS/NCPN/NRTR--2010/361. National Park Service, Fort Collins, CO.

Coles, J., A. Wight, J. Von Loh, K. Schulz, and A. Evenden. 2008b. Vegetation classification and mapping project report, Pipe Spring National Monument. Natural Resource Technical Report NPS/NCPN/NRTR--2008/122. National Park Service, Fort Collins, CO. 196 pp.

Coles, J., A. Wight, J. Von Loh, K. Schulz, and A. Evenden. 2011. Vegetation classification and mapping project report, Golden Spike National Historic Site. Natural Resource Technical Report NPS/NCPN/NRTR---2011/508. National Park Service, Fort Collins, CO. 252 pp. [http://www.nature.nps.gov/im/units/NCPN]

Coles, J., D. Cogan, D. Salas, A. Wight, G. Wakefield, J. Von Loh, and A. Evenden. 2008a. Vegetation classification and mapping project report, Dinosaur National Monument. Natural Resource Technical Report NPS/NCPN/NRTR-2008/112. National Park Service, Fort Collins, CO. 814 pp.

Coles, J., J. Von Loh, A. Evenden, G. Manis, G. Wakefield. and A. Wight. 2008c. Vegetation classification and mapping project report, Natural Bridges National Monument. Natural Resource Technical Report NPS/NCPN/NRTR--2008/077. National Park Service, Fort Collins, CO. 390 pp.

Coles, J., J. Von Loh, A. Wight, K. Schulz, and A. Evenden. 2009b. Vegetation classification and mapping project report, Timpanogos Cave National Monument. Natural Resource Technical Report NPS/NCPN/NRTR--2009/210. National Park Service, Fort Collins, CO. 208 pp.

Coles, J., M. Hansen, and K. Thomas. 2003. Wupatki National Monument, Arizona, vegetation classification and distribution: A USGS-NPS Vegetation Mapping Program study. Southwest Biological Science Center, U.S. Geological Survey Open-file Report. In preparation.

Coles, Janet. Personal communication. Former Ecologist/Project Manager, NatureServe, West Regional Office, Boulder, CO.

Collins, E. I. 1984. Preliminary classification of Wyoming plant communities. Unpublished classification prepared for the Wyoming Natural Heritage Program, The Nature Conservancy, Laramie, WY.

Colorado Natural Heritage Program Ecology Team. 2001. A classification of the native vegetation of Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Conard, S. G., and S. R. Radosevich. 1982. Post-fire succession in white fir (*Abies concolor*) vegetation of the northern Sierra Nevada. Madrono 29(1):42-56.

Cooper, D. J., and C. Severn. 1992. Wetlands of the San Luis Valley, Colorado: An ecological study and analysis of the hydrologic regime, soil chemistry, vegetation and the potential effects of a water table drawdown. Report submitted to the State of Colorado Division of Wildlife, the USDI Fish & Wildlife Service and the Rio Grande Water Conservation District.

Cooper, D. J., and T. R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Colorado Field Office, Boulder. 115 pp.

Cooper, S. V., P. Lesica, R. L. DeVelice, and T. McGarvey. 1995. Classification of southwestern Montana plant communities with emphasis on those of Dillon Resource Area, Bureau of Land Management. Montana Natural Heritage Program, Helena, MT. 154 pp.

Cooper, S. V., and B. L. Heidel. 1997. Population status and ecology of trembling aspen and black cottonwood communities on the Blackfeet Indian Reservation. Prepared for the Blackfeet Nation-Fish and Wildlife Department and the USDI Fish & Wildlife Service by Montana Natural Heritage Program, Helena, MT.

Cooper, S., and R. Pfister. 1981. Forest habitat types of the Blackfeet Indian Reservation. Review Draft, 5/21/81, for Bureau of Indian Affairs, Wind River Agency, Fort Washakie, WY.

Costello, D. F. 1954. Vegetation zones in Colorado. Pages iii-x in: H. D. Harrington, editor. Manual of the plants of Colorado. Sage Books, Denver.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. FWS/OBS-79/31. USDI Fish & Wildlife Service, Office of Biological Services, Washington, DC. 103 pp.

Cox, B. J. 1968. A vegetational comparison of the Gothic and Galena Mountain area. Transactions of the Missouri Academy of Science 2:72-83.

Cox, C. F. 1933. Alpine plant succession on James Peak, Colorado. Ecological Monographs 3:299-372.

Crane, M. F. 1982. Fire ecology of Rocky Mountain Region forest habitat types. USDA Forest Service final report. 272 pp.

Crawford, R. C., C. B. Chappell, C. C. Thompson, and F. J. Rocchio. 2009. Vegetation classification of Mount Rainier, North Cascades, and Olympic national parks. Plant association descriptions and identification keys: Appendices A - G. Natural Resource Technical Report NPS/NCCN/NRTR--2009/D-586. National Park Service, Fort Collins, CO. 586 pp.

Cronquist, A., N. H. Holmgren, and P. K. Holmgren. 1997. Intermountain flora: Vascular plants of the Intermountain West, USA. Volume 3, Part A, subclass Rosidae (except Fabeles). New York Botanical Garden, Bronx, NY. 446 pp.

Crouch, G. L. 1983. Effects of commercial clear-cutting of aspen on understory vegetation and wildlife habitat values in southwestern Colorado. Research Paper RM-246. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Crowe, E. A., B. L. Kovalchik, and M. J. Kerr. 2004. Riparian and wetland vegetation of central and eastern Oregon. Oregon Natural Heritage Information Center, Institute for Natural Resources, Oregon State University, Portland. 473 pp. [http://oregonstate.edu/ornhic/ publications.html]

Crowe, E. A., and R. R. Clausnitzer. 1997. Mid-montane wetland plant associations of the Malheur, Umatilla, and Wallowa-Whitman national forests. Technical Paper R6-NR-ECOL-TP-22-97. USDA Forest Service, Pacific Northwest Region, Portland, OR.

Culver, D. R., M. A. March, S. M. Kettler, and C. A. Pague. 1996. Natural Heritage Inventory of significant animals and plants and classification of riparian plant associations: Timpas Grazing District and Kim Grazing Association. Report prepared for USDA Forest Service, Pike-San Isabel National Forest, La Junta, CO, by Colorado Natural Heritage Program, Fort Collins.

Curry, R. R. 1962. Geobotanical correlations in the alpine and subalpine regions of the Tenmile Range, Summit County, Colorado. Unpublished thesis, University of Colorado, Boulder. 133 pp.

Dastrup, B. C. 1963. Vegetational changes of the Uinta Basin since settlement. Unpublished thesis, Brigham Young University, Provo, UT. 118 pp.

Daubenmire, R. 1975. Floristic plant geography of eastern Washington and northern Idaho. Journal of Biogeography 2:1-18.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62. 131 pp.

Day, T. A., and R. G. Wright. 1985. The vegetation types of Craters of the Moon National Monument. Forestry, Wildlife, and Range Experiment Station Bulletin No. 38. University of Idaho, Moscow. 6 pp.

DeByle, N. V. 1985. Managing wildlife habitat with fire in the aspen ecosystem. Pages 73-82 in: Fire's effects

on wildlife habitat-Symposium proceedings. General Technical Report INT-186. USDA Forest Service, Intermountain Research Station, Ogden, UT.

DeByle, N. V., and R. P. Winokur, editors. 1985. Aspen: Ecology and management in the western United States. USDA Forest Service General Technical Report RM-119. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 283 pp.

DeVelice, R. L. 1983. Forest vegetation of northern New Mexico and southern Colorado. Unpublished dissertation, New Mexico State University, Las Cruces. 191 pp.

DeVelice, R. L. 1992. Classification of the plant communities of Beaverhead, Silver Bow, and Madison counties, Montana. Volume I (text). Prepared for the Montana Natural Heritage Program, Helena, MT. 35 pp.

DeVelice, R. L., J. A. Ludwig, W. H. Moir, and F. Ronco, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. General Technical Report RM-131. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 59 pp.

DeVelice, R. L., J. Lichthardt, and P. S. Bourgeron. 1991. A preliminary classification of the plant communities of northeastern Montana. Prepared for the Montana Natural Heritage Program. Helena, MT. 144 pp.

DeVelice, R. L., S. V. Cooper, J. T. McGarvey, J. Lichthardt, and P. S. Bourgeron. 1995. Plant communities of northeastern Montana: A first approximation. Montana Natural Heritage Program, Helena, MT. 116 pp.

DeVelice, R. L., and J. A. Ludwig. 1983a. Climax forest series of northern New Mexico and southern Colorado. Pages 45-53 in: Proceedings of the Workshop on Southwestern Habitat Types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwest Region, Albuquerque, NM.

DeVelice, R. L., and J. A. Ludwig. 1983b. Forest habitat types south of the Mogollon Rim, Arizona and New Mexico. Final Report, CA K-28-240. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 48 pp. plus appendices.

DeVelice, R. L., and P. Lesica. 1993. Plant community classification for vegetation on BLM lands, Pryor Mountains, Carbon County, Montana. Unpublished report by Montana Natural Heritage Program, Helena, MT. 78 pp.

Dealy, J. E. 1975. Ecology of curl-leaf mahogany (*Cercocarpus ledifolius* Nutt.) in Oregon and adjacent areas. Unpublished dissertation, Oregon State University, Corvallis. 168 pp.

Despain, D. G. 1973a. Vegetation of the Big Horn Mountains, Wyoming, in relation to substrate and climate. Ecological Monographs 43(3):329-354.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin. 25 pp.

Diamond, D., B. Amos, T. Cook, R. Edwards, W. Elliot, R. Evans, and K. Kennedy. 1992. Endangered, threatened, and watchlist of natural communities of Texas. Texas Organization for Endangered Species. Austin, TX. 14 pp.

Dick-Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque. 244 pp.

Dixon, H. 1935. Ecological studies on the high plateaus of Utah. Botanical Gazette 97:272-320.

Donart, G. B., D. D. Sylvester, and W. C. Hickey. 1978b. Potential natural vegetation-New Mexico. New Mexico Interagency Range Commission Report 11.

Donart, G. B., D. Sylvester, and W. Hickey. 1978a. A vegetation classification system for New Mexico, USA. Pages 488-490 in: Rangeland Congress, Denver, CO, 14-18 August 1978. Society for Range Management, Denver.

Donnelly, P., D. Lindsey, E. Muldavin, Y. Chauvin, and A. Browder. 2006. Vegetation communities of Bosque del Apache National Wildlife Refuge. Prepared by U.S. Fish and Wildlife Service, National Wildlife Refuge Remote Sensing Lab, Albuquerque, NM, and Natural Heritage New Mexico, University of New Mexico, Albuquerque. Final report submitted to U.S. Fish and Wildlife Service, Southwest Region (R2), National Wildlife Refuge System (NWR), NWR Remote Sensing Lab, Division of Planning. 27 pp. [http://www.fws.gov/data/documents/BDA%20NVCS%20Veg%20Community%20Report%20Example.pdf]

Dorn, R. D. 1969. Relations of moose, cattle and willows in southwestern Montana. Unpublished thesis, Montana State University, Bozeman. 79 pp.

Dorn, R. D. 1997. Rocky Mountain region willow identification field guide. Renewable Resources R2-RR-97-01. USDA Forest Service, Rocky Mountain Region, Denver, CO. 107 pp.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, DC. 56 pp.

Durkin, P., E. Muldavin, M. Bradley, S. E. Carr, A. Metcalf, R. A. Smartt, S. P. Platania, C. Black, and P. Mehlhop. 1995b. The biodiversity of the Ladder Ranch. Unpublished final report prepared by The Nature Conservancy, New Mexico Field Office, Santa Fe, NM, and the New Mexico Natural Heritage Program, University of New Mexico, Department of Biology, Albuquerque, NM.

Dwyer, D. D., and R. D. Pieper. 1967. Fire effects on blue gramma-pinyon-juniper rangeland in New Mexico. Journal of Range Management 20:359-362.

Ecosystems Working Group. 1998. Standards for broad terrestrial ecosystem classification and mapping for British Columbia. Prepared by the Ecosystems Working Group, Terrestrial Ecosystem Task Force, Resources Inventory Committee, for the Province of British Columbia. 174 pp. plus appendices. [<http://srmwww.gov.bc.ca/risc/pubs/teecolo/tem/indextem.htm>]

Eddleman, L. E., and R. Jaindl. 1994. Great Basin National Park vegetation analysis. Technical Report NPS/PNROSU/NRTR-94/02. National Park Service, Pacific Northwest Region, Seattle, WA. 110 pp.

Edwards, M. C. 1987. Terrestrial ecosystem survey for the Carson National Forest. USDA Forest Service, Southwestern Region, Albuquerque, NM. [in preparation]

Englund, S. R. 2004. *Bromus tectorum* impacts soil carbon storage in semiarid grasslands of Canyonlands National Park. M.S. thesis, University of Utah, Salt Lake City.

Erdman, J. A. 1962. Ecology of the pinyon-juniper woodland of Wetherill Mesa, Mesa Verde National Park, Colorado. Unpublished thesis, University of Colorado, Boulder. 109 pp.

Erdman, J. A. 1969. Pinyon-juniper succession after fires on residual soils of the Mesa Verde, Colorado. Unpublished dissertation, University of Colorado, Boulder. 81 pp.

Erdman, J. A. 1970. Pinyon-juniper succession after natural fires on residual soils of Mesa Verde, Colorado. Brigham Young University Science Bulletin, Biological Series 11(2):1-26.

Erdman, J. A., C. L. Douglas, and J. W. Marr. 1969. Wetherill Mesa Studies, environment of Mesa Verde, Colorado. USDI National Park Service. Archeological Research Series 7-B. Washington, DC. 72 pp.

Evans, R. D., R. Rimer, L. Sperry, and J. Belnap. 2001. Exotic plant invasion alters nitrogen dynamics in an arid grassland. Ecological Applications 11(5):1301-1310.

Evans, S. 1989a. Riparian survey of Washington's Columbia Basin. Unpublished report prepared for The Nature Conservancy Washington Natural Heritage Program, Olympia, Washington.

Evans, S. 1989b. Provisional riparian and aquatic wetland plant communities on the Columbia Plateau. Unpublished report prepared under Contract No. C0089098, with Washington State Department of Ecology. 52 pp.

Evenden, A. G. 1990. Ecology and distribution of riparian vegetation in the Trout Creek Mountains of southeastern Oregon. Ph.D. dissertation, Oregon State University, Corvallis. 156 pp.

Evens, J. M. 2000. Water course vegetation on granite and calcareous substrates in the eastern Mojave Desert, California. Master's thesis, Humboldt State University, Arcata, CA.

Evens, J. M., and S. Hartman. 2007. Vegetation survey and classification for the Northern and Eastern Colorado Desert Coordinated Management Plan (NECO). CNPS Vegetation Program, Sacramento, CA.

Evens, J., and S. San. 2006. Vegetation alliances of the San Dieguito River Park region, San Diego County, California. Final report (August 2005) Version 2 (revised May 2006). Prepared by California Native Plant Society in cooperation with the California Natural Heritage Program of the California Department of Fish and Game and San Diego Chapter of the California Native Plant Society. Sacramento, CA. 271 pp.

Everett, R. L. 1987. Plant response to fire in the pinyon-juniper zone. Pages 152-157 in R. L. Everett, compiler. Proceedings pinyon-juniper conference: 1986 January 13-16, Reno, NV. General Technical Report INT-215. USDA Forest Service, Intermountain Research Station, Ogden, UT.

Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.

FEIS [Fire Effects Information System] 1996. Prescribed fire and fire effects research work unit, Rocky Mountain Research Station (producer). [www.fs.fed.us/database/feis/] (accessed 1998 March 12)

FEIS [Fire Effects Information System]. 1998. USDA Forest Service. [http://www.fs.fed.us/database/feis/]

FEIS [Fire Effects Information System]. 2001. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2001, May). [http://www.fs.fed.us/database/feis/[(accessed 20 July 2001).

Faber-Langendoen, D., J. Drake, S. Gawler, M. Hall, C. Josse, G. Kittel, S. Menard, C. Nordman, M. Pyne, M. Reid, L. Sneddon, K. Schulz, J. Teague, M. Russo, K. Snow, and P. Comer, editors. 2012. Divisions, Macrogroups and Groups for the Revised U.S. National Vegetation Classification. NatureServe, Arlington, VA. plus appendices.

Faber-Langendoen, D., and Midwest State Natural Heritage Program Ecologists. 1996. Terrestrial vegetation of the midwest United States. International classification of ecological communities: Terrestrial vegetation of the United States. The Nature Conservancy, Arlington, VA.

Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. plus appendix (705 pp.).

Faden, A. O. 1977. Vegetation zonation of a Mohave Desert playa. Unpublished thesis, University of Nevada, Las Vegas.

Felger, R. S. 1990. Non-native plants of Organ Pipe Cactus National Monument, Arizona. Technical Report No. 31. University of Arizona, School of Renewable Natural Resources, Cooperative National Park Resources Studies

Unit, Tucson. 93 pp.

Fenton, K., J. R. Bell, and D. Wegner. 2007. Lake Meredith National Recreation Area, Alibates Flint Quarries National Monument, Texas. Technical Memorandum No. 86-68260-07-01. Bureau of Reclamation, Denver, CO.

Ferchau, H. A. 1973. Vegetation inventory analysis & impact study of the Parachute Creek area, Garfield County, Colorado. Part II, Volume 1, Chapter VI:1-77 in: Unpublished Colony Environmental Report for Colony Develop. Operation, Denver, prepared by Thorne Ecological Institute, Boulder.

Fike, J. 1999. Terrestrial and palustrine plant communities of Pennsylvania. Pennsylvania Natural Diversity Inventory. Pennsylvania Department of Conservation and Recreation, Bureau of Forestry, Harrisburg, PA. 86 pp.

Fischer, W. C., and A. F. Bradley. 1987. Fire ecology of western Montana forest habitat types. General Technical Report INT-223. USDA Forest Service, Intermountain Research Station, Ogden, UT. 95 pp.

Fish, E. B. 1966. Secondary succession on upper Kiowa Creek watershed. Unpublished thesis, Colorado State University, Fort Collins. 102 pp.

Fitzhugh, E. L., W. H. Moir, J. A. Ludwig, and F. Ronco, Jr. 1987. Forest habitat types in the Apache, Gila, and part of the Cibola national forests. General Technical Report RM-145. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 116 pp.

Flowers, S. 1962. Vegetation of Morrow Point and Blue Mesa Reservoir basins of the upper Gunnison River, Colorado. Pages 47-102 in: A. M. Woodbury, editor. Ecological studies of the flora and fauna of the Curecanti Reservoir Basins, western Colorado. University of Utah, Anthropological Papers No. 59 (Upper Colo. Series No. 8).

Floyd, M. L., D. D. Hanna, and G. Salamacha. 2001. Post-fire treatment of noxious weeds in Mesa Verde National Park, Colorado. Pages 147-157 in: C. Van Riper, III, et al., editors. Proceedings of the 5th Biennial Conference of Research on the Colorado Plateau, U.S. Geological Survey / FRESC Report Series USGSFRESC/COPL/2001/24. [<http://www.rmrs.nau.edu/lab/people/csieg/sieg_pubs/Exotic_and%20_noxious_plants.pdf>].

Floyd, M. L., editor. 2003. Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. University Press of Colorado, Boulder.

Francis, R. E. 1986. Phyto-edaphic communities of the Upper Rio Puerco Watershed, New Mexico. Research Paper RM-272. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 73 pp.

Francis, R. E., and E. F. Aldon. 1983. Preliminary habitat types of a semiarid grassland. Pages 62-66 in: W. H. Moir and L. Hendzel, technical coordinators. Proceedings of the workshop on southwestern habitat types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. General Technical Report PNW-8. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR. 417 pp.

Freeman, C. E., and W. A. Dick-Peddie. 1970. Woody riparian vegetation in the Black and Sacramento Mountain ranges, southern New Mexico. The Southwestern Naturalist 15(2):145-164.

Friesen, B. A., S. Blauer, K. Landgraf, J. Von Loh, J. Coles, K. Schulz, A. Tendick, A. Wight, G. Wakefield, and A. Evenden. 2010. Vegetation classification and mapping project report, Fossil Butte National Monument. Natural Resource Technical Report NPS/NCPN/NRTR--2010/319. National Park Service, Fort Collins, CO. 552 pp. [http://biology.usgs.gov/npsveg/fobu/foburpt.pdf]

Giese, T. G. 1975. The ecology of the Middle Blue River Valley, Summit County, Colorado, with an analysis of

modifications due to powerline construction. Unpublished thesis, University of Colorado, Boulder. 109 pp.

Girard, M. M., H. Goetz, and A. J. Bjugstad. 1989. Native woodland habitat types of southwestern North Dakota. Research Paper RM-281. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 36 pp.

Girard, M., D. L. Wheeler, and S. B. Mills. 1997. Classification of riparian communities on the Bighorn National Forest. R2-RR-97-02. USDA Forest Service, Rocky Mountain Region, Sheridan, WY. 308 pp.

Gleason, H. A., and A. Cronquist. 1991. Manual of vascular plants of northeastern United States and adjacent Canada. New York Botanical Garden, Bronx, NY. 910 pp.

Graybosch, R. A., and H. Buchanan. 1983. Vegetative types and endemic plants of the Bryce Canyon Breaks. Great Basin Naturalist 43:701-712.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence. 1402 pp.

Greenall, J. A. 1996. Manitoba's terrestrial plant communities. MS Report 96-02, Manitoba Conservation Data Centre, Winnipeg.

Gruell, G. E., S. Bunting, and L. Neuenschwander. 1985. Influence of fire on curlleaf mountain-mahogany in the Intermountain West. Pages 58-72 in: J. E. Lotan and J. K. Brown, compilers. Fire's effects on wildlife habitat-symposium proceedings. USDA Forest Service Technical Report INT-186, Intermountain Forest and Range Experiment Station, Ogden, UT.

Haase, E. F. 1972. Survey of floodplain vegetation along the lower Gila River in southwestern Arizona. Journal of the Arizona Academy of Science 7:75-81.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA Forest Service, Pacific Northwest Region. R6 Area Guide 3-1. 62 pp.

Hall, H. H. 1971. Ecology of a subalpine meadow of the Aquarius Plateau, Garfield and Wayne counties, Utah. Unpublished dissertation, Brigham Young University, Provo, UT.

Hall, J. B., and P. L. Hansen. 1997. A preliminary riparian habitat type classification system for the Bureau of Land Management districts in southern and eastern Idaho. Riparian and Wetland Research Program, School of Forestry, University of Montana. Idaho Bureau of Land Management, Technical Bulletin No. 97-11. 381 pp.

Hanks, J. P., E. L. Fitzhugh, and S. R. Hanks. 1983. A habitat type classification system for ponderosa pine forests of northern Arizona. General Technical Report RM-97. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 22 pp.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004a. USGS-NPS National Vegetation Mapping Program: Walnut Canyon National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, AZ. 219 pp.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004b. USGS-NPS Vegetation Mapping Program: Wupatki National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, AZ. 229 pp.

Hansen, M., J. Coles, K. A. Thomas, D. Cogan, M. Reid, J. Von Loh, and K. Schulz. 2004c. USGS-NPS Vegetation Mapping Program: Sunset Crater National Monument, Arizona, vegetation classification and distribution. U.S. Geological Survey Technical Report. Southwest Biological Science Center, Flagstaff, AZ. 188 pp.

Hansen, M., K. Thomas, and J. Coles. 2003. Walnut Canyon National Monument, Arizona, vegetation classification and distribution: A USGS-NPS Vegetation Mapping Program Study. Southwest Biological Science Center, U.S. Geological Survey Open-file Report. In preparation.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp. + posters.

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988b. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. Montana Forest and Conservation Experiment Station, Missoula. 411 pp.

Hansen, P. L., and G. R. Hoffman. 1988. The vegetation of the Grand River/Cedar River, Sioux, and Ashland districts of the Custer National Forest: A habitat type classification. General Technical Report RM-157. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 68 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Hansen, P., S. Chadde, R. Pfister, J. Joy, D. Svoboda, J. Pierce, and L. Myers. 1988a. Riparian site types, habitat types, and community types of southwestern Montana. Draft Version 1. Montana Riparian Association, Missoula.

Hanson, H. C., and W. S. Ball. 1928. An application of Raunkiaer's law of frequency to grazing studies. Ecology 9:467-473.

Harmon, W. E. 1980. Survey of the flora and vegetation of the Bodo Wildlife Management Area. Unpublished report prepared for The Nature Conservancy, Denver, CO. On file at the Colorado Natural Areas Program, Denver. 40 pp.

Heath, M. E., D. S. Metcalfe, and R. E. Barnes. 1973. Forages: the science of grassland agriculture. Iowa State University Press, Ames.

Heinze, D. H., R. E. Eckert, and P. T. Tueller. 1962. The vegetation and soils of the Steptoe Watershed. Unpublished report prepared for the USDI Bureau of Land Management. 40 pp.

Helm, D. J. 1977. Variations in alpine snowfield vegetation. Unpublished thesis, Colorado State University, Fort Collins. 95 pp.

Helm, D. J. 1981. Vegetation diversity indexes in several vegetation types of western Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 113 pp.

Henderson, J. A., D. A. Peter, R. Lesher, and D. C. Shaw. 1989. Forested plant associations of the Olympic National Forest. USDA Forest Service, Pacific Northwest Region. R6-ECOL-TP-001-88. Portland, OR. 502 pp.

Henderson, J. A., D. A. Peter, and R. Lesher. 1986. Preliminary plant associations of the Olympic National Forest. USDA Forest Service, Pacific Northwest Region. 136 pp.

Henderson, J. S., and M. L. McAllister. 1983. Downey Lake, an inventory of vegetation and wildlife. The Nature Conservancy, Portland, OR.

Henry, R. J. 1981. Riparian vegetation of two mountain ranges in southwestern New Mexico. Unpublished thesis, New Mexico State University, Las Cruces.

Hess, K. 1981. Phyto-edaphic study of habitat types of the Arapaho-Roosevelt National Forest, Colorado. Unpublished dissertation, Colorado State University, Fort Collins. 558 pp.

Hess, K., and C. H. Wasser. 1982. Grassland, shrubland, and forest habitat types of the White River-Arapaho National Forest. Unpublished final report 53-82 FT-1-19. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 335 pp.

Hess, K., and R. R. Alexander. 1986. Forest vegetation of the Arapaho and Roosevelt national forests in northcentral Colorado: A habitat type classification. Research Paper RM-266. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 48 pp.

Hibner, C. D. 2009. Special project soil survey of Bandelier National Monument. Natural Resources Conservation Science. In cooperation with the USDI National Park Service and the New Mexico Agricultural Experiment Station. [in review]

Hironaka, M., M. A. Fosberg, and A. H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. Forestry, Wildlife, and Range Experiment Station Bulletin No. 15, University of Idaho, Moscow. 44 pp.

Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. The Southwestern Naturalist 45(4):385-420.

Hoagland, B. W. 1998c. Oklahoma riparian vegetation. In: A. Fallon and M. Smolen, editors. Riparian area management handbook. Publication number E-952. Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater.

Hoffman, G. R., and R. R. Alexander. 1976. Forest vegetation of the Bighorn Mountains, Wyoming: A habitat type classification. Research Paper RM-170. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 38 pp.

Hoffman, G. R., and R. R. Alexander. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: A habitat type classification. General Technical Report RM-221. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 41 pp.

Hoffman, G. R., and R. R. Alexander. 1983. Forest vegetation of the White River National Forest in western Colorado: A habitat type classification. Research Paper RM-249. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 36 pp.

Hoffman, G. R., and R. R. Alexander. 1987. Forest vegetation of the Black Hills National Forest of South Dakota and Wyoming: A habitat type classification. Research Paper RM-276. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 48 pp.

Holland, J. 1982. A floristic and vegetation analysis of the Newberry Mountains, Clark County, Nevada. Unpublished thesis, University of Nevada, Las Vegas. Reproduced in the Lake Mead Report Series by University of Nevada Cooperative National Park Resources Studies Unit, Las Vegas.

Holland, R. F. 1986b. Preliminary descriptions of the terrestrial natural communities of California. Unpublished report prepared for the California Department of Fish and Game, Nongame-Heritage Program and Natural Diversity Database, Sacramento. 156 pp.

Holland, V. L., and D. J. Keil. 1995. California vegetation. Kendall/Hunt Publishing Company, Dubuque, IA. 516 pp.

Holm, T. 1927. The vegetation of the alpine region of the Rocky Mountains in Colorado. Pages 1-45 in: National Academy of Sciences 19. Third Memoir.

Hop, K., M. Reid, J. Dieck, S. Lubinski, and S. Cooper. 2007. U.S. Geological Survey-National Park Service Vegetation Mapping Program: Waterton-Glacier International Peace Park. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, WI. 131 pp. plus Appendices A-L.

Hopkins, W. E. 1979a. Plant associations of the Fremont National Forest. USDA Forest Service Technical Report R6-ECOL-79-004. Pacific Northwest Region, Portland.

Howard, J. L. 1997a. *Aristida purpurea*. In: Fire Effects Information System [Online]. USDA, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [http://www.fs.fed.us/database/feis/] (accessed 1 April 2008 and 19 June 2011).

Howard, J. L. 2003. *Atriplex canescens*. In: Fire Effects Information System [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [http://www.fs.fed.us/database/feis/] (accessed 13 July 2007).

IDCDC [Idaho Conservation Data Center]. 2005. Wetland and riparian plant associations in Idaho. Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise. [http://fishandgame.idaho.gov/tech/CDC/ecology/wetland_riparian_assoc.cfm] (accessed 14 June 2005).

Isaacson, H. E. 1967. Ecological provinces within the pinyon-juniper type of the Great Basin and Colorado Plateau. Unpublished thesis, Utah State University, Logan. 44 pp.

Jameson, D. A. 1962. Effects of burning on a galleta-black grama range invaded by juniper. Ecology 43:760-763.

Jameson, D. A., J. A. Williams, and E. W. Wilton. 1962. Vegetation and soils of Fishtail Mesa, Arizona. Ecology 43:403-410.

Jankovsky-Jones, M., C. J. Murphy, and C. L. Coulter. 2001. Riparian and wetland plant associations of southwestern Idaho in the Lower Snake River District, Bureau of Land Management. Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise.

Jankovsky-Jones, M., S. K. Rust, and R. K. Moseley. 1999. Riparian reference areas in Idaho: A catalog of plant associations and conservation sites. General Technical Report RMRS-GTR-20. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT. 141 pp.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province Wallowa-Whitman National Forest. Technical Paper R6-ECOL-TP-255A-86. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. 399 pp. plus appendices.

Johnson, C. G., and R. R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest R6-ERW-TP-036-92. 163 pp. plus appendices.

Johnson, J. R., and G. F. Payne. 1968. Sagebrush reinvasion as affected by some environmental influences. Journal of Range Management 21:209-213.

Johnson, K. R. 1932a. Plant ecology of a glacial lake. Journal of the Colorado-Wyoming Academy of Science 1(4):13 (Abstract).

Johnson, K. R. 1932b. Ecology of a glacial lake in central Colorado. Unpublished thesis, University of Colorado, Boulder. 30 pp.

Johnson, K. R. 1936. Ecology of a glacial lake in central Colorado. University of Colorado Studies 23(3):235-243.

Johnson, K. R. 1939. Plant ecology of northwestern Colorado lakes and surrounding areas. Unpublished dissertation, University of Colorado, Boulder. 138 pp.

Johnston, B. C. 1984. Plant associations of Region Two. Edition 3.5. USDA Forest Service, Rocky Mountain Region. Lakewood, CO.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Johnston, B. C., and L. Hendzel. 1985. Examples of aspen treatment, succession and management in western Colorado. USDA Forest Service, Range Wildlife Fisheries and Ecology. Denver, CO. 164 pp.

Johnston, B. C., and L. Huckaby. 2001. Ecological types of the Upper Gunnison Basin. Technical Report R2-RR-2001-01. USDA Forest Service, Rocky Mountain Region, Denver, CO.

Jones, G. 1992b. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Jones, G. P. 1989b. Survey of plant species and communities of interest in the Beaver Rim Area of Critical Environmental Concern. Report submitted to the Bureau of Land Management, Rawlins District Office, under Work Effort No. WY030-09-4352-06-2512. Wyoming Natural Diversity Database, Laramie, WY.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Jones, G., and S. Ogle. 2000. Characterization abstracts for vegetation types on the Bighorn, Medicine Bow, and Shoshone national forests. Prepared for USDA Forest Service, Region 2 by the Wyoming Natural Diversity Database, University of Wyoming.

Jones, J. R., and N.V. DeByle. 1985. Morphology. Pages 11-20 in: N. V. DeByle and R. P. Winokur, editors. Aspen: Ecology and management in the western United States. General Technical Report RM-119. USDA Forest Service, Rocky Mountain Forest Range Experiment Station, Fort Collins, CO.

Kagan, J. S., J. A. Christy, M. P. Murray, and J. A. Titus. 2000-2004. Classification of native vegetation of Oregon. Oregon Natural Heritage Program, Portland. 63 pp.

Kallender, H. R. 1959. Controlled burning in ponderosa pine stands of the Fort Apache Indian Reservation. Pages 20-22 in: R. R. Humphrey, compiler. Your range--its management. Special Report No. 2. University of Arizona, Agricultural Extension Service, Tucson, AZ.

Karl, M. G., R. K. Heitschmidt, and M. R. Haferkamp. 1999. Vegetation biomass dynamics and patterns of sexual reproduction in a northern mixed-grass prairie. The American Midland Naturalist 141:227-237.

Kartesz, J. T. 1994a. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Second edition. Volume 1--Checklist. Timber Press, Portland, OR. 622 pp.

Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J. T. Kartesz and C. A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Kauffman, J. B. 1982. Synecological effects of cattle grazing riparian ecosystems. Unpublished thesis, Oregon State

University, Corvallis. 283 pp.

Kauffman, J. B., W. C. Krueger, and M. Vaura. 1983. Effects of late season cattle grazing on riparian plant communities. Journal of Range Management 37:685-691.

Kauffman, J. B., W. C. Krueger, and M. Vaura. 1985. Ecology and plant communities of the riparian area associated with Catherine Creek in northeastern Oregon. Technical Bulletin 147. Eastern Oregon Agricultural Experiment Station, Oregon State University, Corvallis. 35 pp.

Keammerer, W. R. 1974b. Vegetation of Parachute Creek Valley. Pages 4-91 in: Environmental inventory and impact analysis of a proposed utilities corridor in Parachute Creek Valley, Co. Unpublished report prepared for Colony Development Operation, Denver, Colo.

Keammerer, W. R., and R. E. Stoecker. 1975. Vegetation and wildlife studies along proposed corridors for oil shale tract C-b. Unpublished report prepared for Shell Oil Co., Denver, by Stoecker-Keammerer and Associates, Boulder, CO. 86 pp.

Keammerer, W. R., and R. E. Stoecker. 1980. Vegetation and wildlife studies for the Mount Emmons project. Unpublished report prepared for AMAX Environmental Services, Inc., by Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 3 volumes.

Keammerer, W. R., and S. J. Peterson. 1981. Vegetation studies on the Naval Oil Shale Reserve. Unpublished report prepared for TRW Energy Systems Group, McLean, Virginia, by Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 77 pp.

Keeler-Wolf, T. 1997. Preliminary table of Mojave Desert ecosystem vegetation types.

Keeler-Wolf, T. 2007. Mojave Desert scrub vegetation. Pages 609-656 in: M. G. Barbour, T. Keeler-Wolf, and A. A. Schoenherr, editors. 2007. Terrestrial vegetation of California. Third edition. University of California Press, Berkeley.

Keeler-Wolf, T. Personal communication. Senior Vegetation Ecologist, Wildlife and Habitat Data Analysis Branch, California Department of Fish and Game, Sacramento, CA.

Keeler-Wolf, T., C. Roye, and K. Lewis. 1998. Vegetation mapping and classification of the Anza-Borrego Desert State Park, California. Unpublished report on file at California Natural Diversity Database, California Department Fish and Game, Sacramento.

Keeler-Wolf, T., M. Schindel, S. San, P. Moore, and D. Hickson. 2003a. Classification of the vegetation of Yosemite National Park and surrounding environs in Tuolumne, Mariposa, Madera and Mono counties, California. Unpublished report by NatureServe in cooperation with the California Native Plant Society and California Department of Fish and Game, Wildlife and Habitat Data Analysis Branch, Sacramento, CA.

Keeler-Wolf, T., S. San, and D. Hickson. 2005. Vegetation classification of Joshua Tree National Park, Riverside and San Bernardino counties, California. Unpublished report to the National Park Service. California Fish and Game and California Native Plant Society, Sacramento, CA.

Keeler-Wolf, T., and J. Evens. 2006. Vegetation classification of the Santa Monica Mountains National Recreation Area and environs in Ventura and Los Angeles counties, California. A report submitted to National Park Service, Santa Monica Mountains National Recreation Area by California Department of Fish and Game, Wildlife and Habitat Data Analysis Branch and The California Native Plant Society,Vegetation Program, Sacramento, CA.

Keeler-Wolf, T., and K. Thomas. 2000. Draft descriptions of vegetation alliances for the Mojave Ecosystem Mapping

project. California Natural Diversity Database, California Department of Fish and Game, Sacramento.

Kelting, R. W. 1948. Changes in vegetation on stock pond dams near Norman, Oklahoma. Unpublished M.S. thesis, University of Oklahoma, Norman.

Kelting, R. W., and W. T. Penfound. 1950. The vegetation of stock pond dams in central Oklahoma. American Midland Naturalist 44:69-75.

Kemp, K. 1965. A study of litter and vegetation on the upper chaparral area of central Arizona. Unpublished thesis, University of Arizona, Tucson. 79 pp.

Kennedy, K. L. 1983a. A habitat-type classification for the pinyon-juniper woodlands of the Lincoln National Forest. Unpublished thesis, New Mexico State University, Las Cruces. 87 pp.

Kierstead, J., and T. Pogson. 1976. A summer flora of the Alvord Basin. Appendix 1. Pages 1-1 to 1-54 in: K. Roberts, editor. A preliminary ecological survey of the Alvord Basin. Final Technical Report. NSF-SOS (76-08175). Eastern Oregon State College. 15 pp. plus 6 appendices.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., E. Reyes, J. Evens, J. Buck, and D. Johnson. 2009. Vegetation classification and mapping project, Pinnacles National Monument. Natural Resource Technical Report NPS/SFAN/NRTR-2009/XXX. National Park Service, Fort Collins, CO.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999b. A classification of riparian and wetland plant associations of Colorado: A user's guide to the classification project. Colorado Natural Heritage Program, Colorado State University, Fort Collins CO. 70 pp. plus appendices.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999a. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., E. Van Wie, and M. Damm. 1997a. A classification of the riparian vegetation of the South Platte Basin (and part of Republican River Basin), Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins. 243 pp.

Kittel, G., R. Rondeau, and S. Kettler. 1995. A classification of the riparian vegetation of the Gunnison River Basin, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Prepared by Colorado Natural Heritage Program, Fort Collins. 114 pp.

Klein, A., J. Crawford, J. Evens, D. Hickson, and T. Keeler-Wolf. 2007. Vegetation alliances and associations of the

northern Sierra Nevada foothills, California. A report to Habitat Conservation Division, California Department of Fish and Game, California Native Plant Society, Sacramento.

Klein, A., and J. Evens. 2005. Vegetation alliances of western Riverside County, California. Unpublished report prepared for California Department of Fish and Game, Habitat Conservation Division, California Native Plant Society, Sacramento, CA.

Kleiner, E. F. 1968. Comparative study of grasslands of Canyonlands National Park. Unpublished dissertation, University of Utah, Salt Lake City. 58 pp.

Kleiner, E. F. 1983. Successional trends in an ungrazed, arid grassland over a decade. Journal of Range Management 36(1):114-118.

Kleiner, E. F., and K. T. Harper. 1972. Environment and community organization in grasslands of Canyonlands National Park. Ecology 53(2):299-309.

Kleiner, E. F., and K. T. Harper. 1977. Occurrence of four major perennial grasses in relation to edaphic factors in a pristine community. Journal of Range Management 30(4):286-289.

Knight, D. H. 1994. Mountains and plains: Ecology of Wyoming landscapes. Yale University Press, New Haven, MA. 338 pp.

Knight, D. H., G. P. Jones, Y. Akashi, and R. W. Myers. 1987. Vegetation ecology in the Bighorn Canyon National Recreation Area. Unpublished report prepared for the USDI National Park Service and University of Wyoming-National Park Service Research.

Komarkova, V. 1976. Alpine vegetation of the Indian Peaks Area, Front Range, Colorado Rocky Mountains. Unpublished dissertation, University of Colorado, Boulder. 655 pp.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre national forests. Unpublished final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 270 pp. plus appendices.

Komarkova, V. K., R. R. Alexander, and B. C. Johnston. 1988b. Forest vegetation of the Gunnison and parts of the Uncompahgre national forests: A preliminary habitat type classification. Research Paper RM-163. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 65 pp.

Komarkova, V., A. Peters, G. Kamani, W. Jones, V. Howard, H. Gordon, and K. Southwick. 1988a. Natural recovery of plant communities on disturbance plots and history of land use in the Niwot Ridge/Green Lakes Valley, Front Range, Colorado. University of Colorado Longterm Ecological Research Working Paper 88/1. Boulder, CO. 46 pp.

Koniak, S. 1985. Succession in pinyon-juniper woodlands following wildfire in the Great Basin. Great Basin Naturalist 45:556-566.

Kovalchik, B. L. 1987. Riparian zone associations - Deschutes, Ochoco, Fremont, and Winema national forests. USDA Forest Service Technical Paper 279-87. Pacific Northwest Region, Portland, OR. 171 pp.

Kovalchik, B. L. 1993. Riparian plant associations on the national forests of eastern Washington - Draft version 1. USDA Forest Service, Colville National Forest, Colville, WA. 203 pp.

Kovalchik, B. L. 2001. Classification and management of aquatic, riparian and wetland sites on the national forests of eastern Washington. Part 1: The series descriptions. 429 pp. plus appendix. [http://www.reo.gov/col/wetland_

classification/wetland_classification.pdf]

Kovalchik, B. L., and W. Elmore. 1992. Effects of cattle grazing systems on willow-dominated plant associations in central Oregon. In: W. P. Clary, E. D. McArthur, D. Bedunah, and C. L. Wambolt, compilers. Proceedings-Symposium on Ecology and Management of Riparian Shrub Communities, May 29-31, 1991, Sun Valley, ID. General Technical Report INT-289. USDA Forest Service, Intermountain Forest and Range Experiment Station. Ogden, UT. 232 pp.

Kunze, L. M. 1994. Preliminary classification of native, low elevation, freshwater wetland vegetation in western Washington. Washington State Department of Natural Resources, Natural Heritage Program. 120 pp.

Kurzius, M. 1981. Vegetation and flora of the Grapevine Mountains, Death Valley National Monument, California - Nevada. Unpublished thesis, University of Nevada, Las Vegas.

Ladyman, J. A. R., and E. Muldavin. 1996. Terrestrial cryptograms of pinyon-juniper woodlands in the southwestern United States: A review. General Technical Report RM-GTR-280. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 33 pp.

Lamb, S. H. 1975. Woody plants of the Southwest: A field guide with descriptive text, drawings, range maps and photographs. The Sunstone Press, Santa Fe, NM.

Langenheim, J. H. 1962. Vegetation and environmental patterns in the Crested Butte area, Gunnison County, Colorado. Ecological Monographs 32:249-285.

Larson, G. E. 1993. Aquatic and wetland vascular plants of the northern Great Plains. General Technical Report RM-238. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 681 pp.

Larson, M., and W. H. Moir. 1987. Forest and woodland habitat types of northern New Mexico and northern Arizona. Edition 2. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Leary, K. D., and P. M. Peterson. 1984. Soil analyses in relation to vegetation in the Cottonwood Mountains, Death Valley National Monument. University of Nevada Cooperative National Park Resources Studies Unit Report 036/01, Las Vegas.

Lesica, P., and R. L. DeVelice. 1992. Plant communities of the Pryor Mountains. Preliminary report prepared by the Montana Natural Heritage Program, Helena, MT.

Lewis, M. E. 1970. Alpine rangelands of the Uinta Mountains, Ashley and Wasatch national forests, Region 4 of the USDA Forest Service. Unpublished report mimeographed for USDA Forest Service, Region IV, Ogden, UT. 75 pp.

Lewis, M. E. 1975a. Plant communities of the Jarbidge Mountain Complex, Humboldt National Forest. Unpublished report compiled for USDA Forest Service, Region IV, Ogden, UT. 22 pp.

Lillybridge, T. R., B. L. Kovalchik, C. K. Williams, and B. G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. General Technical Report PNW-GTR-359. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 335 pp.

Little, E. L. 1987. Pinyon trees (*Pinus edulis*) remeasured after 47 years. Pages 65-68 in: Proceedings - pinyon-juniper conference. General Technical Report INT-215. USDA Forest Service, Intermountain Research Station, Ogden,

UT.

Loder, C. W. 1964. Alpine tundra of Cottonwood Pass, Colorado. Unpublished thesis. Western State College, Gunnison, Colorado. 139 pp.

Loveless, C. M. 1963. Ecological characteristics of a selected mule deer winter range. Unpublished dissertation, Colorado State University, Fort Collins. 318 pp.

Loveless, C. M. 1967. Ecological characteristics of a mule deer winter range. Colorado Department of Game, Fish and Parks Technical Publication 20. 125 pp.

Lynn, R., M. Larson, D. Hoeft, L. Todd, T. Raetz, L. Fager, and G. Barranco. No date. Black Hills National Forest ecological land units study. USDA Forest Service, Black Hills National Forest, SD.

MNNHP [Minnesota Natural Heritage Program]. 1993. Minnesota's native vegetation: A key to natural communities. Version 1.5. Minnesota Department of Natural Resources, Natural Heritage Program, St. Paul, MN. 110 pp.

MTNHP [Montana Natural Heritage Program]. 1988. Draft guide to the natural vegetation of Montana. Montana Natural Heritage Program, Helena. 389 pp.

MTNHP [Montana Natural Heritage Program]. 2002b. List of ecological communities for Montana. Montana Natural Heritage Program, Montana State Library, Helena, MT.

MTNHP [Montana Natural Heritage Program]. No date. Unpublished data on file. Helena, MT.

MacKenzie, W. H., and J. R. Moran. 2004. Wetlands of British Columbia: A guide to identification. Land Management Handbook No. 52. Research Branch, British Columbia Ministry of Forests and Lands, Victoria, BC. 287 pp.

Madany, M. H., and N. E. West. 1980b. Fire history of two montane forest areas of Zion National Park. Pages 50-56 in: M. A. Stokes and J. H. Dieterich, technical coordinators. Proceedings of the fire history workshop; 1980 October 20-24; Tucson, AZ. General Technical Report RM-81. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Malusa, J. 2003. Vegetation of the Cabeza Prieta National Wildlife Refuge, Arizona. Report submitted to Organ Pipe Cactus National Monument, NPS Cooperative Agreement CA1248.00.002. TA. UA2-71, NPS Cooperative Agreement 1443CA860197006. USGS Southwest Biological Science Center, Sonoran Desert Field Station, University of Arizona, Tucson.

Manning, M. 1988. Ecology and rooting characteristics of four intermountain meadow community types. Unpublished thesis, University of Nevada, Reno.

Manning, M. E., and W. G. Padgett. 1991. Riparian community type classification for the Humboldt and Toiyabe national forests, Nevada and eastern California. Unpublished draft report prepared for USDA Forest Service, Intermountain Region Ecology and Classification Program, Ogden, UT. 490 pp.

Manning, M. E., and W. G. Padgett. 1992. Riparian community type classification for the Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region Ecology and Classification Program. 274 pp.

Manning, M. E., and W. G. Padgett. 1995. Riparian community type classification for Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region. 306 pp.

Marr, J. W., D. A. Boyce, and J. W. Todd. 1973b. Preliminary report on the Redcliff project, Eagle County, Colorado.

Unpublished report to the D. E. Fleming Company, Denver, and the Colorado River Water Conservation District, Glenwood Springs, by University of Colorado, Boulder. 9 pp.

Marr, J. W., D. Buckner, and C. Mutel. 1973a. Ecological analyses of potential shale oil products pipeline corridors in Colorado and Utah. Unpublished report prepared for Colony Development Operation, Atlantic Richfield Company, Denver, by Thorne Ecological Institute and University of Colorado, Boulder. 96 pp. plus appendices.

Marr, J. W., R. Fritz, J. Meyer, and P. Murphy. 1979. Final report-terrestrial plant ecology-stand ecosystem data tables, Juniper/Cross Mountain Project. Report prepared for Colorado River Water Conservation District, Glenwood Springs, CO, by University of Colorado, Boulder. 47 pp.

Marriott, H. J., and G. P. Jones. 1989. Special status plant surveys and plant community surveys in the Trapper Creek and Medicine Lodge Wilderness Study Areas and the Spanish Point Karst ACEC. Report submitted to the Bureau of Land Management, Worland District Office, under Cooperative Agreement Task Order No. WY910-CA9-001TQE1. Wyoming Natural Diversity Database, Laramie. 42 pp. plus appendices.

Marriott, Hollis J. Personal communication. Former Heritage Botanist, WYNDD, and former Public Lands Coordinator, The Nature Conservancy. 655 N. Cedar, Laramie, WY 82070. (307) 721-4909.

Mason, L. R., H. M. Andrews, J. A. Carley, and E. D. Haacke. 1967. Vegetation and soils of No Man's Mesa relict area. Journal of Range Management 20:45-59.

Mattson, D. J. 1984. Classification and environmental relationships of wetland vegetation in central Yellowstone National Park. Unpublished thesis, University of Idaho, Moscow. 409 pp.

Mauk, R. L., and J. A. Henderson. 1984. Coniferous forest habitat types of northern Utah. General Technical Report INT-170. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 89 pp.

McCain, C., and J. A. Christy. 2005. Field guide to riparian plant communities in northwestern Oregon. Technical Paper R6-NR-ECOL-TP-01-05. USDA Forest Service, Pacific Northwest Region, Portland. 357 pp.

McDonald, A. 1938. Erosion and its control in Oklahoma Territory. Miscellaneous Publication 301, U.S. Department of Agriculture, Washington, DC.

McIntosh, A. C. 1923. Vegetation at different elevations in Boulder Canyon. Unpublished thesis, University of Colorado, Boulder. 35 pp.

McKown, B., S. W. Koch, R. G. Balice, and P. Neville. 2003. Land cover classification map for the Eastern Jemez Region. LA-14029, Los Alamos National Laboratory, Los Alamos, NM.

Medina, A. L. 1986. Riparian plant communities of the Fort Bayard watershed in southwestern New Mexico. Southwestern Naturalist 31(3):345-359.

Merkle, J. 1962. Plant communities of the Grand Canyon area, Arizona. Ecology 43(4):698-711.

Metcalfe, O. B. 1902. Flora of Mesilla Valley. Unpublished thesis, New Mexico State University, Las Cruces. 22 pp.

Miller, D. A., D. A. Mouat, and B. D. Treadwell. 1977. Remote sensing analysis and literature survey pertaining to the vegetation of the Petrified Forest National Park. Report of work performed under NASA and the National Park Service. 48 pp.

Milton, N. M., and T. L. Purdy. 1983. Plant and soil relationships in two hydrothermally altered areas of the Great Basin. Great Basin Naturalist 43(3):457-469.

Mitchell, J. E., N. E. West, and R. W. Miller. 1966. Soil physical properties in relation to plant community patterns in the shadscale zone of northwestern Utah. Ecology 47(4):627-630.

Moir, W. H. 1963. Vegetational analysis of three southern New Mexico mountain ranges. Unpublished thesis, New Mexico State University, Las Cruces. 77 pp.

Moir, W. H., and J. A. Ludwig. 1979. A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico. Research Paper RM-207. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 47 pp.

Moir, W. H., and J. O. Carleton. 1987. Classification of pinyon-juniper (P-J) sites on national forests in the Southwest. Pages 216-226 in: R. L. Everett, editor. Proceedings of the Pinyon-Juniper Conference, Reno, NV, 13-16 January 1986. General Technical Report. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 581 pp.

Morgan, M. D. 1969. Ecology of aspen in Gunnison County, Colorado. The American Midland Naturalist 82(1):204-228.

Moseley, R. K. 1987b. Area of Critical Environmental Concern and Research Natural Area proposal for the Malm Gulch and Germer Basin area, Bureau of Land Management, Salmon District, Idaho. Unpublished report prepared for USDI Bureau of Land Management, Salmon District, ID, by The Nature Conservancy, Moscow, ID. 18 pp.

Mozingo, H. 1987. Shrubs of the Great Basin: A natural history. University of Nevada Press, Las Vegas. 342 pp.

Mueggler, W. F. 1988. Aspen community types of the Intermountain Region. General Technical Report INT-250. USDA Forest Service, Intermountain Research Station, Ogden, UT. 135 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1982. Aspen community types on the Caribou and Targhee national forests in southeastern Idaho. Research Paper INT-294. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 32 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1986. Aspen community types of Utah. Research Paper INT-362. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Mueggler, W. F., and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. General Technical Report INT-66. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 154 pp.

Muldavin, E. 1987. Gila Riparian Preserve Design. Unpublished report prepared for The Nature Conservancy, New Mexico Field Office by New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E. H., R. L. DeVelice, and F. Ronco, Jr. 1996. A classification of forest habitat types southern Arizona and portions of the Colorado Plateau. General Technical Report RM-GTR-287. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 130 pp.

Muldavin, E., A. Kennedy, C. Jackson, T. Neville, P. Neville, K. Schulz, and M. Reid. 2011b. Vegetation classification and map report: Bandelier National Monument (draft). Natural Resource Technical Report NPS/SCPN/NRTR--2011/438 draft, National Park Service, Fort Collins, CO.

Muldavin, E., A. Kennedy, C. Jackson, T. Neville, P. Neville, K. Schulz, and M. Reid. [2011]c. Vegetation classification and map report: Salinas Pueblo Missions National Monument (draft). Natural Resource Technical Report NPS/XXXX/NRTR--draft. National Park Service, Fort Collins, CO. [in preparation]

Muldavin, E., A. Kennedy, C. Jackson, T. Neville, P. Neville, M. Hall, and M. Reid. [2011]a. Vegetation classification and map report: El Malpais National Park (draft). Natural Resource Technical Report NPS/XXXX/NRTR--draft. National Park Service, Fort Collins, CO. [in preparation]

Muldavin, E., G. Harper, P. Neville, and Y. Chauvin. 1998b. The vegetation of White Sands Missile Range, New Mexico. Volume II. Vegetation map. Final report for Cooperative Agreement No. 14-16-00-91-233 White Sands Missile Range, U.S. Fish & Wildlife Service. The Nature Conservancy and the University of New Mexico.

Muldavin, E., G. Shore, K. Taugher, and B. Milne. 1998d. A vegetation map classification and map for the Sevilleta National Wildlife Refuge, New Mexico. Final report submitted to USDI, U.S. Fish and Wildlife Service, Sevilleta National Wildlife Refuge, Socorro, NM, by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque. 73 pp. + appendices.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000a. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Muldavin, E., P. Mehlhop, and E. DeBruin. 1994a. A survey of sensitive species and vegetation communities in the Organ Mountains of Fort Bliss. Volume III: Vegetation communities. Report prepared for Fort Bliss, Texas, by New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E., P. Neville, C. Jackson, and T. Neville. 2006. A vegetation map of Valles Caldera National Preserve, New Mexico. Natural Heritage New Mexico Publication No. 06-GTR-302. Natural Heritage New Mexico, University of New Mexico, Albuquerque. 59 pp.

Muldavin, E., P. Neville, P. Arbetan, Y. Chauvin, A. Browder, and T. Neville. 2003. A vegetation map of Carlsbad Caverns National Park, New Mexico. Final report submitted in partial fulfillment of Cooperative Agreement No. Ca-7170-99-004. New Mexico Natural Heritage Program at the University of New Mexico, Albuquerque. 102 pp.

Muldavin, E., R. DeVelice, and W. Dick-Peddie. 1987. Forest habitat types of the Prescott, Tonto and western Coronado national forests, Arizona. Unpublished final report prepared for Rocky Mountain Forest and Range Experiment Station, CO. 71 pp.

Muldavin, E., R. L. DeVelice, and W. A. Dick-Peddie. 1986. Forest habitat types of the Fort Apache, San Carlos and Hualapai Indian reservations, Arizona. Final Report Cooperative Agreement 28-K3-208 Addendum, Rocky Mountain Forest and Range Experiment Station and New Mexico State University. 67 pp.

Muldavin, E., V. Archer, and P. Neville. 1998a. A vegetation map of the Borderlands Ecosystem Management Area. Final report submitted to USDA Forest Service, Rocky Mountain Experiment Station, Flagstaff, AZ, by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM. 58 pp.

Muldavin, E., Y. Chauvin, T. Neville, P. Arbetan, A. Fettes A. Kennedy, and L. Arnold. 2011d. A vegetation classification and map: Capulin Volcano National Monument. Natural Resource Technical Report NPS/SOPN/NRTR--2011/461. National Park Service, Fort Collins, CO. 158 pp.

Muldavin, E., Y. Chauvin, and G. Harper. 2000b. The vegetation of White Sands Missile Range, New Mexico: Volume I. Handbook of vegetation communities. Final report to Environmental Directorate, White Sands Missile Range. New Mexico Natural Heritage Program, University of New Mexico, Albuquerque. 195 pp. plus appendices

Muldavin, E., and P. Mehlhop. 1992. A preliminary classification and test vegetation map for White Sands Missile Range and San Andreas National Wildlife Refuge, New Mexico. University of New Mexico, New Mexico Natural Heritage Program.

Muldavin, E., and P. Tonne. 2003. A vegetation survey and preliminary ecological assessment of Valles Caldera National Preserve, New Mexico. Natural Heritage New Mexico Publication No. 03-GTR-272. Natural Heritage New Mexico, University of New Mexico, Albuquerque. 73 pp. plus appendices.

Murphy, P. H. 1982. The forest vegetation of the Lost Creek area in the southern Front Range, Colorado. Unpublished thesis, University of Colorado, Boulder. 145 pp.

Murray, M. P. 2000. Wetland plant associations of the western hemlock zone in the central coastal and westslope Cascade Mountains. Unpublished report, Oregon Natural Heritage Program, Portland, OR. 82 pp. [http://www.natureserve.org/nhp/us/or/nw_or_wetlands.pdf]

Mutel, C. F. 1973. An ecological study of the plant communities of certain montane meadows in the Front Range of Colorado. Unpublished thesis, University of Colorado, Boulder. 77 pp.

Mutel, C. F. 1976. From grassland to glacier: An ecology of Boulder County, Colorado. Johnson Publishing Company, Boulder. 169 pp.

Mutz, K. M., and R. Graham. 1982. Riparian community type classification-Big Piney Range District, Wyoming. Unpublished report prepared for USDA Forest Service, Intermountain Region under contract 53-84M8-1-974, by Meiiji Resource Consultants, Layton, UT. 88 pp.

NDNHI [North Dakota Natural Heritage Inventory]. No date. Unpublished data. Vegetation classification of North Dakota. North Dakota Natural Heritage Inventory, North Dakota Parks & Recreation Department, Bismarck.

NMNHP [New Mexico Natural Heritage Program]. No date. Unpublished data on file. Albuquerque, NM.

Nachlinger, J. L., and G. A. Reese. 1996. Plant community classification of the Spring Mountains National Recreation Area, Clark and Nye counties, Nevada. Unpublished report submitted to USDA Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area, Las Vegas, NV. The Nature Conservancy, Northern Nevada Office, Reno, NV. 85 pp. plus figures and appendices.

Naumann, Tamara. Personal communication. Botanist, National Park Service, Dinosaur National Monument, Dinosaur, CO.

Neid, S., J. E. Stevens, K. Forest, and M. Fink. 2007. Sand Creek Massacre National Historic Site: Vegetation classification and mapping. Natural Resource Technical Report NPS/SOPN/NRTR--2007/050. National Park Service, Fort Collins, CO. 112 pp.

Nichol, A. A. 1937. The natural vegetation of Arizona. University of Arizona Agricultural Experiment Station Technical Bulletin 68:177-222.

Nixon, E. S. 1967b. A comparative study of the mountain brush vegetation in Utah. Great Basin Naturalist 27(2):59-66.

Northcutt, B. E. 1978. The plant ecology of Butler Wash, southeastern Utah. Unpublished thesis, University of Colorado, Boulder. 118 pp.

Norton, B. E., J. Tuhy, and S. Jensen. 1981. Riparian community classification for the Grey's River, Wyoming. Unpublished final report prepared by Department of Range Science, Utah State University, Logan for USDA Forest Service, Region 4, Ogden, UT. 188 pp.

Olgeirson, E. R. 1972. Comparative physiognomic trends in vegetation and soil on a bald near tree-line in Colorado. Unpublished dissertation, University of Colorado, Boulder. 114 pp.

Olgeirson, E. R. 1974. Parallel conditions and trends in vegetation and soil on a bald near treeline, Boreas Pass, Colorado. Arctic and Alpine Research 6:185-203.

Olson, R. A., and W. A. Gerhart. 1982. A physical and biological characterization of riparian habitat and its importance to wildlife in Wyoming. Unpublished report prepared for Wyoming Fish and Game Department, Cheyenne, WY. 188 pp.

Ortenberger, A. I., and R. D. Bird. 1933. The ecology of the western Oklahoma salt plains. Publications of the University of Oklahoma Biological Survey 5:49-64.

Ostler, W. K., D. J. Hansen, D. C. Anderson, and D. B. Hall. 2000. Classification of vegetation on the Nevada Test Site. DOE/NV/11718-477. U.S. Department of Energy, Bechtel Nevada Ecological Services, Las Vegas, NV. 102 pp.

Owns, T., project coordinator, et al. 2004. U.S. Geological Survey and National Park Service Vegetation Mapping Program: Florissant Fossil Beds National Monument. U.S. Geological Survey and National Park Service. 390 pp.

Padgett, W. G. 1981. Ecology of riparian plant communities in southern Malheur National Forest. M.S. thesis. Oregon State University, Corvallis. 143 pp.

Padgett, W. G. 1982. Ecology of riparian plant communities in southern Malheur National Forest. Unpublished thesis, Oregon State University, Corvallis. 143 pp.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1988b. Riparian community type classification of Utah. Publication R4-ECOL-88-01. USDA Forest Service, Forest and Range Experiment Station, Ogden, UT.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. Research Paper R4-ECOL-89-0. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Padgett, W. G., and M. E. Manning. 1988. Preliminary riparian community type classification for Nevada. Draft. Unpublished report prepared for USDA Forest Service Region IV, Intermountain Region Ecology and Classification Program, Ogden, UT.

Palmer, E. J. 1929. The ligneous flora of the Davis Mountains. Journal of Arnold Arboretum 10:8-45.

Pase, C. P., and A. W. Lindenmuth, Jr. 1971. Effects of prescribed fire on vegetation and sediment in oak-mountain mahogany chaparral. Journal of Forestry 69:800-805.

Paulsen, H. A., Jr. 1969. Forage values on a mountain grassland-aspen range in western Colorado. Journal of Range Management 22:102-107.

Paysen, T. E., J. A. Derby, H. Blake, Jr., V. C. Bleich, and J. W. Mincks. 1980. A vegetation classification system applied to southern California. General Technical Report PSW-45. USDA Forest Service, USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Peet, R. K. 1975. Forest vegetation of the east slope of the northern Colorado Front Range. Unpublished dissertation, Cornell University, Ithaca, NY.

Peet, R. K. 1981. Forest vegetation of the Colorado Front Range. Vegetatio 45:3-75.

Penfound, W. T. 1953. Plant communities of Oklahoma lakes. Ecology 34:561-583.

Peterson, E. B. 2008. International Vegetation Classification alliances and associations occurring in Nevada with proposed additions. Nevada Natural Heritage Program, Carson City, NV. 348 pp.

Peterson, P. M. 1984. Flora and physiognomy of the Cottonwood Mountains, Death Valley National Monument, California. University of Nevada Cooperative National Park Resources Studies Unit Report CPSU/UNLV 022/06. Las Vegas, NV.

Petranka, J. W., and R. Holland. 1980. A quantitative analysis of bottomland communities in south-central Oklahoma. Southwestern Naturalist 25:207-214.

Pfister, R. D. 1972. Vegetation and soils in the subalpine forests of Utah. Unpublished dissertation, Washington State University, Pullman. 98 pp.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. General Technical Report INT-34. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 174 pp.

Plumb, G. A. 1988. An algorithmic approach to automated vegetation mapping of Big Bend National Park, Texas. Ph.D. dissertation, University of Kansas, Lawrence. 449 pp.

Pool, R. J. 1914. A study of the vegetation of the sandhills of Nebraska. Minnesota Botanical Studies 4:189-312.

Potter, D. A. 2005. Riparian plant community classification: West slope, central and southern Sierra Nevada, California. Technical Paper R5-TP-022. USDA Forest Service, Pacific Southwest Region, Vallejo, CA. 634 pp.

Potter, L. D., and D. R. Moir. 1961. Phytosociological study of burned and unburned deciduous woods, Turtle Mountains, North Dakota. Ecology 42:468-480.

Powell, D. C. 1988a. Aspen community types of the Pike and San Isabel national forests in south-central Colorado. USDA Forest Service, Rocky Mountain Region, Report R2-ECOL-88-01. 254 pp.

Ralston, G. L. 1969. Plant zonation on dune sands of Washoe Lake, Washoe County, Nevada. Unpublished thesis, University of Nevada, Reno.

Ramaley, F. 1915. The relative importance of different species in a mountain grassland. Botanical Gazette 60:154-157.

Ramaley, F. 1916a. Quadrat studies in a mountain grassland. Botanical Gazette 62:70-74.

Ramaley, F. 1916b. Dry grassland of a high mountain park in northern Colorado. The Plant World 19(4):249-270.

Ramaley, F. 1919a. The role of sedges in some Colorado plant communities. American Journal of Botany 6:120-130.

Ramaley, F. 1920. Subalpine lake-shore vegetation in north central Colorado. American Journal of Botany 7:57-74.

Rector, C. D. 1979. Lower Gunnison River Basin wetland inventory and evaluation. Unpublished thesis, University of Colorado, Boulder. 71 pp.

Redente, E. F., J. E. Friedlander, and T. McLendon. 1992. Response of early and late semiarid seral species to nitrogen and phosphorus gradients. Plant and Soil 140(1):127-135.

Reed, R. M. 1971. Aspen forests of the Wind River Mountains, Wyoming. The American Midland Naturalist 86(2):327-343.

Reed, R. M. 1976. Coniferous forest habitat types of the Wind River Mountains, Wyoming. The American Midland Naturalist 95(1):159-173.

Reid, M. S., K. A. Schulz, P. J. Comer, M. H. Schindel, D. R. Culver, D. A. Sarr, and M. C. Damm. 1999. An alliance level classification of vegetation of the coterminous western United States. Unpublished final report to the University of Idaho Cooperative Fish and Wildlife Research Unit and National Gap Analysis Program, in fulfillment of Cooperative Agreement 1434-HQ-97-AG-01779. The Nature Conservancy, Western Conservation Science Department, Boulder, CO.

Reid, M. S., S. V. Cooper, and G. Kittel. 2004. Vegetation classification of Waterton-Glacier International Peace Park. Final report for USGS-NPS Vegetation Mapping Program, International Peace Park Mapping Project. NatureServe, Arlington VA.

Reid, M. S., and M. E. Hall. 2010. Vegetation classification of Grand Canyon National Park. Draft report submitted to National Park Service, Fort Collins, CO.

Reid, W. H. 1974. Analysis of plant ecological systems through simulation of individual organisms. Unpublished dissertation, University of Colorado, Boulder. 265 pp.

Richard, C., G. Kittel, and S. Kettler. 1996. A classification of the riparian vegetation of the San Juan National Forest. Draft 1 report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Rickard, W. H., and J. C. Beatley. 1965. Canopy-coverage of the desert shrub vegetation mosaic of the Nevada Test Site. Ecology 46(4):524-529.

Robbins, W. W. 1918. Successions of vegetation in Boulder Park, Colorado. Botanical Gazette 65(6):493-525.

Roberts, D. W. 1980. Forest habitat types of the Bear's Paw Mountains and Little Rocky Mountains, Montana. Unpublished thesis, Department of Forestry, University of Montana, Missoula. 116 pp.

Roberts, D. W., D. W. Wight, and G. P. Hallsten. 1992. Plant community distribution and dynamics in Bryce Canyon National Park. Unpublished final report for Bryce Canyon National Park Project PX1200-7-0966. 146 pp.

Rogers, C. M. 1953. The vegetation of the Mesa de Maya region of Colorado, New Mexico, and Oklahoma. Lloydia 16(4):257-290.

Rolfsmeier, S. B., and G. Steinauer. 2010. Terrestrial ecological systems and natural communities of Nebraska (Version IV - March 9, 2010). Nebraska Natural Heritage Program, Nebraska Game and Parks Commission. Lincoln, NE. 228 pp.

Rominger, J. M., and L. A. Paulik. 1983. A floristic inventory of the plant communities of the San Francisco Peaks Research Natural Area. General Technical Report RM-96. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 9 pp.

Romme, W. H., K. D. Heil, J. M. Porter, and R. Fleming. 1993. Plant communities of Capitol Reef National Park, Utah. USDI National Park Service, Technical Report NPS/NAUCARE/NRTER-93/02. Cooperative Park Studies Unit, Northern Arizona University. 37 pp.

Rowlands, P. G., and N. J. Brian. 1996. A perimeter tracing method for estimating basal cover: Monitoring the endangered sentry milk-vetch at Grand Canyon National Park, Arizona. Southwestern Naturalist 41(2):169-178.

Salas, D. E., D. Wegner, and C. Bolen. 2010a. Vegetation classification and distribution mapping report: Navajo National Monument. Natural Resource Technical Report NPS/SCPN/NRTR--2010/298. National Park Service,

Fort Collins, CO. 160 pp.

Salas, D. E., D. Wegner, and L. Floyd-Hanna. 2009. Vegetation mapping and classification report: Aztec Ruins National Monument. Natural Resource Technical Report NPS/SCPN/NRTR--2009/244. National Park Service, Fort Collins, CO. 90 pp.

Salas, D. E., J. Stevens, K. Schulz, M. Artmann, B. Friesen, S. Blauer, E. W. Schweiger, and A. Valdez. 2010b. Vegetation classification and mapping project report: Great Sand Dunes National Park and Preserve. Natural Resource Report NPS/ROMN/NRR--2010/179. National Park Service, Fort Collins, CO.

Salas, D. E., and C. Bolen. 2010a. Vegetation classification and distribution mapping report: El Morro National Monument. Natural Resource Technical Report NPS/SCPN/NRTR-2010/365. National Park Service, Fort Collins, CO. 122 pp.

Salas, D., J. Stevens, and K. Schulz. 2005. USGS-NPS Vegetation Mapping Program: Rocky Mountain National Park, Colorado. Technical Memorandum No. 8260-05-02. USDI Bureau of Reclamation, Denver, CO. 161 pp. plus Appendices A-L.

Salas, D., L. Floyd-Hanna, and D. Hanna. 2011. Vegetation classification and mapping project report: Chaco Culture National Historical Park. Natural Resource Technical Report NPS/SCPN/NRTR--2011/452. National Park Service, Fort Collins, CO. 142 pp.

Salas, D., and C. Bolen. 2010b. Vegetation classification and distribution mapping report: Hubbell Trading Post National Historic Site. Natural Resource Technical Report NPS/SCPN/NRTR-2010/301. National Park Service, Fort Collins, CO. 35 pp.

Sanderson, J., and S. Kettler. 1996. A preliminary wetland vegetation classification for a portion of Colorado's west slope. Report prepared for Colorado Department of Natural Resources, Denver, CO, and U.S. Environmental Protection Agency, Region VIII, Denver, CO. Colorado Natural Heritage Program, Ft. Collins, CO. 243 pp.

Savage, M., and T. W. Swetnam. 1990. Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. Ecology 71(6)2374-2378.

Sawyer, J. O., T. Keeler-Wolf, and J. Evens. 2009. A manual of California vegetation. Second edition. California Native Plant Society, Sacramento CA. 1300 pp.

Sawyer, J. O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento. 471 pp.

Sawyer, J. O., and T. Keeler-Wolf. 2005. A manual of California vegetation. II. Draft manuscript. California Native Plant Society, Sacramento, CA.

Schmoll, H. M. 1935. Vegetation of the Chimney Rock area, Pagosa-Piedra region, Colorado. Private Edition, Distributed by University of Chicago Libraries, Chicago, IL. 58 pp.

Schramm, D. R. 1982. Floristics and vegetation of the Black Mountains, Death Valley National Monument. Unpublished report prepared for the University of Nevada, Las Vegas.

Schultz, L. M., E. E. Neely, and J. S. Tuhy. 1987. Flora of the Orange Cliffs of Utah. Great Basin Naturalist 47:287-298.

Schulz, K. A. 2004. Vegetation classification of Buenos Aires National Wildlife Refuge, Arizona. Unpublished report submitted to USDI Fish and Wildlife Service. NatureServe, Western Regional Office, Boulder, CO.

Schulz, K. A., and M. E. Hall. 2011. Vegetation inventory project: Great Basin National Park. Unpublished report submitted to USDI National Park Service, Mojave Desert Inventory and Monitoring Network. NatureServe, Western Regional Office, Boulder, CO. 30 pp. plus Appendices A-H.

Severson, K. E., and J. F. Thilenius. 1976. Classification of quaking aspen stands in the Black Hills and Bear Lodge Mountains. Research Paper RM-166. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 24 pp.

Shanks, D. L. 1977. Aerial photo densitometry for rangeland planning and evaluation. Unpublished thesis, Colorado State University, Fort Collins. 66 pp.

Shaw, R. B., S. L. Anderson, K. A. Schultz, and V. E. Diersing. 1989. Plant communities, ecological checklist, and species list for the U.S. Army Pinon Canyon Maneuver Site, Colorado. Colorado State University, Department of Range Science, Science Series No. 37, Fort Collins. 71 pp.

Shepherd, H. R. 1975. Vegetation of two dissimilar bighorn sheep ranges in Colorado. Colorado Division of Wildlife Report 4. 223 pp.

Shepperd, W. D. 1990. Initial growth, development, and clonal dynamics of regenerated aspen in the Rocky Mountains. Research Paper RM-312. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 8 pp.

Shields, L. M., W. H. Rickard, and F. Drouet. 1959. A botanical study of nuclear effects at the Nevada Test Site. 1958 Annual Report, New Mexico Highlands University, to U.S. Atomic Energy Commission.

Shiflet, T. N., editor. 1994. Rangeland cover types of the United States. Society for Range Management. Denver, CO. 152 pp.

Shupe, J. B., J. D. Brotherson, and S. R. Rushforth. 1986. Patterns of vegetation surrounding springs in Goshen Bay, Utah County, Utah, U.S.A. Hydrobiologia 139:97-107.

Shute, D., and N. E. West. 1978. The application of ECOSYM vegetation classifications to rangelands near Price, Utah. Appendix reports 14 and 16 in: J. A. Henderson, L. S. Davis, and E. M. Ryberg, editors. ECOSYM: A classification and information system for wildland resource management. Utah State University, Logan. 53 pp.

Smith, S. D., and C. L. Douglas. 1989. The ecology of saltcedar (*Tamarix chinensis*) in Death Valley National Monument and Lake Mead National Recreation Area: An assessment of techniques and monitoring for saltcedar control in the park system. University of Nevada Cooperative National Park Resources Studies Unit Report 041/03, Las Vegas. 63 pp.

Smith, T. L. 1991. Natural ecological communities of Pennsylvania. First revision. Unpublished report. Pennsylvania Science Office of The Nature Conservancy, Middletown, PA. 111 pp.

Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver.

Somers, P., G. E. Nichols, and R. W. Stransky. 1980. Final report: Baseline ecological study of Narraguinnep Research Natural Area, San Juan National Forest. Unpublished report prepared by Fort Lewis College, Durango, CO. 23 pp.

Southeastern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Durham, NC.

Steele, R., R. D. Pfister, R. A. Ryker, and J. A. Kittams. 1981. Forest habitat types of central Idaho. General Technical

Report INT-114. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 138 pp.

Steele, R., S. V. Cooper, D. M. Ondov, D. W. Roberts, and R. D. Pfister. 1983. Forest habitat types of eastern Idaho - western Wyoming. General Technical Report INT-144. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 122 pp.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Steinhoff, H. W. 1978. Management of Gambel oak associations for wildlife and livestock. Unpublished report prepared for USDA Forest Service, Denver, CO. 119 pp.

Stevens, R. L., and C. W. Shannon. 1917. Plant life in Oklahoma. In: C. W. Shannon, editor. Animal and plant life of Oklahoma. Oklahoma Geological Survey, Norman.

Stewart, B. K. 1940. Plant ecology and paleoecology of the Creede Valley, Colorado. Unpublished dissertation, University of Colorado, Boulder. 154 pp.

Stewart, G., W. P. Cottam, and S. S. Hutchings. 1940. Influence of unrestricted grazing on northern salt desert plant associations in western Utah. Journal of Agricultural Research 60(5):289-317.

Stromberg, J. C. 1993a. Fremont cottonwood-Goodding willow riparian forests: A review of their ecology, threats, and recovery potential. Journal of the Arizona-Nevada Academy of Science 27(1):97-110.

Stuever, M. C., and J. S. Hayden. 1997a. Plant associations of Arizona and New Mexico. Edition 3. Volume 2: Woodlands. USDA Forest Service, Southwestern Region, Habitat Typing Guides. 196 pp.

Stuever, M. C., and J. S. Hayden. 1997b. Plant associations of Arizona and New Mexico. Edition 3. Volume 1: Forests. USDA Forest Service, Southwestern Region. Habitat Typing Guides. 291 pp.

Stuth, J. W. 1975. Livestock, deer and logging interactions in the lodgepole pine-pumice region of central Oregon. Ph.D. dissertation, Oregon State University, Corvallis. 175 pp.

Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants Special Issue 9(3-4):70-139.

Szaro, R. C., and L. F. DeBano. 1985. The effects on streamflow modification on the development of a riparian ecosystem. Pages 211-215 in: R. R. Johnson, C. D. Ziebell, D. R. Patton, P. F. Folliott, and R. H. Hamre, editors. Riparian ecosystems and their management: Reconciling conflicting uses. Proceedings from the First North American Riparian Conference. General Technical Report RM-120. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

TNC [The Nature Conservancy]. 1992b. Element stewardship abstract for *Populus fremontii - Salix gooddingii* riparian forest. The Nature Conservancy, Arizona Field Office, Tucson, AZ.

TNC [The Nature Conservancy]. 1995e. USGS-NPS Vegetation Mapping Program: Vegetation classification of Tuzigoot National Monument. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN, and International Headquarters, Arlington, VA. 59 pp.

TNC [The Nature Conservancy]. [1998]d. Classification of the vegetation of Agate Fossil Beds National Monument. USGS-NPS Vegetation Mapping Program. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN, and International Headquarters, Arlington, VA. 37 pp.

TNHS [Texas Natural History Survey]. No date. Unpublished data. Texas Natural History Survey, The Nature Conservancy, San Antonio.

Tausch, R. J., and P. T. Tueller. 1977. Plant succession following chaining of pinyon-juniper woodlands in eastern Nevada. Journal of Range Management 30(1):44-49.

Taylor, A. H. 1980. Plant communities and elevation in the diked portion of Joe Ney Slough: A baseline assessment of a marsh restoration project in Coos Bay, Oregon. M.S. thesis. Oregon State University, Corvallis. 105 pp.

Taylor, D. W., and K. A. Teare. 1979a. Ecological survey of the vegetation of the proposed Trelorita Research Natural Area, Shasta-Trinity National Forest, Trinity County, California. Unpublished report. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Tendick A., G. Kittel, J. Von Loh, P. Williams, D. Cogan, J. Coles, A. Wight, G. Wakefield, and A. Evenden. 2011b. Vegetation classification and mapping project report, Bryce Canyon National Park. Natural Resource Technical Report NPS/NCPN/NRTR--2011/442. National Park Service, Fort Collins, CO.

Tendick, A., B. Friesen, G. Kittel, P. Williams, J. Coles, A. Wight, G. Wakefield, and A. Evenden. 2011a. Vegetation classification and mapping project report, Cedar Breaks National Monument. Natural Resource Technical Report NPS/NCPN/NRTR--2011/470. National Park Service, Fort Collins, CO.

Tendick, A., J. Coles, P. Williams, G. Bradshaw, G. Manis, A. Wight, G. Wakefield, and A. Evenden. 2010. Vegetation classification and mapping project report, Curecanti National Recreation Area. Natural Resource Technical Report NPS/NCPN/NRTR--2010/408. National Park Service, Fort Collins, CO. 797 pp.

Terwilliger, C., Jr., K. Hess, and C. H. Wasser. 1979b. The habitat types of Region II. USDA Forest Service: A preliminary list and description. Unpublished initial progress report for Habitat Type Classification, Region 2, USDA Forest Service.

Terwilliger, C., K. Hess, and C. Wasser. 1979a. Key to the preliminary habitat types of Region 2. Addendum to initial progress report for habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Thilenius, J. F., G. R. Brown, and A. L. Medina. 1995. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. General Technical Report RM-GTR-263. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 60 pp.

Thomas, K. A., M. L. McTeague, A. Cully, K. Schulz, and J. M. S. Hutchinson. 2009a. Vegetation classification and distribution mapping report: Petrified Forest National Park. National Resource Technical Report NPS/SCPN/NRTR--2009/273. National Park Service, Fort Collins, CO. 294 pp.

Thomas, K. A., M. L. McTeague, L. Ogden, K. Schulz, T. Fancher, R. Waltermire, and A. Cully. 2010. Vegetation classification and distribution mapping report: Canyon de Chelly National Monument. National Resource Technical Report NPS/SCPN/NRTR-2010/306. National Park Service, Fort Collins, CO. 338 pp.

Thomas, K. A., M. L. McTeague, L. Ogden, M. L. Floyd, K. Schulz, B. Friesen, T. Fancher, R. Waltermire, and A. Cully. 2009b. Vegetation classification and distribution mapping report: Mesa Verde National Park. Natural Resource Report NPS/SCPN/NRR--2009/112. National Park Service, Fort Collins, CO. 352 pp.

Thomas, K., M. Hansen and C. Seger. 2003b. Vegetation of Petrified Forest National Park, Part I: Vegetation of Petrified Forest National Park. Southwest Biological Science Center, U.S. Geological Survey unpublished report to Petrified Forest National Park.

Thompson, W. H., and P. L. Hansen. 2002. Classification and management of riparian and wetland sites of Alberta's

Grasslands Natural Region and adjacent subregions. Bitterroot Restoration, Inc., Cows and Fish, Lethbridge. 416 pp.

Tiedemann, J. A. 1978. Phyto-edaphic classification of the Piceance Basin. Unpublished dissertation, Colorado State University, Fort Collins. 281 pp.

Tiedemann, J. A., and C. Terwilliger, Jr. 1978. Phyto-edaphic classification of the Piceance Basin. Colorado State University, Range Science Department Science Series 31. 265 pp.

Tirmenstein, D. 1999a. *Juniperus communis*. In: Fire Effects Information System [Online]. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). [http://www.fs.fed.us/database/feis/] (accessed 9 March 2005).

Tisdale, E. W. 1986. Canyon grasslands and associated shrublands of west-central Idaho and adjacent areas. Bulletin No. 40. Forest, Wildlife and Range Experiment Station, University of Idaho, Moscow. 42 pp.

Titus, J. H., and J. A. Christy. 1996a. Vegetation of Big Marsh, Deschutes National Forest, Oregon. Report to Deschutes National Forest. Oregon Natural Heritage Program, The Nature Conservancy, Portland.

Titus, J. H., and J. A. Christy. 1999. Vegetation of Big Marsh, Deschutes National Forest. Natural Areas Journal. Report to the USDA Forest Service. Unpublished manuscript at ORNHP, Portland. [in press]

Townsend, T. W. 1966. Plant characteristics relating to the desirability of rehabilitating the *Arctostaphylos patula-Ceanothus velutinus-Ceanothus prostratus* association on the east slope of the Sierra Nevada. Unpublished thesis, University of Nevada, Reno. 90 pp.

Tuhy, J. S. 1981. Stream bottom community classification for the Sawtooth Valley, Idaho. Unpublished thesis, University of Idaho, Moscow. 230 pp.

Tuhy, J. S., and S. Jensen. 1982. Riparian classification for the Upper Salmon and Middle Fork Salmon River drainages, Idaho. Unpublished report prepared for the USDA Forest Service, Intermountain Region by White Horse Associates, Smithfield, UT. 183 pp.

U.S. Bureau of Reclamation. 1976. Flora and terrestrial vertebrate studies of the Grand Valley, Colorado. Pages 56-85 and 283-354 in: Final report to the U.S. Bureau of Reclamation by Ecology Consultants, Inc., Fort Collins, CO.

UNESCO [United Nations Educational, Scientific and Cultural Organization]. 1973. International classification and mapping of vegetation. Series 6, Ecology and Conservation. United Nations Educational, Scientific, and Cultural Organization. Paris. 93 pp.

USFS [U.S. Forest Service]. 1937. Range plant handbook. Dover Publications Inc., New York. 816 pp.

USFS [U.S. Forest Service]. 1981a. TES-7, South La Luz grazing allotment. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1981b. TES-2, Cuba Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices, and maps.

USFS [U.S. Forest Service]. 1982. TES-9, Heber Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1983a. TES-4, Coyote Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1983b. Plant associations of Region Two. Third edition. USDA Forest Service, Region Two, Range, Wildlife, and Ecology, Denver, CO. 379 pp.

USFS [U.S. Forest Service]. 1985a. Forest and woodland plant associations (habitat types) for the Kaibab and Coconino national forests, Arizona. Unpublished training materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985c. TES-1, Terrestrial ecosystem survey handbook, appendix B. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1985d. Woodland and forest plant associations (habitat types) south of the Mogollon Rim, Arizona. Unpublished training materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985e. TES-3, western part Rio Arriba County. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1985g. Key to woodland plant associations and plant communities, Lincoln National Forest. Unpublished materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Ungar, I. A. 1968. Species-soil relationships on the Great Salt Plains of northern Oklahoma. The American Midland Naturalist 80(2):392-407.

Utah Environmental and Agricultural Consultants. 1973. Pages 2-38 in: Environmental setting, impact, mitigation and recommendations for a proposed oil products pipeline between Lisbon Valley, Utah and Parachute Creek, Colorado. Unpublished report for Colony Development Operation, Atlantic Richfield Company, Denver, CO.

Vaghti, M. G. 2003. Riparian vegetation classification in relation to environmental gradients, Sacramento River, CA. Thesis, University of California, Davis.

Van Pelt, N. S. 1978. Woodland parks in southeastern Utah. Unpublished thesis, University of Utah, Salt Lake City.

Volland, L. A. 1976. Plant communities of the central Oregon pumice zone. USDA Forest Service R-6 Area Guide 4-2. Pacific Northwest Region, Portland, OR. 113 pp.

Volland, L. A. 1978. Trends in standing crop and species composition of a rested Kentucky bluegrass meadow over an 11-year period. Pages 525-529 in: D. N. Hyder, editor. Proceedings, First International Rangeland Congress, Denver, CO.

Volland, L. A., and J. D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. USDA Forest Service. Pacific Northwest Region, Portland, OR. 23 pp.

Von Loh, J. 2000. Draft local descriptions of the vegetation associations of Ouray National Wildlife Refuge. USGS Bureau of Reclamation, Remote Sensing and GIS Group, Denver Federal Center, Denver.

Von Loh, J., D. Cogan, K. Schulz, D. Crawford, T. Meyer, J. Pennell, and M. Pucherelli. 2002. USGS-USFWS Vegetation Mapping Program, Ouray National Wildlife Refuge, Utah. USDI Bureau of Reclamation, Remote Sensing and GIS Group, Technical Memorandum 8260-02-03. Denver Federal Center, Denver, CO. 225 pp.

Von Loh, J., G. Wakefield, A. Wight, A. Evenden, and J. Coles. 2008. Vegetation classification and mapping project report, Hovenweep National Monument. Natural Resource Report NPS/NCPN/NRTR--2008/092. National Park Service, Fort Collins, CO. 328 pp.

Von Loh, J., K. Landgraf, A. Evenden, T. Owens, S. Blauer, and M. Reid. 2007. Vegetation classification and mapping

project report, Colorado National Monument. Natural Resource Report NPS/NCPN/NRTR--2007/061. National Park Service, Fort Collins, CO. 564 pp.

Vories, K. C. 1974. A vegetation inventory and analysis of the Piceance Basin and adjacent drainages. Unpublished thesis. Western State College of Colorado, Gunnison. 243 pp.

WNDD [Wyoming Natural Diversity Database]. No date. Unpublished data on file. Wyoming Natural Diversity Database, University of Wyoming, Laramie, WY.

WNHP [Washington Natural Heritage Program]. No date. Unpublished data files. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Wagner, W. L., W. C. Martin, and E. F. Aldon. 1978. Natural succession on strip-mined lands in northwestern New Mexico. Reclamation Review 1:67-73.

Walford, G. M. 1996. Statewide classification of riparian and wetland dominance types and plant communities - Bighorn Basin segment. Report submitted to the Wyoming Department of Environmental Quality, Land Quality Division by the Wyoming Natural Diversity Database. 185 pp.

Ware, G. H., and W. T. Penfound. 1949. The vegetation of the lower levels of the floodplain of the south Canadian River in central Oklahoma. Ecology 30:478-484.

Warren, P. L., B. K. Mortensen, B. D. Treadwell, J. E. Bowers, and K. L. Reichhardt. 1981. Vegetation of Organ Pipe Cactus National Monument. Cooperative National Park Resources Studies Unit Technical Report 7. Tucson, AZ. 140 pp.

Warren, P. L., K. L. Reichhardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982. Vegetation of Grand Canyon National Park. Cooperative National Park Resources Studies Unit Technical Report 9. Tucson, AZ. 140 pp.

Warren, P. L., and B. D. Treadwell. 1980. Vegetation of the Three-Bar Wildlife Study Area, Mazatzal Mountains, Arizona. Unpublished report prepared for Arizona Game and Fish Department.

Wasser, C. H., and K. Hess. 1982. The habitat types of Region II. USDA Forest Service: A synthesis. Final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 140 pp.

Watson, J. R. 1912. Plant geography of north central New Mexico: Contributions from the Hull Botanical Laboratory. Botanical Gazette 54:194-217.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, NE. 395 pp.

Webb, G. M., and J. D. Brotherson. 1988. Elevational changes in woody vegetation along three streams in Washington County, Utah. Great Basin Naturalist 48:512-529.

Wells, P. V. 1960. Physiognomic intergradation of vegetation on the Pine Valley Mountains in southwestern Utah. Ecology 41:553-556.

West, N. E. 1983a. Great Basin-Colorado Plateau sagebrush semi-desert. Pages 331-349 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E. 1983c. Western Intermountain sagebrush steppe. Pages 351-374 in: N. E. West, editor. Temperate deserts

and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E. 1983d. Colorado Plateau-Mohavian blackbrush semi-desert. Pages 399-412 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E., R. J. Tausch, and P. T. Tueller. 1998. A management-oriented classification of pinyon-juniper woodlands of the Great Basin. General Technical Report RMRS-GTR-12. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT. 42 pp.

West, N. E., R. T. Moore, K. A. Valentine, L. W. Law, P. R. Ogden, F. C. Pinkney, P. T. Tueller, and A. A. Beetle. 1972. Galleta: Taxonomy, ecology and management of *Hilaria jamesii* on western rangelands. Utah Agricultural Experiment Station. Bulletin 487. Logan, UT. 38 pp.

Western Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boulder, CO.

Wight, J. R. 1965. Site and vegetation characteristics and relationships of juniper communities in northwestern Wyoming Unpublished dissertation, University of Wyoming, Laramie.

Wight, J. R., and H. G. Fisser. 1968. *Juniperus osteosperma* in northwestern Wyoming: Their distribution and ecology. University of Wyoming Agricultural Experiment Station Science Monograph 7. Laramie. 28 pp.

Williams, C. K., T. R. Lillybridge, and B. G. Smith. 1990b. Forested plant associations of the Colville National Forest. Report prepared for USDA Forest Service, Colville National Forest, Colville, WA. 133 pp.

Williams, C. K., and T. R. Lillybridge. 1983. Forested plant associations of the Okanogan National Forest. USDA Forest Service, Pacific Northwest Region. R6-Ecol-132b-1983. 140 pp.

Williams, C. K., and T. R. Lillybridge. 1985. Forested plant associations of the Colville National Forest. Draft. Unpublished field guide prepared for USDA Forest Service.

Wilson, H. C. 1969. Ecology and successional patterns of wet meadows, Rocky Mountain National Park, Colorado. Unpublished dissertation, University of Utah, Salt Lake City. 99 pp.

Wright, H. A. 1972. Shrub response to fire. Pages 204-217 in: C. M. McKell, J. P. Blaisdell, and J. R. Goodin, editors. Wildland shrubs: Their biology and utilization. General Technical Report INT-1. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Wright, H. A. 1980. The role and use of fire in the semi-desert grass-shrub type. General Technical Report INT-85. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 23 pp.

Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state of the art review. General Technical Report INT-58. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Wright, H. A., and A. W. Bailey. 1980. Fire ecology and prescribed burning in the Great Plains - A research review. General Technical Report INT-77. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 61 pp.

Wright, H. E., Jr., A. M. Bent, B. S. Hansen, and L. J. Mahar, Jr. 1973. Present and past vegetation of the Chuska Mountains, northwestern New Mexico. Geological Society of America Bulletin 84:1155-1179.

Yake, S., and J. D. Brotherson. 1979. Differentiation of serviceberry habitats in the Wasatch Mountains of Utah.

Journal of Range Management 32(4):379-386.

Young, J. A., and R. A. Evans. 1973. Downy brome-intruder in the plant succession of big sagebrush communities in the Great Basin. Journal of Range Management 26:410-415.

Young, J. A., and R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. Journal of Range Management 31:283-289.

Young, J. F. 1982. Soil survey of Teton County, Wyoming, Grand Teton National Park Area. USDA Soil Conservation Service and Wyoming Agricultural Experiment Station. 173 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985a. Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service, Intermountain Region. R4-Ecol-85-01. Ogden, UT. 78 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985b. Riparian community type classification of northern Utah and adjacent Idaho. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 104 pp.

Youngblood, A. P., and R. L. Mauk. 1985. Coniferous forest habitat types of central and southern Utah. General Technical Report INT-187. USDA Forest Service, Intermountain Research Station, Ogden, UT. 89 pp.

Youngblood, A. P., and W. F. Mueggler. 1981. Aspen community types on the Bridger-Teton National Forest in western Wyoming. Research Paper INT-272. USDA Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT. 34 pp.

Zimmerman, T. 1978. Skull Creek Study Area Forestry. Unpublished report. USDI Bureau of Land Management, Craig District Office, Craig, CO. 62 pp

Appendix E: Vegetation Association - map class table

Because the National Vegetation Classification Standard (NVCS) Association is too fine a level for mapping at the scale at which this project was conducted, NVCS Associations were sometimes combined into broader categories to create map classes. Every attempt was made to align map classes with levels in the NVCS hierarchy.

ASSOCIATION	MAP CLASS
Abies concolor - Pseudotsuga menziesii / Carex spp. Forest	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance
Abies concolor - Pseudotsuga menziesii / Robinia neomexicana Woodland	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance
Abies concolor / Cercocarpus ledifolius Woodland	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance
Abies concolor / Juniperus communis Forest	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance
Abies concolor / Mahonia repens Forest	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance
Abies concolor / Symphoricarpos oreophilus Forest	*Abies concolor - Pseudotsuga menziesii* Moist Forest Alliance
Abies lasiocarpa - Picea engelmannii / Carex siccata Forest	*Abies lasiocarpa - Picea engelmannii* Southern Rocky Mountain Dry Forest Alliance
Abies lasiocarpa - Picea engelmannii / Juniperus communis Woodland	*Abies lasiocarpa - Picea engelmannii* Southern Rocky Mountain Dry Forest Alliance
Abronia elliptica Herbaceous Dune Vegetation [Park Special]	*Abronia elliptica* Herbaceous Dune Vegetation
Acacia greggii - Larrea tridentata - (Hymenoclea salsola) Wash Shrubland [Park Special]	*Acacia greggii* Shrublands
Acacia greggii Shrubland	*Acacia greggii* Shrublands
Acacia greggii Wash Shrubland	*Acacia greggii* Shrublands
Acer negundo / Brickellia (grandiflora, longifolia) Woodland	*Acer negundo* Woodland Alliance
Acer negundo / Quercus gambelii Woodland	*Acer negundo* Woodland Alliance
Acer negundo / Quercus turbinella Woodland [Park Special]	*Acer negundo* Woodland Alliance
Aletes macdougalii Herbaceous Vegetation [Park Special]	*Arid West Emergent* Marsh
Ambrosia dumosa - Encelia farinosa Dwarf-Shrubland	*Ambrosia (dumosa, eriocentra)* Dwarf-Shrubland Alliance
Ambrosia dumosa - Ephedra (fasciculata, nevadensis) Dwarf-Shrubland	*Ambrosia (dumosa, eriocentra)* Dwarf-Shrubland Alliance
Ambrosia dumosa Dwarf-Shrubland	*Ambrosia (dumosa, eriocentra)* Dwarf-Shrubland Alliance
Ambrosia eriocentra - (Coleogyne ramosissima) Dwarf-Shrubland	*Ambrosia (dumosa, eriocentra)* Dwarf-Shrubland Alliance
Amelanchier utahensis Shrubland	*Cercocarpus montanus - Amelanchier utahensis* Shrubland Alliance
Arctostaphylos - Quercus turbinella Shrubland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Arctostaphylos patula Shrubland	*Arctostaphylos patula* Shrubland
Arctostaphylos pungens Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Aristida purpurea Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Artemisia bigelovii - Ephedra (viridis, torreyana) Talus Shrubland	*Artemisia bigelovii* Shrubland Alliance
Artemisia bigelovii / Bouteloua gracilis Dwarf-shrub Herbaceous Vegetation	*Artemisia bigelovii* Shrubland Alliance
Artemisia bigelovii Shrubland	*Artemisia bigelovii* Shrubland Alliance
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Semi-natural Shrubland	*Artemisia tridentata* Shrubland Alliance

ASSOCIATION	MAP CLASS
Artemisia tridentata - Ephedra spp. Shrubland	*Artemisia tridentata* Shrubland Alliance
Artemisia tridentata - Purshia stansburiana Shrubland [Park Special]	*Artemisia tridentata* Shrubland Alliance
Artemisia tridentata / Bouteloua gracilis Shrubland	*Artemisia tridentata* Shrubland Alliance
Artemisia tridentata Shrubland	*Artemisia tridentata* Shrubland Alliance
Atriplex canescens - Artemisia tridentata Shrubland	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Atriplex canescens / Muhlenbergia porteri Shrubland	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Atriplex canescens / Pleuraphis jamesii Shrubland	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Atriplex canescens Shrubland	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Atriplex confertifolia Great Basin Shrubland	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Atriplex obovata Talus Dwarf-Shrubland	*Atriplex obovata [*Talus*]* Dwarf-Shrubland
Baccharis emoryi - Salix exigua Shrubland	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Baccharis emoryi / Imperata brevifolia Shrubland [Park Special]	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Baccharis salicifolia Riparian Shrubland	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Baccharis sarothroides Shrubland [Park Special]	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Bebbia juncea Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Bouteloua eriopoda Coconino Plateau Shrub Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Brickellia longifolia Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Bromus tectorum Semi-natural Herbaceous Vegetation	Great Basin and *Inter*Mountain *Ruderal* Dry Shrubland and Grassland Group
Built Up	Unvegetated Surfaces and Built Up Areas
Canotia holacantha Grand Canyon Shrubland	*Canotia holacantha* [Grand Canyon] Shrubland
Carex athrostachya Herbaceous Vegetation [Park Special]	Vancouverian & Rocky Mountain Montane Wet Meadow Group
Carex siccata - Carex rossii Herbaceous Vegetation	Southern Rocky Mountain Montane-Subalpine Grassland Group
Ceanothus fendleri / Poa fendleriana Shrub-Steppe Shrubland	Ceanothus fendleri / Poa fendleriana Shrub-Steppe Shrubland
Celtis laevigata / Cladium sp. Saturated Seep Shrubland [Park Special]	Colorado Plateau Hanging Garden Seep Group

ASSOCIATION	MAP CLASS
Cercis orbiculata Seep Shrubland [Park Special]	Colorado Plateau Hanging Garden Seep Group
Cercocarpus intricatus - (Quercus turbinella) Mixed Shrubland	*Cercocarpus intricatus - (Quercus turbinella)* Mixed Shrubland
Chilopsis linearis Shrubland	*Acacia greggii* Shrublands
Cladium californicum Seep [Park Special]	Colorado Plateau Hanging Garden Seep Group
Coleogyne ramosissima - Ephedra spp. Warm Desert Shrubland	*Coleogyne ramosissima* Shrublands
Coleogyne ramosissima - Purshia stansburiana Shrubland	*Coleogyne ramosissima* Shrublands
Coleogyne ramosissima Shrubland	*Coleogyne ramosissima* Shrublands
Colorado Plateau Hanging Garden Seep Group	Colorado Plateau Hanging Garden Seep Group
Encelia farinosa - Ephedra (fasciculata, nevadensis) Shrubland	*Encelia (farinosa, resinifera)* Shrubland Alliance
Encelia resinifera Shrubland	*Encelia (farinosa, resinifera)* Shrubland Alliance
Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	*Ephedra (torreyana, viridis)* / Mixed Semi-Desert Grasses Shrubland
Ephedra fasciculata / Mixed Semi-Desert Grasses Shrubland	*Ephedra fasciculata* Mojave Desert Shrubland Alliance
Ephedra fasciculata Mojave Desert Shrubland Alliance	*Ephedra fasciculata* Mojave Desert Shrubland Alliance
Ephedra fasciculata Shrubland	*Ephedra fasciculata* Mojave Desert Shrubland Alliance
Ephedra nevadensis - Yucca baccata Basalt Shrubland	*Ephedra nevadensis - Yucca baccata* Basalt Shrubland
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	*Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation
Ephedra torreyana - Opuntia basilaris Shrubland	*Ephedra torreyana - Opuntia basilaris* Shrubland
Ephedra trifurca Badlands Shrubland	*Ephedra trifurca* Badlands Shrubland
Equisetum X ferrissii Herbaceous Vegetation	Arid West Emergent Marsh
Ericameria nauseosa / *Bouteloua gracilis* Shrub Herbaceous Vegetation	*Ericameria nauseosa - Gutierrezia Seral* Shrubland Alliance
Ericameria nauseosa Desert Wash Shrubland	*Ericameria nauseosa* Desert Wash Shrubland
Ericameria paniculata Wash Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Eriogonum corymbosum Badlands Sparse Vegetation	*Eriogonum corymbosum* Badlands Sparse Vegetation
Erodium cicutarium Semi-natural Annual Herbaceous Vegetation	Great Basin and *Inter*Mountain *Ruderal* Dry Shrubland and Grassland Group
Fallugia paradoxa Grand Canyon Desert Wash Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Fendlera rupicola Talus Shrubland	*Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus Shrubland Alliance
Festuca (calligera, arizonica, brachyphylla) Herbaceous Vegetation	Southern Rocky Mountain Montane-Subalpine Grassland Group

ASSOCIATION	MAP CLASS
Fouquieria splendens / Encelia (farinosa, resinifera) Shrubland	*Encelia (farinosa, resinifera)* Shrubland Alliance
Fouquieria splendens Shrubland	*Fouquieria splendens* Shrubland Alliance
Fraxinus anomala - Rhus trilobata Talus Shrubland	*Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus Shrubland Alliance
Fraxinus velutina Riparian Woodland [Park Special]	*Populus fremontii - Salix gooddingii* Woodland Alliance
Gutierrezia (microcephala, sarothrae) Dwarf-Shrubland [Park Special]	*Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis)* Mojave Desert Shrubland Alliance
Gutierrezia (sarothrae, microcephala) - Ephedra spp. - Agave utahensis Dwarf-Shrubland	*Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis)* Mojave Desert Shrubland Alliance
Hesperostipa comata - (Bouteloua eriopoda, Pleuraphis jamesii) Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Hesperostipa comata Great Basin Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Hymenoclea salsola Wash Shrubland	Warm Semi-Desert Shrub *& Herb Wash-Arroyo*
*Inter*Mountain Semi-Desert Grassland Group	Intermountain Semi-Desert Grassland Group
Isocoma acradenia Shrubland	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland
Juniperus osteosperma - (Pinus monophylla) / Arctostaphylos pungens Woodland	*Pinus monophylla - Juniperus osteosperma /* Shrub Understory Woodland Alliance
Juniperus osteosperma - (Pinus monophylla) / Ceanothus greggii Woodland	*Pinus monophylla - Juniperus osteosperma /* Shrub Understory Woodland Alliance
Juniperus osteosperma / Artemisia tridentata Woodland	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma / Elymus elymoides Woodland [Park Special]	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma / Pleuraphis jamesii Woodland	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma / Poa fendleriana Woodland [Park Special]	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma / Sparse Understory Woodland	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma Savanna Alliance	*Juniperus osteosperma* Woodlands/Savannahs
Juniperus osteosperma Woodland Alliance	*Juniperus osteosperma* Woodlands/Savannahs
Krameria erecta Shrubland [Park Special]	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance
Krascheninnikovia lanata / Hesperostipa comata Dwarf-Shrubland	*Krascheninnikovia lanata* Dwarf-Shrubland Alliance
Krascheninnikovia lanata Dwarf-Shrubland	*Krascheninnikovia lanata* Dwarf-Shrubland Alliance
Larrea tridentata - Ambrosia dumosa - Fouquieria splendens Shrubland	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance
Larrea tridentata - Ambrosia dumosa - Krameria (erecta, grayi) Shrubland	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance
Larrea tridentata - Ambrosia dumosa Shrubland	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance
Larrea tridentata - Coleogyne ramosissima Shrubland	*Larrea tridentata - Encelia spp.* Shrubland Alliance
Larrea tridentata - Encelia farinosa - Fouquieria splendens Shrubland	*Larrea tridentata - Encelia spp.* Shrubland Alliance

ASSOCIATION	MAP CLASS
Larrea tridentata - Encelia farinosa Shrubland	*Larrea tridentata - Encelia spp.* Shrubland Alliance
Larrea tridentata - Encelia spp. Shrubland Alliance	*Larrea tridentata - Encelia spp.* Shrubland Alliance
Larrea tridentata Shrubland	*Larrea tridentata - Encelia spp.* Shrubland Alliance
Lycium and*ersonii - Ephedra (torreyana, viridis)* Shrubland	*Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis)* Mojave Desert Shrubland Alliance
Lycium pallidum Shrubland [Park Special]	Shadscale-Saltbush Cool Semi-Desert Scrub Group
Mortonia utahensis Shrubland	*Mortonia utahensis* Shrubland
Muhlenbergia montana Herbaceous Vegetation	Southern Rocky Mountain Montane-Subalpine Grassland Group
Nolina microcarpa Shrubland [Park Special]	*Nolina (bigelovii-parryi-microcarpa)* Mojave Desert Shrubland Alliance
Opuntia bigelovii Shrubland	*Opuntia bigelovii* Mojave Desert Shrubland Alliance
Opuntia polyacantha / *Pleuraphis jamesii* Shrubland	*Ericameria nauseosa - Gutierrezia Seral* Shrubland Alliance
Ostrya knowltonii Woodland	*Fraxinus anomala - Rhus trilobata - Fendlera rupicola* Talus Shrubland Alliance
Parthenium incanum - (Ephedra fasciculata) Shrubland [Park Special]	*Ephedra fasciculata* Mojave Desert Shrubland Alliance
Peucephyllum schottii Sparse Vegetation [Park Special]	*Peucephyllum schottii* Sparse Vegetation
Phragmites australis Western North America Temperate Semi-natural Herbaceous Vegetation	*Phragmites australis* Western North America Temperate Semi-natural Herbaceous Vegetation
Picea pungens / *Carex siccata* Forest	*Picea pungens* / *Carex siccata* Forest
Pinus edulis - (Juniperus osteosperma) / *Bouteloua gracilis* Woodland	*Pinus edulis - Juniperus osteosperma* / Grass - Forb Understory Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Amelanchier utahensis* Woodland	*Pinus edulis - Juniperus osteosperma* / *Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Arctostaphylos pungens* Woodland	*Pinus edulis - Juniperus osteosperma* / *Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Artemisia bigelovii* Woodland	*Pinus edulis - Juniperus osteosperma* / *Artemisia* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Artemisia* Woodland Alliance	*Pinus edulis - Juniperus osteosperma* / *Artemisia* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Cercocarpus - Quercus* Woodland Alliance	*Pinus edulis - Juniperus osteosperma* / *Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Cercocarpus intricatus* Woodland	*Pinus edulis - Juniperus osteosperma* / Talus *or* Canyon Slope *Scrub* Alliance
Pinus edulis - Juniperus osteosperma / *Cercocarpus ledifolius* Woodland	*Pinus edulis - Juniperus osteosperma* / *Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / *Coleogyne ramosissima* Woodland	*Pinus edulis - Juniperus osteosperma* / *Coleogyne ramosissima* Woodland
Pinus edulis - Juniperus osteosperma / Mixed Shrubs Talus Woodland	*Pinus edulis - Juniperus osteosperma* / Talus or Canyon Slope Scrub Alliance

ASSOCIATION	MAP CLASS
Pinus edulis - Juniperus osteosperma / Mortonia utahensis Woodland [Park Special]	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	*Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	*Pinus edulis - Juniperus osteosperma* / Sparse Understory Woodland
Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance	*Pinus edulis - Juniperus osteosperma* / Talus or Canyon Slope Scrub Alliance
Pinus edulis - Juniperus spp. / Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana) Woodland	*Pinus edulis - Juniperus osteosperma / Artemisia* Woodland Alliance
Pinus edulis - Juniperus spp. / Cercocarpus montanus - Mixed Shrubs Woodland	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance
Pinus edulis - Juniperus spp. / Poa fendleriana Woodland	*Pinus edulis - Juniperus osteosperma* / Grass - Forb Understory Woodland Alliance
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Artemisia tridentata Woodland	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Artemisia Woodland Alliance	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Bouteloua gracilis Woodland	*Pinus monophylla - Juniperus osteosperma* / Grass - Forb Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Cercocarpus montanus - Quercus gambelii Woodland [Provisional]	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima Woodland	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Purshia stansburiana Woodland	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Quercus turbinella Woodland	*Pinus monophylla - Juniperus osteosperma* / Shrub Understory Woodland Alliance
Pinus monophylla - Juniperus osteosperma / Sparse Understory Woodland	*Pinus monophylla - Juniperus osteosperma* / Grass - Forb Understory Woodland Alliance
Pinus ponderosa / Arctostaphylos patula Woodland	*Pinus ponderosa* Forest and Woodland with Shrub Understory Alliance
Pinus ponderosa / Bouteloua gracilis Woodland	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance
Pinus ponderosa / Carex siccata Woodland	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance
Pinus ponderosa / Poa fendleriana Woodland	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance
Pinus ponderosa / Pteridium aquilinum Woodland	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance
Pinus ponderosa / Purshia stansburiana Woodland	*Pinus ponderosa* Forest and Woodland with Shrub Understory Alliance
Pinus ponderosa / Quercus gambelii Woodland	*Pinus ponderosa* Forest and Woodland with Shrub Understory Alliance
Pinus ponderosa / Robinia neomexicana Woodland	*Pinus ponderosa* Forest and Woodland with Shrub Understory Alliance

ASSOCIATION	MAP CLASS
Pinus ponderosa / Sparse Understory Woodland	*Pinus ponderosa* Forest and Woodland with Shrub Understory Alliance
Pleuraphis jamesii Herbaceous Vegetation	Dry Semi-Desert Grassland Alliance
Pleuraphis rigida Herbaceous Vegetation	*Pleuraphis rigida* Herbaceous Vegetation
Pluchea sericea Seasonally Flooded Shrubland	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Poa fendleriana Herbaceous Vegetation	Southern Rocky Mountain Montane-Subalpine Grassland Group
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation	Western North American Ruderal Wet Meadow & Marsh Group
Populus fremontii - Fraxinus velutina Woodland	*Populus fremontii - Salix gooddingii* Woodland Alliance
Populus fremontii - Salix gooddingii Woodland	*Populus fremontii - Salix gooddingii* Woodland Alliance
Populus fremontii - Salix gooddingii Woodland Alliance	*Populus fremontii - Salix gooddingii* Woodland Alliance
Populus fremontii / Acer negundo Forest	*Populus fremontii - Salix gooddingii* Woodland Alliance
Populus fremontii / Baccharis emoryi Woodland	*Populus fremontii - Salix gooddingii* Woodland Alliance
Populus tremuloides - Ceanothus fendleri / Carex spp. Shrubland	*Populus tremuloides - Ceanothus fendleri / Carex spp.* Shrubland
Populus tremuloides / Carex siccata Forest	*Populus tremuloides / Carex siccata* Forest
Populus tremuloides / Juniperus communis Forest	*Populus tremuloides / Amelanchier - Symphoricarpos* Mesic Forest Alliance
Populus tremuloides / Muhlenbergia montana Woodland [Park Special]	*Populus tremuloides* Dry Forest Alliance
Populus tremuloides / Pteridium aquilinum Forest	*Populus tremuloides / Amelanchier - Symphoricarpos* Mesic Forest Alliance
Populus tremuloides / Robinia neomexicana Woodland	*Populus tremuloides / Robinia neomexicana* Shrubland
Prosopis glandulosa var. torreyana Sand Dune Shrubland [Park Special]	*Prosopis glandulosa var. torreyana* Shrubland
Prosopis glandulosa var. torreyana Shrubland	*Prosopis glandulosa var. torreyana* Shrubland
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	*Abies concolor - Pseudotsuga menziesii* Moist Forest Alliance
Psorothamnus fremontii - Acacia greggii [Shale] Sparse Vegetation [Park Special]	*Psorothamnus fremontii - Acacia greggii* [Shale] Sparse Vegetation
Psorothamnus fremontii Shrubland	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance
Purshia stansburiana Shrubland	*Purshia stansburiana* Shrubland [Provisional]
Quercus gambelii - Arctostaphylos pungens Shrubland [Park Special]	*Quercus gambelii* Shrubland Alliance
Quercus gambelii / Amelanchier utahensis Shrubland	*Quercus gambelii* Shrubland Alliance
Quercus gambelii / Poa fendleriana Shrubland	*Quercus gambelii* Shrubland Alliance
Quercus gambelii / Robinia neomexicana / Symphoricarpos rotundifolius Shrubland	*Quercus gambelii* Shrubland Alliance
Quercus gambelii / Robinia neomexicana Shrubland	*Quercus gambelii* Shrubland Alliance
Quercus gambelii Shrubland	*Quercus gambelii* Shrubland Alliance

ASSOCIATION	MAP CLASS
Quercus gambelii Shrubland Alliance	*Quercus gambelii* Shrubland Alliance
Quercus turbinella - (Rhus trilobata, Artemisia tridentata) Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Quercus turbinella - Coleogyne ramosissima Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Quercus turbinella - Garrya flavescens - Arctostaphylos pungens Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Quercus turbinella - Juniperus osteosperma Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Quercus turbinella - Ptelea trifoliata - Fraxinus anomala Mesic Shrubland	*Arctostaphylos - Quercus turbinella* Shrubland Alliance
Quercus X pauciloba Shrubland	*Quercus X pauciloba* Shrubland
Robinia neomexicana Shrubland	*Quercus gambelii* Shrubland Alliance
Salazaria mexicana Shrubland	*Acacia greggii - Chilopsis linearis* Desert Wash Alliance
Salix exigua / Barren Shrubland	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Salix exigua / Equisetum X ferrissii Shrubland [Park Special]	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance
Salix gooddingii / Baccharis emoryi Woodland	*Populus fremontii - Salix gooddingii* Woodland Alliance
Salix gooddingii Woodland	*Populus fremontii - Salix gooddingii* Woodland Alliance
Salsola spp. Semi-natural Herbaceous Vegetation	Great Basin and Interountain Ruderal Dry Shrubland and Grassland Group
Southern Rocky Mountain *Montane*-Subalpine Grassland Group	Southern Rocky Mountain Montane-Subalpine Grassland Group
Sparsely Vegetated Slickrock	Sparsely Vegetated Slickrock
Suaeda moquinii Shrubland	*Suaeda moquinii* Shrubland Alliance
Tamarix spp. Temporarily Flooded Semi-natural Shrubland	*Tamarix spp.* Temporarily Flooded Semi-natural Shrubland
Unvegetated Surfaces	Unvegetated Surfaces and Built Up Areas
Vitis arizonica Shrubland [Park Special]	*Vitis arizonica* Shrubland
Water	Water
Yucca baccata Shrubland [Park Special]	*Yucca baccata* Shrubland
Yucca brevifolia / Coleogyne ramosissima Wooded Shrubland	*Yucca brevifolia* Mojave Desert Shrubland Alliance
Yucca schidigera - Larrea tridentata - Ambrosia dumosa Shrubland	*Yucca schidigera* Mojave Desert Shrubland Alliance

Appendix F: Table of mapping errors

This table presents the results of accuracy assessment across all three phases of mapping. It table is composed of four columns: the map class of the segment tested, the map class of the vegetation sampled in that segment, the number of cases in which that match occurred, and the total number of segments tested in that map class. A traditional error matrix is provided separately for download on the NPS Vegetation Inventory Program products website as a spreadsheet table (http://science.nature.nps.gov/im/inventory/veg/products.cfm), but is not printed here because its size (47 rows by 47 columns) would be uninformative on letter-size pages.

Because the project was begun and the mapping and accuracy assessment contract was awarded to Kass Green Associates before the release of revised accuracy assessment requirements in 2010, the methods used reflected the original (1996) NPS / USGS accuracy assessment guidelines. These original guidelines are available, on request, from the USGS / NPS Core Science Analytics and Synthesis group or the USGS-NPS Vegetation Characterization Program at: csas@usgs.gov. The new guidelines are available at:

http://www1.usgs.gov/vip/standards/NPSVI_Accuracy_Assessment_Guidelines_ver2.pdf.

Map Model Class	Vegetation Sample	Number	Total
Abies concolor - Pseudotsuga menziesii Dry Forest Alliance	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance	46	55
	Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance	3	
	Pinus ponderosa Forest and Woodland with Herbaceous Understory Alliance	3	
	Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	1	
	Populus tremuloides / Carex siccata Forest	1	
	Southern Rocky Mountain *Montane* - Subalpine Grassland Group	1	
Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance	3	52
	Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance	45	
	Picea pungens / Carex siccata Forest	3	
	Populus tremuloides / Carex siccata Forest	1	
Acacia greggii Shrublands	*Acacia greggii* Shrublands	36	47
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	1	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	4	
	Ephedra torreyana - Opuntia basilaris Shrubland	1	
	Populus fremontii - Salix gooddingii Woodland Alliance	1	
	Prosopis glandulosa var. torreyana Shrubland	4	

Map Model Class	Vegetation Sample	Number	Total
Arctostaphylos - Quercus turbinella Shrubland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	40	63
	Artemisia bigelovii Shrubland Alliance	1	
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	1	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Cercocarpus intricatus Shrubland Alliance	3	
	Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	1	
	Coleogyne ramosissima Shrubland	1	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	1	
	Juniperus osteosperma Woodlands / Savannahs	1	
	Mortonia utahensis Shrubland	2	
	Pinus edulis - Juniperus osteosperma / *Artemisia* Woodland Alliance	1	
	Pinus edulis - Juniperus osteosperma / *Cercocarpus - Quercus* Woodland Alliance	3	
	Pinus edulis - Juniperus osteosperma / *Coleogyne ramosissima* Woodland	1	
	Pinus edulis - Juniperus osteosperma / *Quercus turbinella* Woodland	3	
	Populus fremontii - Salix gooddingii Woodland Alliance	1	
	Quercus gambelii Shrubland Alliance	1	
	Southern Rocky Mountain Montane - Subalpine Grassland Group	1	
Artemisia bigelovii Shrubland Alliance	*Artemisia bigelovii* Shrubland Alliance	18	73
	Artemisia tridentata Shrubland Alliance	4	
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	8	
Artemisia tridentata Shrubland Alliance	*Artemisia bigelovii* Shrubland Alliance	2	
	Artemisia tridentata Shrubland Alliance	38	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	2	
	Juniperus osteosperma Woodlands / Savannahs	1	
Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance	27	41
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	3	
	Populus fremontii - Salix gooddingii Woodland Alliance	3	
	Prosopis glandulosa var. torreyana Shrubland	1	
	Tamarix spp. Temporarily Flooded Semi-natural Shrubland	6	
	Acacia greggii Shrublands	1	

Map Model Class	Vegetation Sample	Number	Total
Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	*Acacia greggii* Shrublands	1	45
	Artemisia bigelovii Shrubland Alliance	1	
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	4	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	35	
	Encelia (farinosa, resinifera) Shrubland Alliance	1	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	1	
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	1	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	1	
Canotia holacantha [Grand Canyon] Shrubland	*Canotia holacantha [*Grand Canyon*]* Shrubland	5	5
Ceanothus fendleri / Poa fendleriana Shrub-Steppe Shrubland	*Ceanothus fendleri / Poa fendleriana* Shrub-Steppe Shrubland	3	3
Cercocarpus intricatus Shrubland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	2	39
	Artemisia tridentata Shrubland Alliance	1	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Cercocarpus intricatus Shrubland Alliance	30	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	1	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	1	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	1	
Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	*Artemisia bigelovii* Shrubland Alliance	1	5
	Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	4	
Coleogyne ramosissima Shrublands	*Acacia greggii* Shrublands	1	56
	Coleogyne ramosissima Shrubland	45	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	4	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	1	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	1	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	1	
	Larrea tridentata - Encelia spp. Shrubland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	1	
	Pleuraphis rigida Herbaceous Vegetation	1	

Map Model Class	Vegetation Sample	Number	Total
Encelia (farinosa, resinifera) Shrubland Alliance	*Acacia greggii* Shrublands	3	70
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	3	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Encelia (farinosa, resinifera) Shrubland Alliance	38	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	8	
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	3	
	Ephedra torreyana - Opuntia basilaris Shrubland	3	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	6	
	Larrea tridentata - Encelia spp. Shrubland Alliance	2	
	Populus fremontii - Salix gooddingii Woodland Alliance	1	
	Prosopis glandulosa var. torreyana Shrubland	2	
Ephedra (torreyana, viridis) / Mixed Semi-desert Grasses Shrubland	*Acacia greggii* Shrublands	1	58
	Artemisia bigelovii Shrubland Alliance	3	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Coleogyne ramosissima Shrubland	1	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	36	
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	4	
	Ephedra torreyana - Opuntia basilaris Shrubland	3	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	4	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	5	
Ephedra fasciculata Mojave Desert Shrubland Alliance	*Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia* Shrubland	1	39
	Encelia (farinosa, resinifera) Shrubland Alliance	4	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	2	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	32	
Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	*Artemisia bigelovii* Shrubland Alliance	1	34
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	1	
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	29	
	Ephedra torreyana - Opuntia basilaris Shrubland	2	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	1	
Ephedra torreyana - Opuntia basilaris Shrubland	*Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia)* Sparse Vegetation	1	36
	Ephedra torreyana - Opuntia basilaris Shrubland	35	

Map Model Class	Vegetation Sample	Number	Total
Eriogonum corymbosum Badlands Sparse Vegetation	*Eriogonum corymbosum* Badlands Sparse Vegetation	24	24
Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	*Acacia greggii* Shrublands	1	42
	Artemisia tridentata Shrubland Alliance	1	
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	1	
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	1	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	34	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	3	
Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	4	66
	Artemisia tridentata Shrubland Alliance	1	
	Coleogyne ramosissima Shrubland	2	
	Ephedra (torreyana, viridis) / Mixed Semi-Desert Grasses Shrubland	5	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	5	
	Ephedra torreyana - Opuntia basilaris Shrubland	3	
	Eriogonum corymbosum Badlands Sparse Vegetation	1	
	Fraxinus anomala - Rhus trilobata - Fendlera rupicola Talus Shrubland Alliance	1	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	35	
	Mortonia utahensis Shrubland	4	
	Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	1	
	Pinus monophylla - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	1	
	Pleuraphis rigida Herbaceous Vegetation	3	
Juniperus osteosperma Woodlands / Savannahs	*Juniperus osteosperma* Woodlands / Savannahs	30	41
	Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	2	
	Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	5	
	Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	2	
	Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	1	
Larrea tridentata - Ambrosia spp. Shrubland Alliance	*Larrea tridentata - Ambrosia spp.* Shrubland Alliance	43	45
	Larrea tridentata - Encelia spp. Shrubland Alliance	1	
	Pleuraphis rigida Herbaceous Vegetation	1	

Map Model Class	Vegetation Sample	Number	Total
Larrea tridentata - Encelia spp. Shrubland Alliance	*Acacia greggii* Shrublands	2	70
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	3	
	Encelia (farinosa, resinifera) Shrubland Alliance	7	
	Ephedra fasciculata Mojave Desert Shrubland Alliance	3	
	Larrea tridentata - Ambrosia spp. Shrubland Alliance	7	
	Larrea tridentata - Encelia spp. Shrubland Alliance	46	
	Pleuraphis rigida Herbaceous Vegetation	1	
	Prosopis glandulosa var. torreyana Shrubland	1	
Mortonia utahensis Shrubland	*Coleogyne ramosissima* Shrubland	1	49
	Ephedra torreyana - (Atriplex canescens, Atriplex confertifolia) Sparse Vegetation	1	
	Gutierrezia (sarothrae, microcephala) - Ephedra (torreyana, viridis) Mojave Desert Shrubland Alliance	2	
	Mortonia utahensis Shrubland	44	
	Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	1	
Picea pungens / Carex siccata Forest	*Abies concolor - Pseudotsuga menziesii* Dry Forest Alliance	1	42
	Abies lasiocarpa - Picea engelmannii Southern Rocky Mountain Dry Forest Alliance	2	
	Picea pungens / Carex siccata Forest	36	
	Pinus ponderosa Forest and Woodland with Herbaceous Understory Alliance	1	
	Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	1	
	Southern Rocky Mountain Montane - Subalpine Grassland Group	1	
Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	*Artemisia bigelovii* Shrubland Alliance	1	60
	Artemisia tridentata Shrubland Alliance	5	
	Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	40	
	Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	11	
	Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	2	
	Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance	1	

Map Model Class	Vegetation Sample	Number	Total
Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	2	46
	Artemisia bigelovii Shrubland Alliance	1	
	Cercocarpus intricatus Shrubland Alliance	2	
	Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	31	
	Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	2	
	Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	2	
	Pinus edulis - Juniperus osteosperma / Talus *or* Canyon Slope *Scrub* Alliance	5	
Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	*Pinus edulis - Juniperus osteosperma / Artemisia* Woodland Alliance	1	40
	Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	37	
	Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	1	
	Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance	1	
Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance	1	16
	Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	15	
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	*Cercocarpus intricatus* Shrubland Alliance	1	55
	Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	1	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	7	
	Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland	1	
	Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	38	
	Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	4	
	Populus fremontii - Salix gooddingii Woodland Alliance	3	
Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	*Juniperus osteosperma* Woodlands / Savannahs	3	30
	Pinus edulis - Juniperus osteosperma / Artemisia Woodland Alliance	5	
	Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	1	
	Pinus edulis - Juniperus osteosperma / Sparse Understory Woodland	21	
Pinus edulis - Juniperus osteosperma / Talus or Canyon Slope Scrub Alliance	*Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus* Woodland Alliance	1	2
	Pinus edulis - Juniperus osteosperma / Talus *or* Canyon Slope Scrub Alliance	1	

Map Model Class	Vegetation Sample	Number	Total
Pinus monophylla - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	*Juniperus osteosperma* Woodlands / Savannahs	13	31
	Pinus monophylla - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	16	
	Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	2	
Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	1	68
	Juniperus osteosperma Woodlands / Savannahs	2	
	Pinus edulis - Juniperus osteosperma / *Coleogyne ramosissima* Woodland	1	
	Pinus monophylla - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	18	
	Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	46	
Pinus ponderosa Forest and Woodland with Herbaceous Understory Alliance	*Picea pungens* / *Carex siccata* Forest	2	53
	Pinus edulis - Juniperus osteosperma / Grass - Forb Understory Woodland Alliance	1	
	Pinus ponderosa Forest and Woodland with Herbaceous Understory Alliance	41	
	Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	8	
	Southern Rocky Mountain *Montane* - Subalpine Grassland Group	1	
Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance	4	43
	Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	38	
	Quercus gambelii Shrubland Alliance	1	
Pleuraphis rigida Herbaceous Vegetation	*Pleuraphis rigida* Herbaceous Vegetation	11	11
Populus fremontii - Salix gooddingii Woodland Alliance	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance	2	27
	Populus fremontii - Salix gooddingii Woodland Alliance	25	
Populus tremuloides - Ceanothus fendleri / *Carex spp*. Shrubland	*Pinus ponderosa* Forest and Woodland with Herbaceous Understory Alliance	1	41
	Populus tremuloides - Ceanothus fendleri / *Carex spp.* Shrubland	36	
	Quercus gambelii Shrubland Alliance	1	
	Southern Rocky Mountain Montane - Subalpine Grassland Group	3	
Populus tremuloides / *Carex siccata* Forest	*Populus tremuloides - Ceanothus fendleri* / *Carex spp.* Shrubland	1	16
	Populus tremuloides / *Carex siccata* Forest	12	
	Populus tremuloides / *Robinia neomexicana* Shrubland	3	
Populus tremuloides / Robinia neomexicana Shrubland	*Populus tremuloides* / *Robinia neomexicana* Shrubland	2	2

Map Model Class	Vegetation Sample	Number	Total
Prosopis glandulosa var. torreyana Shrubland	*Acacia greggii* Shrublands	4	55
	Baccharis spp. - Salix exigua - Pluchea sericea Shrubland Alliance	3	
	Populus fremontii - Salix gooddingii Woodland Alliance	3	
	Prosopis glandulosa var. torreyana Shrubland	38	
	Tamarix spp. Temporarily Flooded Semi-natural Shrubland	7	
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	*Pseudotsuga menziesii / Symphoricarpos oreophilus* Forest	6	6
Quercus gambelii Shrubland Alliance	*Arctostaphylos - Quercus turbinella* Shrubland Alliance	1	55
	Cercocarpus montanus - Amelanchier utahensis Shrubland Alliance	2	
	Pinus edulis - Juniperus osteosperma / Cercocarpus - Quercus Woodland Alliance	1	
	Pinus monophylla - Juniperus osteosperma / Shrub Understory Woodland Alliance	1	
	Pinus ponderosa Forest and Woodland with Shrub Understory Alliance	3	
	Quercus gambelii Shrubland Alliance	47	
Southern Rocky Mountain Montane-Subalpine Grassland Group	*Ceanothus fendleri / Poa fendleriana* Shrub-Steppe Shrubland	1	44
	Southern Rocky Mountain Montane - Subalpine Grassland Group	43	
Tamarix spp. Temporarily Flooded Semi-natural Shrubland	*Baccharis spp. - Salix exigua - Pluchea sericea* Shrubland Alliance	2	46
	Brickellia longifolia - Fallugia paradoxa - Isocoma acradenia Shrubland	1	
	Populus fremontii - Salix gooddingii Woodland Alliance	3	
	Prosopis glandulosa var. torreyana Shrubland	3	
	Tamarix spp. Temporarily Flooded Semi-natural Shrubland	37	

Appendix G: Vegetation and fuels survey field data sheets

This appendix contains the final forms of the field data sheets used during the surveys of classification plots and observation points. The first four pages contain the plot forms for vegetation classification plots. The next two pages contain the data sheets used for collecting data on observation points. The observation point data sheet was also used for recording springs and significant infestations of exotic species which field crews found noteworthy. The final two pages contain the data sheet used for collecting fuels data. Two transects were collected in forest and woodland vegetation, unless it was dominated by pinyon and / or juniper. In that case only one transect was recorded.

GRAND CANYON N.P. – LAKE / PARA PLOT SURVEY FORM
2005 VEGETATION MAPPING PROGRAM

SURVEY AND SITE INFORMATION

Plot Code: GRCA _ _ _ _ _ _ _ Quad name: _____ BPU Code: _____ Survey Date: _____

Park Site Name_____ Location (Circle One): North Rim South Rim LAMB

Surveyors_____ Inner Canyon Colorado River Corridor Environs

Datum: WGS 84 /Other_____ Plot Center: Field Northing ____ . _____ (deg) Easting ___ ___ . _____ ___ ___ (deg)
Corner: Northing ____ . _____ (deg) Easting ___ . _____ (deg) Corner: Northing ____ . _____ (deg) Easting ___ . _____ (deg)
Corner: Northing ____ . _____ (deg) Easting ___ . _____ (deg) Corner: Northing ____ . _____ (deg) Easting ___ . _____ (deg)

☐ Coordinates from USGS NAD27 Quad Map (if checked enter coordinates under GPS comments)

GPS UNIT: Garmin 60 CSx / Other: _____ Error: +/- _____m (PDOP: _____) 3D NAV? Y / N WAAS Differential? Y / N

GPS Comments:

Directions to Plot:

Sq plot (20 x 20) (10m x 10m)	Rect Plot: len(m)_____ x wid(m)_____	Circ. Plot (100 m², 400 m², 1000m²)	Azi _____deg

Camera #: ____ Camera Ht: _____m Photopoint coords (if not plot center) Northing ___ . ____ ___ (deg) Easting ___ ___ . _____ ___ (deg)

Description of Photopoint:_____

View#	Time	V or H	Bearing	Photographer	View from Photopoint
1					
2					
3					
4					
a					

Views 1-4 - cardinal directions N,E,S,W; view a - person standing on the photopoint itself to help relocate it in future, additional representative views

Plot representativeness (discuss plot placement and explain non-representativeness)

ENVIRONMENTAL DESCRIPTION

Elevation _____ m From: GPS / Map (circle one) | Slope _____(deg) Aspect_____

Topographic Position: High level High Slope Mid Slope Low Slope Backslope Step in Slope Toe Slope Low Level Interfluve

Landform: Alluvial Fan, Colluvium, Rockpile Drainage Channel, Valley Bottom Fill, Side Slope, Interfluve, Intermittent Stream, Ridge, Slick Rock, Terrace, Mesa, Butte, Cliff Talus, Sand Dune, Plateau
Other _____

Geology: Aeolian sands Basalt Conglomerate Limestone Moisture Obscured by Soil Sandstone Shale Schist
Other_____

Cowardin System
____ Upland ____ Palustrine

Hydrology
___ Unknown
___ Permanently Flooded ___ Seasonally Flooded ___ Temporarily Flooded
___ Semipermanently Flooded ___ Saturated ___ Intermittently Flooded

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc):

GRAND CANYON N.P. – LAKE / PARA PLOT SURVEY FORM
2003 VEGETATION MAPPING PROGRAM

PLOT CODE: GRCA. _ _ _ _ _ _ DATE: _____

ENVIRONMENTAL DESCRIPTION (Continued)

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*

___ Bare soil (<0.1 mm)
___ Sand (0.1-2 mm)
___ Gravel (2 mm – 6.4 cm)
___ Rock (> 6.4 cm)
___ Bedrock (solid surface)
___ Litter/Duff (dead plant material <3 cm diameter)
___ Coarse woody debris (dead wood 3-15 cm)
___ Woody debris structure (dead >10 cm deep & wide)
___ Live veg (litter / wood)
___ Lichen (ground)
___ Moss (ground)
___ Microbiotic soil crust
___ Water
___ Other: _____

Soil Texture (see soil key):

___ sand
___ loamy sand
___ sandy loam
___ loam
___ silt loam
___ silt
___ clay loam
___ silty clay
___ sandy clay
___ clay
___ peat
___ muck
___ sandy clay loam
___ silty clay loam

Soil Drainage:

___ Rapidly drained
___ Well drained
___ Moderately well drained
___ Somewhat poorly drained
___ Poorly drained
___ Very poorly drained

Surface Water w/in 25m? YES/NO Seep Spring Stream Pothole River

Soil Moisture: dry moist saturated standing water

Animal Use Evidence:

___ Burrows
___ Scat (Whose? _____)
___ Browsing Evidence
___ Grazing Evidence
___ Animal / Game Trails
___ Vegetation Damage (animal)
___ Bedding Sites
___ Nests (Whose? _____)
___ Animal Sighting
___ Other: _____

Anthropogenic Disturbances:

___ Campsite Evidence
___ Trails
___ Rock Cairns
___ Microbiotic Crust Damage
___ Vegetation Damage (human)
___ ORV Evidence
___ Historic Feature
___ Archaeological Feature
___ Other: _____

Natural disturbances

___ Drought (tree & shrub die-back)
___ Fire
___ Flood
___ Mass Wasting
___ Water gullies
___ Vegetation Damage (natural)
___ Other: _____

Other Comments. Describe surrounding communities and how they relate to the plot.

VEGETATION DESCRIPTION (Only check one within each box)

Leaf Phenology
(of dominant stratum)

Trees and Shrubs
___ Evergreen
___ Cold-deciduous
___ Mixed evergreen-cold-deciduous

OR

Herbs
___ Annual
___ Perennial

Leaf Type
(of dominant stratum)

___ Broad-leaved
___ Needle-leaved
___ Microphyllous
___ Graminoid
___ Forb
___ Pteridophyte
___ Non-vascular
___ Mixed (describe)

Physiognomic Class (see cheat sheet)

___ Forest
___ Woodland
___ Shrubland
___ Wooded Shrubland
___ Dwarf Shrubland
___ Shrub Herbaceous
___ Wooded Herbaceous
___ Herbaceous
___ Nonvascular
___ Sparsely Vegetated

Habitat Type:

___ Subalpine conifer forest
___ Mixed conifer
___ Ponderosa pine
___ Great Basin mountain scrub
___ Great Basin conifer woodland
___ Great basin desertscrub
___ Mojave desertscrub
___ Alpine/subalpine grassland
___ Interior wetlands
___ Riparian
___ Other _____

GRAND CANYON N.P. – LAKE / PARA PLOT SPECIES/STRATA FORM
2003 VEGETATION MAPPING PROGRAM

Plot Code: GRCA _ _ _ _ _ _ **Date:** _____

VEGETATION DESCRIPTION

Provisional Community Name: _____

Supplemental Form (Please Check if Used): ☐

Species/Strata: Starting with the uppermost stratum, list all species with full scientific names, cover class and % cover for each species in the stratum. For each tree species estimate seedling, sapling, and total cover in appropriate stratum. Once species level information is completed, then complete height class and cover class for each strata (shaded blocks). Indicate with an asterisk (*) diagnostic species for each stratum and check whether a specimen has been collected. Additional space is available on the back side of this form. List species outside the plot at the end of the table and designate with a 0 in Cover Class Column.

SPECIES/STRATA TABLE / TREES & SHRUBS				
Strata / Species Scientific Name	*	Cover Class	% Cover	Spec. ✓
Whole Plot: Height to Lowest Ladder Fuel ____ (m)				
T1 EMERGENT Strata Height ____ Strata Cover ____				
T2 CANOPY Strata Height ____ Strata Cover ____				
T3 SUBCANOPY Strata Height ____ Strata Cover ____				
S1 TALL SHRUB (> 2m) Strata Height ____ Strata Cover ____				
S2 SHORT SHRUB (< 2m) Strata Height ____ Strata Cover ____				
S3 DWARF SHRUB (< 0.5m) Strata Height ____ Strata Cover ____				

SPECIES/STRATA TABLE / HERBACEOUS				
Strata / Species Scientific Name	*	Cover Class	% Cover	Spec. ✓
Height to Live Crown ____ (m)				
Hr HERBACEOUS Sum of H1, H2, H3, H4 Strata Height ____ Strata Cover ____				
H1 GRAMINOIDS Strata Height ____ Strata Cover ____				
H2 FORBS Strata Height ____ Strata Cover ____				
H3 FERNS & ALLIES Strata Height ____ Strata Cover ____				
H4 TREE SEEDLINGS Strata Height ____ Strata Cover ____				
N NON-VASCULAR Strata Height ____ Strata Cover ____				

Cover Scale for Species

t = few T = <1% 1a = 5.01 -> 10% 2 = 15.01 -> 25% 4 = 35.01 -> 45% 6 = 55.01 -> 65% 8 = 75.01 -> 85% 10 = > 95%
P = 1-5% 1b = 10.01 -> 15% 3 = 25.01 -> 35% 5 = 45.01 -> 55% 7 = 65.01 -> 75% 9 = 85.01 -> 95%

Height Scale for Strata

01 = < 0.5 m 03 = 1.01 -> 2 m 05 = 5.01 -> 10 m 07 = 15.01 -> 20 m 09 = 35.01 -> 50 m
02 = 0.5-1 m 04 = 2.01 -> 5 m 06 = 10.01 -> 15 m 08 = 20.01 -> 35 m 10 = > 50 m

GRAND CANYON N.P. – LAKE / PARA PLOT SPECIES/STRATA FORM

2008 VEGETATION MAPPING PROGRAM

Plot Code: GRCA. __ __ __ __ __ Date: ____________________

SUPPLEMENTAL SPECIES AND TREE INFORMATION.

Use when there is no room on the main data sheet, for recording tree DBH/DRC measurements and for Park Specials: rare plants and exotics.

BE SURE TO INDICATE ON THE OTHER SIDE THAT THERE IS MORE OVER HERE.

SPECIES/STRATA TABLE / TREES & SHRUBS

	(Diag?) *	Cover Class	% Cover	Specimen ✓
Stratum:				
Stratum:				
Stratum:				
Stratum:				
Stratum:				
Stratum:				

Tree DBH Data

Record the species of trees in the plot and create a comma separated list of DBH measurements for that species in the plot. Measure all stems of multi-stemmed individuals and contain in parentheses.

Species	DBH

Rare Plant Information:

Species Name ______________________________

Estimated # ______ Area Covered by Population _______ (m^2)

Flowering ___% Fruiting ___% Vegetative ___% *add to 100

Evidence of Disease, Predation, Injury ________________

____

Evidence of Pollinators ______________________

Evidence of Reproductive Success ________________

____

____

Exotic Plant Information:

Species Name ____________________

Infested Area _______ (m^2) Gross Infested Area _______ (m^2)

Flowering ____% Fruiting ____% Vegetative ____% *must add to 100

Site Notes ____

____

____

____

*Infested Area = The actual cover (shadow) of plants within the population.

Gross Infested Area = The overall extent of the population in the observed area.

Exotic Plant Action Taken:

Treatment: A=No Action D=Mechanical

of Plants Pulled: __________

Light Exposure (circle): Open Full-shade Partial-shade

Control Notes ____

____

____

____

FOR EXOTIC TREE SPECIES, please estimate # of each in the plot:

______ Seedlings ______ Saplings ______ Mature

Cover Scale for Species

t = few
T = 0-1%
P = 1 - 5%
1a = 5.01 -> 10%
1b = 10.01 -> 15%
2 = 15.01 -> 25%
3 = 25.01 -> 35%
4 = 35.01 -> 45%
5 = 45.01 -> 55%
6 = 55.01 -> 65%
7 = 65.01 -> 75%
8 = 75.01 -> 85%
9 = 85.01 -> 95%
10 > 95%

Height Scale for Strata

01 < 0.5 m
02 = 0.5 – 1 m
03 = 1.01 -> 2 m
04 = 2.01 -> 5 m
05 = 5.01 -> 10 m
06 = 10.01 -> 15 m
07 = 15.01 -> 20 m
08 = 20.01 -> 35 m
09 = 35.01 -> 50 m
10 > 50 m

GRAND CANYON N.P. – LAKE / PARA OBSERVATION POINT FORM
2008 VEGETATION MAPPING PROGRAM

SURVEY AND SITE INFORMATION

Point Code: GRCA_ 9 _ _ _ _ _ Quad name: _____ BPU Code: _____ Survey Date: _____

Type of Observation (Circle One): VEG/OBS SPRING/HANGING INVASIVE RARE PLANT OTHER (Specify) _____

Park Site Name: _____ Location (Please Circle One): North Rim South Rim LAMR

Surveyors: _____ Size of Area: _____ (m2) Inner Canyon Colorado River Corridor Environs

Datum: WGS 84 Other: _____ Field Northing: _ _ _ _ _ _ . _ _ _ _ _ _ (deg) Field Easting: _ _ _ _ _ . _ _ _ _ _ _ _ (deg)

☐ Coordinates from USGS NAD27 Quad Map (if checked, enter coordinates under GPS comments)

GPS UNIT: Garmin 60 CSx / Other: _____ Error: +/- _____ m (PDOP: _____) 3D NAV? Y / N WAAS Differential? Y / N

GPS Comments:

Camera #: ____ Camera Ht: _____ m Photopoint coords (if not plot center) Northing: _ _ . _ _ _ _ _ (deg) Easting: _ _ _ . _ _ _ _ _ (deg)

Description of Photopoint: _____

View #	Time	View H	Bearing	Photographer	View from Photopoint

View a - person standing on the photopoint itself to help relocate it in future, view 1-2 additional representative views of Observation Point area

ENVIRONMENTAL DESCRIPTION

Elevation _____ m From: GPS / Map (circle one) | Slope _____ (deg) Aspect: _____

Topographic Position: High level High Slope Mid Slope Low Slope Backslope Step in Slope Toe Slope Low Level Interfluve

Landforms: Alluvial Fan, Colluvium, Rockpile, Drainage Channel, Valley Bottom Fill, Side Slope, Interfluve, Ridge, Intermittent Stream, Slick Rock, Terrace, Mesa, Butte, Cliff, Talus, Sand Dune, Plateau, Other: _____

Geology: Aeolian sands Basalt Conglomerate Limestone Moistone Obscured by Soil Sandstone Shale Schist Other: _____

Surface Water w/in 25m? YES/NO Seep Spring Stream Pothole River | Soil Moisture: dry moist saturated standing water

Cowardin System
____ Upland ____ Palustrine

Hydrology
___ Unknown
___ Permanently Flooded ___ Seasonally Flooded ___ Temporarily Flooded
___ Semipermanently Flooded ___ Saturated ___ Intermittently Flooded

Environmental Comments:

GRAND CANYON N.P. – LAKE / PARA OBSERVATION POINT FORM

2008 VEGETATION MAPPING PROGRAM

Provisional Community Name: _____ Plot Code: GRCA_9

Stratum Code	Stratum Ht Class	Stratum Cvr Class	Dominant Species (mark diagnostic species with *)	% Cover
_____	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
_____	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
			_____	_____
_____	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____
_____	_____	_____	_____	_____
			_____	_____
			_____	_____
			_____	_____

Strata:

T1	Emergent (above canopy)	S1	Tall Shrub (> 1m)	H1	Graminoids	H4	Tree Seedlings
T2	Canopy	S2	Short Shrub (< 2m)	H2	Forbs	N	Non-vascular
T3	Sub-canopy	S3	Dwarf Shrub (< 0.5m)	H3	Ferns & Allies		

Ground Cover: *(please use cover scale below)*

- ___ Bare soil (<0.1 mm)
- ___ Sand (0.1-2 mm)
- ___ Gravel (2 mm – 6.4 cm)
- ___ Rock (>6.4 cm)
- ___ Bedrock (solid surface)
- ___ Litter/Duff (dead plant material <3 cm diameter)
- ___ Course woody debris (dead wood 3-10 cm)
- ___ Woody debris structure (dead >10 cm deep & wide)
- ___ Live veg (litter / wood)
- ___ Lichen (ground)
- ___ Moss (ground)
- ___ Microbiotic soil crust
- ___ Water
- ___ Other: _____

VEGETATION DESCRIPTION (Check only 1 per column)

Leaf phenology (of dominant stratum)

Trees and Shrubs
- ___ Evergreen
- ___ Cold-deciduous
- ___ Mixed evergreen-cold-deciduous

Herbs
- ___ Annual
- ___ Perennial

Leaf Type (of dominant stratum)
- ___ Broad-leaved
- ___ Needle-leaved
- ___ Microphyllous
- ___ Graminoid
- ___ Forb
- ___ Pteridophyte
- ___ Non-vascular
- ___ Mixed (describe _____)

Physiognomic Class
- ___ Forest
- ___ Woodland
- ___ Shrubland
- ___ Wooded Shrubland
- ___ Dwarf Shrubland
- ___ Shrub Herbaceous
- ___ Wooded herbaceous
- ___ Herbaceous
- ___ Nonvascular
- ___ Sparsely Vegetated

Habitat Type:
- ___ Subalpine conifer forest
- ___ Mixed conifer
- ___ Ponderosa pine
- ___ Great Basin mountain scrub
- ___ Great Basin conifer woodland
- ___ Great basin desertscrub
- ___ Mojave desertscrub
- ___ Alpine/subalpine grassland
- ___ Interior wetlands
- ___ Riparian
- Other _____

Height Scale for Strata:

01 = < 0.5 m	06 = 10-15 m
02 = 0.5-1 m	07 = 15-20 m
03 = 1-2 m	08 = 20-35 m
04 = 2-5 m	09 = 35-50 m
05 = 5-10 m	10 = >50 m

Cover Scale for Strata & Ground Cover:

01 = 0 – 10%
02 = 10 – 25%
03 = 25 – 60%
04 = 60 – 100%

Rare Plant Information:

Species Name _____

Estimated # _____ Area Covered by Population _____ (m^2)

Flowering ____% Fruiting ____% Vegetative ____% *must add to 100*

Evidence of Disease, Predation, Injury _____

Evidence of Pollinators _____

Evidence of Reproductive Success _____

Exotic Plant Information:

Species Name _____

Infested Area _____ (m^2) Gross Infested Area _____ (m^2)

Flowering ____% Fruiting ____% Vegetative ____% *must add to 100*

Site Notes: _____

*Infested Area=The actual cover of the plants within the population.
Gross Infested Area=The overall extent of the population in the observed area

Exotic Plant Action Taken:

Treatment: A=No Action D=Mechanical

of Plants Pulled: _____

Light Exposure (circle): Open Full-shade Partial-shade

Control Notes _____

FOR TREE SPECIES, please estimate # of each in the area:

_____ Seedlings _____ Saplings _____ Mature

GRAND CANYON N.P. – LAKE/PARA FUELS FORM
2008 VEGETATION MAPPING PROJECT

PLOT CODE: GRCA. _ _ _ _ _ SURVEYORS: _____ DATE: _____

FUEL MODEL:

____ ____ ____
Per Scott & Burgan (e.g. GS2)

P / J AGE CLASS

- ☐ Not PJ
- ☐ Seedling / Sapling (< 80 yrs.)
- ☐ Vigorous Mature (81 – 135 yrs.)
- ☐ Old (136 – 200 yrs. no shrub layer)
- ☐ Overmature (> 200 yrs.)

Ground Cover

Doctor estimate of % in each category for plot: should total to 100%. Grass is grass, ground is ground.

Ground Cover Category	%	Ground Cover Category	%
Unburnable ground (rock, bare soil, etc.)		Moderate shrubs (1/4 – 1 meter tall)	
Biotic soil crust		Tall shrubs (> 1 meter tall)	
Short grass or forbs (< 1/4 meter tall)		Short-needle conifer litter	
Moderate grass or forbs (1/4 – 1/2 meter tall)		Long-needle conifer litter	
Tall grass or forbs (> 1/2 meter tall)		Deciduous litter	
Short shrubs (< 1/4 meter tall)		Jackpots of dead and down fuel	

Transect 1

Slope _____ (deg)

Azimuth _____

1 hr tally (18 – 20in along transect) (< ¼ ")	
10 hr tally (18 – 20in along transect) (¼ " to 1")	
100 hr tally (18 – 20in along transect) (1" to 3")	

Large Woody Intercepts (> 3 ")

Diam (cm)	Decay Class (S or R)

Litter Duff Depth (to nearest 0.1 inch)

Intercept	Litter	Duff
2m		
4m		
6m		
8m		
10m		
12m		
14m		
16m		
18m		
20m		

Fuels Comments:

Transect 2 (Not in P/J)

Slope _____ (deg)

Azimuth _____

1 hr tally (18 – 20in along transect) (< ¼ ")	
10 hr tally (18 – 20in along transect (¼ " to 1")	
100 hr tally (18 – 20in along transect) (1" to 3")	

Large Woody Intercepts (> 3")

Diam (cm)	Decay Class (S or R)

Litter Duff Depth (to nearest 0.1 inch)

Intercept	Litter	Duff
2m		
4m		
6m		
8m		
10m		
12m		
14m		
16m		
18m		
20m		

* Measure all conditions except 1s on 6" over transect *** Rocks = 0 litter / 0 duff
* Litter = unconsolidated on top, Duff = consolidated, down to mineral soil
* Take 1000 hr measurements perpendicular to long length of log
* Reconstruct flattened but intact rotten 1000 hr fuels to cylindrical log
* Offset duff / litter to left or right if log encountered at the point
* Average litter and duff over a 20 x 20 cm square around the point

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 113/127833, 666/127833, February 2015

National Park Service
Department of the Interior

Natural Resource Stewardship and Science
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™