National Park Service
U.S. Department of the Interior

Natural Resource Program Center

Vegetation Classification and Distribution Mapping Report

Mesa Verde National Park

Natural Resource Report NPS/SCPN/NRR—2009/112



ON THE COVER

Mesa Verde National Park with La Plata Mountains in the background. Courtesy Southwest Biological Science Center, U.S. Geological Survey.

Vegetation Classification and Distribution Mapping Report

Mesa Verde National Park

Natural Resource Report NPS/SCPN/NRR—2009/112

Authors
Kathryn A. Thomas
U.S. Geological Survey
Southwest Biological Science Center
Tucson, Arizona

Monica L. McTeague
Northern Arizona University
Flagstaff, Arizona

Lindsay Ogden
Arctic Slope Regional Corporation Management Services
Fort Collins, Colorado

M. Lisa Floyd
Prescott College
Prescott, Arizona

Keith Schulz
NatureServe
Boulder, Colorado

Beverly Friesen
U.S. Geological Survey
Rocky Mountain Geographic Science Center
Denver, Colorado

Tammy Fancher
Robert Waltermire
U.S. Geological Survey
Fort Collins Science Center
Denver, Colorado

Anne Cully
National Park Service
Southern Colorado Plateau Network
Northern Arizona University
PO Box 5765
Flagstaff, Arizona

Project Coordinators
Anne Cully and Monica L. McTeague

Editing and Design
Alice Wondrak Biel
National Park Service
Inventory & Monitoring Program
Intermountain Region
Denver, Colorado

May 2009

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado





The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics 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 high-priority, current natural resource management information with managerial application. The series targets a general, diverse audience, and may contain NPS policy considerations or address sensitive issues of management applicability.

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 are those of the author(s) and 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 National Park Service.

This report is available from the Southern Colorado Plateau Network website, http://www.nature.nps.gov/im/units/SCPN, as well as at the Natural Resource Publications Management web site, http://www.nature.nps.gov/publications/NRPM, and the USGS-NPS Vegetation Characterization Program website, http://biology.usgs.gov/npsveg.

Please cite this publication as:

Thomas, K. A., M. L. McTeague, L. Ogden, M. L. Floyd, K. Schulz, B. Friesen, T. Fancher, R. Waltermire, and A. Cully. 2009. Vegetation classification and distribution mapping report: Mesa Verde National Park. Natural Resource Report NPS/SCPN/NRR—2009/112. National Park Service, Fort Collins, Colorado.

NPS 100020, May 2009

Contents

Figures v
Tables vii
Acronyms and Abbreviations ix
Executive Summary xi
Acknowledgements xiii

Chapter 1: Introduction 1
1.1 Background 1
1.2 Scope and Products 1
1.3 The USGS-NPS Vegetation Mapping Program 2
1.4 The National Vegetation Classification Standard 2
1.5 Park Environment 5
1.5.1 Park establishment 5
1.5.2 Pre-park history 5
1.5.3 Climate 5
1.5.4 Geology, hydrology, and topography 8
1.5.5 Wildlife 8
1.5.6 Vegetation 9

Chapter 2: Identification and Classification of Plant Communities 11
2.1 Methods 11
2.1.1 Relevé data 11
2.1.2 Photointerpreter observations 15
2.1.3 NVC nomenclature 16
2.2 Results 16
2.2.1 Field documentation for plant communities 16
2.2.2 Plant community characteristics 17
2.3 Discussion 17

Chapter 3: Base Map Class Development 23
3.1 Methods 23
3.1.1 Overview 23
3.1.2 Base data and imagery 23
3.1.3 Modeling polygons 25
3.1.4 Base map class labels 26
3.2 Results 27
3.3 Discussion 27

Chapter 4: Accuracy Assessment and Additional Map Classes 33
4.1 Methods 33
4.1.1 Field sampling design 33
4.1.2 Field data collection 34
4.1.3 Field data processing and accuracy assessment statistics 35
4.1.4 Group and management map classes 36
4.2 Results 36
4.2.1 Accuracy assessment samples 36
4.2.2 Base map class accuracy and summary statistics 36
4.2.3 Group map class accuracy and summary statistics 44
4.2.4 Management map class accuracy and summary statistics 49
4.3 Discussion 49
4.3.1 Challenges 49
4.3.2 Uses and limitations of the vegetation map database and affiliated products 49

Chapter 5: Literature Cited.....55
Glossary.....59
Appendix A: List of Project Products.....69
Appendix B: Relevé Numbers.....71
Appendix C: Global and Local Plant Community Descriptions.....79
Appendix D: Plant Species List.....219
Appendix E: Plant Community and Map Class Key.....227
Appendix F: Plant Community and Map Class Crosswalk.....241
Appendix G: Map Class Summaries.....245
Appendix H: Accuracy Assessment Data.....327

Figures

Figure 1.5-1. Mesa Verde National Park, the project environs, and surrounding land owners. 6
Figure 1.5-2. Geographic places within Mesa Verde National Park. 7
Figure 2.1.1.3-1. Non-metric multi-dimensional scaling (NMS) ordination of 147 classification relevés collected in 2004. 13
Figure 2.1.1.3-2. Cluster analysis of relevés produces a dendrogram that separates relevés by information content. 14
Figure 2.1.1.3-3. The number of significant indicators and the p-value for indicator species analysis scores, calculated for each level of the cluster dendrogram and plotted against the number of clusters in the dendrogram for that level. 15
Figure 2.2.1. Locations of 147 classification relevés measured in 2004 and used to quantify 34 plant communities at Mesa Verde National Park. 16
Figure 3.1.2.1. Flight lines and photo centers for true-color aerial photography acquired for the Mesa Verde National Park vegetation mapping project. 24
Figure 3.1.3.2. Mesa Verde National Park DOQQs were divided into three sections to develop map units. 25
Figure 3.1.4.1. Location of photointerpretation observation sites visited in late 2004. 26
Figure 3.2. Base map classes. 29
Figure 4.2.1. Location of accuracy assessment sites observed in 2006 37
Figure 4.2.2.2-1. Gambel Oak Shrubland (base map class 31) 42
Figure 4.2.2.2-2. Mixed Montane Shrubland (base map class 33) 42
Figure 4.2.2.2-3. Gambel Oak - Mixed Montane Shrubland (base map class 30) 42
Figure 4.2.2.2-4. Colorado Pinyon - Utah Juniper / Mixed Montane Shrub Woodland (base map class 14). 42
Figure 4.2.2.2-5. Post-Fire Mixed Herbaceous Vegetation (base map class 42) 43
Figure 4.2.2.2-6. Colorado Pinyon - Utah Juniper / Bitterbrush / Muttongrass Woodland (base map class 9) 43
Figure 4.2.2.2-7. Colorado Pinyon - Utah Juniper / Gambel Oak Woodland (base map class 12). 43
Figure 4.2.3.1. Group map classes. 45
Figure 4.2.4.1. Management map classes. 50

Tables

Table 1.2. Terminology used to describe vegetation and map classes in Mesa Verde National Park..... 1
Table 1.4. The National Vegetation Classification Standard, version 2, with definitions and examples. 4
Table 2.1.1.2. Summary of data collected within 2004 classification relevés. 12
Table 2.2. Plant communities at Mesa Verde National Park, and source of supporting field documentation. 19
Table 3.2-1. Base map classes at Mesa Verde NP and the plant communities they represent. 30
Table 3.2-2. Base map classes at Mesa Verde NP occurring in polygons smaller than the MMU size. 32
Table 4.1.1. Sampling design scenarios to determine target number of field accuracy assessment observation sites. 34
Table 4.1.2. Summary of data collected within accuracy assessment observation sites, 2006. 35
Table 4.2.2.1-1. Base map class accuracy statistics. 38
Table 4.2.2.2. Base map class summary statistics. 40
Table 4.2.3.1-1. Crosswalk of group map classes and base map classes. 46
Table 4.2.3.1-2. Group map class accuracy statistics. 47
Table 4.2.3.2. Group map class summary statistics. 48
Table 4.2.4.1-1. Crosswalk of management map classes and base map classes. 51
Table 4.2.4.1-2. Management map class accuracy statistics. 52
Table 4.2.4.2. Management map class summary statistics. 53
Table A. Mesa Verde National Park data products. 69
Table B. Plot numbers documenting plant communities at Mesa Verde National Park. 72
Table H1. Contingency table: Base map classes. 328
Table H2. Contingency table: Group map classes. 331
Table H3. Contingency table: Management map classes. 332

Acronyms and Abbreviations

AA	accuracy assessment
ac	acres
APFO	Aerial Photography Field Office
BLM	U.S. Bureau of Land Management
BOR	U.S. Bureau of Reclamation
CEGL	community element code–global
CI	confidence interval
CIR	color infrared
cm	centimeter
DEM	digital elevation model
DOQQ	digital orthophoto quarter quadrangle
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
FORT	USGS Fort Collins Science Center
ft	foot/feet
GIS	geographic information system
GPS	global positioning system
ha	hectares
I&M	Inventory and Monitoring Program
in	inch
ISA	indicator species analysis
ITIS	Integrated Taxonomic Information System
km	kilometer
m	meters
MEVE	Mesa Verde National Park
.mdb	Microsoft Access file format
mi	miles
MMU	minimum mapping unit
n.d.	no date
NA	not applicable
NAD83	North American datum of 1983
NAU	Northern Arizona University
NMS	Non-metric multi-dimensional scaling
NPS	National Park Service
NS	not sampled
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
.pdf	Adobe portable document format
RMGSC	USGS Rocky Mountain Geographic Science Center
SBSC	USGS Southwest Biological Science Center
SCPN	Southern Colorado Plateau Network
spp.	species (plural)
TNC	The Nature Conservancy
UNESCO	United Nations Education, Science, and Cultural Organization
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UTM	Universal Transverse Mercator
.xls	Microsoft Excel file format

Executive Summary

The classification and distribution mapping of the vegetation of Mesa Verde National Park (MEVE) and surrounding environment was achieved through a multi-agency effort between 2004 and 2007. The National Park Service's Southern Colorado Plateau Network facilitated the team that conducted the work, which comprised the U.S. Geological Survey's Southwest Biological Science Center, Fort Collins Research Center, and Rocky Mountain Geographic Science Center; Northern Arizona University; Prescott College; and NatureServe.

The project team described 47 plant communities for MEVE, 34 of which were described from quantitative classification based on field-relevé data collected in 1993 and 2004. The team derived 13 additional plant communities from field observations during the photointerpretation phase of the project. The National Vegetation Classification Standard served as a framework for classifying these plant communities to the alliance and association level. Eleven of the 47 plant communities were classified as "park specials;" that is, plant communities with insufficient data to describe them as new alliances or associations.

The project team also developed a spatial vegetation map database representing MEVE, with three different map-class schemas: base, group, and management map classes. The base map classes represent the finest level of spatial detail. Initial polygons were developed using Definiens Professional (at the time of our use, this software was called eCognition), assisted by interpretation of 1:12,000 true-color digital orthophoto quarter quadrangles (DOQQs). These polygons (base map classes) were labeled using manual photo interpretation of the DOQQs and 1:12,000 true-color aerial photography. Field visits verified interpretation concepts.

The vegetation map database includes 46 base map classes, which consist of associations, alliances, and park specials classified with quantitative analysis, additional associations and park specials noted during photointerpretation, and non-vegetated land cover, such as infrastructure, land use, and geological land cover. The base map classes consist of 5,007 polygons in the project area. A field-based accuracy assessment of the base map classes showed overall accuracy to be 43.5%. Seven map classes comprise 89.1% of the park vegetated land cover.

The group map classes represent aggregations of the base map classes, approximating the group level of the National Vegetation Classification Standard, version 2 (Federal Geographic Data Committee 2007), and reflecting physiognomy and floristics. Terrestrial ecological systems, as described by NatureServe (Comer et al. 2003), were used as the first approximation of the group level. The project team identified 14 group map classes for this project. The overall accuracy of the group map classes was determined using the same accuracy assessment data as for the base map classes. The overall accuracy of the group representation of vegetation was 80.3%.

In consultation with park staff, the team developed management map classes, consisting of park-defined groupings of base map classes intended to represent a balance between maintaining required accuracy and providing a focus on vegetation of particular interest or import to park managers. The 23 management map classes had an overall accuracy of 73.3%.

While the main products of this project are the vegetation classification and the vegetation map database, a number of ancillary digital geographic information system and database products were also produced that can be used independently or to augment the main products. These products include shapefiles of the locations of field-collected data and relational databases of field-collected data.

Acknowledgements

Behind the authors of this report are the U.S. Geological Survey (USGS), National Park Service (NPS), Northern Arizona University (NAU), and Prescott College affiliates that were responsible for much of the project's execution. The project team thanks the Prescott College classification field crew (Eugene Reininger, Meghan Pope, Dustin Hanna, Lani Hanna, and David Hanna) and the USGS Southwest Biological Science Center (SBSC) and NAU accuracy assessment field crew (Tina Billie, Meredith Jabis, Kelsey Johnson, Meghan Pope, Patty Guertin, and Bob Beatson, led by Jessa Fischer) for their hard work in the field. Steve Blauer, Keith Landgraff, and Buck Cully assisted the USGS Rocky Mountain Geographic Science Center with field reconnaissance. Jonathan Donaldson, Lakhbir Kaur, and Stacy McKnight at NAU provided data entry and quality control. Jonathan Donaldson and Rob Hunt provided important background research for the plant community descriptions and for the background information on Mesa Verde National Park, respectively. Terry Arundel and Jered Hansen provided technical support to the SBSC, and Hannah Moyer, of Arctic Slope Regional Corporation Management Services, provided technical support to the Fort Collins Science Center. Patty Guertin provided invaluable support during the compilation and publishing of the final products.

Logistical and administrative support was provided by Mark Sogge, Linda Lasley, John D. Kite, and Wendy Parrish of the SBSC; Marie Saul and Cindy Judge of NAU; and Leslie Holland-Bartels and Carl Markon of the USGS Alaska Science Center. We particularly thank the staff of the Alaska Science Center for housing and providing operational support for Monica McTeague during the last part of the project.

Marilyn Colyer, George San Miguel, and Allan Loy at Mesa Verde National Park provided housing, critical logistical support, and guidance to the project. The NPS Southern Colorado Plateau Network, through coordinator Lisa Thomas, provided funding support; information technology specialist Nicole Tancreto helped with database development and spatial data acquisition. Tom Forsyth and Lynelle Wright at the NPS Intermountain Region assisted with contract development. From the USGS-NPS Vegetation Mapping Program national office, the entire project team received critical financial and programmatic support from Karl Brown, Tammy Hamer, Chris Lea, and Mike Story.

Allan Bell, of the U.S. Bureau of Reclamation, assisted with acquisition of digital orthophoto quadrangle imagery. Cindy Sessions, of the U.S. Department of Agriculture's Aerial Photography Field Office, assisted with the acquisition of aerial photography for the project.

A number of landowners and agencies provided us access to some sites in the park and within the project boundaries. This included permission from the U.S. Bureau of Land Management, with assistance from Steven Beverliln, the Montezuma County Landfill, with support from Deborah Barton, the Mesa Verde Foundation, with help from Jim Dyer, and several private landowners.

The project also benefited from the critical review of the report and digital products by Janet Coles, of the Northern Colorado Plateau Network, and Sarah Studd, of the Sonoran Desert Network. Emily Sherbrook and Ron Kirby, both of the U.S. Geological Survey, and Jodi Norris, Allison Snyder, and Alice Wondrak Biel, of the Southern Colorado Plateau Network, provided additional reviews.

We are extremely grateful for the help, advice, and assistance that all these people and their respective institutions provided the project.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Chapter 1
Introduction

1.1 Background

Vegetation is a primary resource of natural areas, and description of vegetation composition, structure, and distribution is fundamental to effective land management. The term "vegetation" encompasses plants at multiple scales, from the most refined floristic levels (referred to as "plant communities" in this report) to the broadest physiognomic, or life-form levels. This report describes the methods and results of a three-year project (2004–2007) to classify, describe, and develop a vegetation map database for Mesa Verde National Park.

The National Park Service's (NPS) Southern Colorado Plateau Network (SCPN), part of the servicewide Inventory and Monitoring (I&M) Program, organized and coordinated vegetation classification, description, and mapping at Mesa Verde National Park (MEVE). For MEVE as well as its other 18 network parks, the SCPN needed baseline vegetation data upon which to develop and implement specific monitoring programs, and park managers needed baseline data and information on park resources for management purposes.

In addition to the NPS, the project team included the U.S. Geological Survey's (USGS) Southwest Biological Science Center (SBSC), Fort Collins Science Center (FORT), and Rocky Mountain Geographic Science Center (RMGSC); Northern Arizona University (NAU); Prescott College; and NatureServe. Arctic Slope Regional Corporation Management Services provided contractor services to FORT. The USGS-NPS Vegetation Mapping Program partially funded the project, and the project team used the Vegetation Mapping Program's programmatic standards.

1.2 Scope and Products

The scope of this project was Mesa Verde National Park and its environs, consisting of an approximately 1-km buffer around the park boundaries and some additional areas of interest to park resource staff in the northern section. The total project area was 31,068 ha (76,778 ac); lands within the park boundary comprised 21,648 ha (53,494 ac), or 70% of the project area.

A major component of the project was identification and classification of plant communities, based on field-collected vegetation data and, to a lesser extent, observations made during fieldwork conducted in association with photointerpretation. The first step for the project team was to identify and quantitatively describe plant communities using the National Vegetation Classification Standard (NVCS) as a classification framework. Plant communities refer to the finest floristic levels of the NVCS (associations and alliances) and to park specials (i.e., plant communities with insufficient data to describe them as new alliances or associations) for some stands (Table 1.2).

Second, the team created a spatial database (the vegetation map database) depicting the park's vegetation and land cover. The vegetation map database represents three map-class schemas (Table 1.2):

Table 1.2. Terminology used to describe vegetation and map classes in Mesa Verde National Park.

Terminology	Origin	Derivation
Plant communities	Associations, alliances, and park specials	Field relevés or observations
Base map class	Individual plant communities or groupings of plant communities	Photointerpretation
Group map class	Groupings of base map classes reflecting physiognomy and floristics	Based on ecological systems
Management map class	Groupings of base map classes reflecting management interests	Park defined

- the "base" map class, the finest level of floristic detail that could be mapped,
- the "group" map class, a physiognomic-floristic view of the vegetation, and
- the "management" map class, park-defined groupings of base map classes intended to represent a balance between maintaining required accuracy and providing a focus on vegetation of particular interest or import to park managers.

Finally, each map-class schema was assessed for accuracy. The base map classes and group map classes were not changed. The management map classes were refined somewhat following a meeting with park resource staff.

This report and appendices includes the results, methods, and findings for the Mesa Verde National Park project. The project has also produced a number of interrelated products, available on a DVD that accompanies the hard-copy version of this report or on the USGS-NPS Vegetation Mapping Program web site, http://biology.usgs.gov/npsveg/. A full listing of project products, their availability, file name, and format appears in Appendix A.

1.3 The USGS-NPS Vegetation Mapping Program

The USGS-NPS Vegetation Mapping Program is a cooperative project between the USGS and the NPS to classify, describe, and map vegetation in more than 270 national park units within the United States.* The USGS Center for Biological Informatics administers the program, in cooperation with the NPS Inventory & Monitoring Program. Through implementation of the NPS Natural Resource Challenge (NPS 1999), significant funding became available for completing important natural resource baseline inventories in park units, including vegetation classification and mapping. This support provided the NPS the opportunity to move forward with dozens of new park-unit vegetation classification and mapping projects.

The Vegetation Mapping Program supports consistent vegetation classification, mapping, and accuracy assessment protocols and standards across all park-mapping projects. The program has established guidance for all vegetation-mapping projects in four documents:

- Standardized National Vegetation System (TNC and ESRI 1994a)
- Methodology for Assessing the Utility of Existing Data for Vegetation Mapping (TNC and ESRI 1996)
- Field Methods for Vegetation Mapping (TNC and ESRI 1994b)
- Accuracy Assessment Procedures (ESRI et al. 1994)

In addition, the program has defined national standards for all park vegetation classification and mapping projects:

- Vegetation classification follows the Federal Geographic Data Committee (FGDC) standard for vegetation classification, the National Vegetation Classification Standard.
- Spatial data formatting follows the FGDC standards for spatial data transfer.
- Metadata for each spatial dataset uses the FGDC metadata standard.
- Spatial data is provided with a horizontal positional accuracy that meets National Map Accuracy Standards at the 1:24,000 scale; each well-defined object within the spatial database is within 1/50 of an inch display scale or 12.2 m (40 ft) of its actual location.
- All plant names used in the classification are consistent with the Integrated Taxonomic Information System (ITIS).
- Each vegetated map class will meet or exceed 80% accuracy at the 90% confidence level.
- The minimum mapping unit (MMU) is 0.5 ha (1.24 ac).

1.4 The National Vegetation Classification Standard

Patterns of vegetation vary continuously over landscapes. Classification systems attempt to categorize those patterns by identifying and describing assemblages of plants that repeat in similar habitats. The NVCS provides a classification

*Language for the sections on the USGS-NPS Vegetation Mapping Program, National Vegetation Classification Standard, and Federal Geographic Data Committee was modified from von Loh and others (2006).

framework that is used in all NPS vegetation mapping projects (Comer et al. 2003, TNC and ESRI 1994a). In 1997, the FGDC formally adopted the NVCS version 1 (FGDC 1997). During the course of this project, version 2 of the NVCS (FGDC 2008) was approved. An additional distinction is that the NVCS refers to the framework and rules of classification, and is not the same as the National Vegetation Classification (NVC), described below.

The NVCS evolved from vegetation classification primarily conducted over more than two decades by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network (Grossman et al. 1998). It derives in part from earlier vegetation classification produced by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Use of this standardized classification system helps ensure data compatibility throughout the NPS and other agencies.

The NVCS is a hierarchical system that allows vegetation classification to occur at multiple scales. In version 1, there are seven levels, the upper five based on the physiognomic characteristics of vegetation, and the lower two based on the floristic characteristics of the plant community.

Version 2 (FGDC 2008) has eight levels (Table 1.4). The upper three levels (which are a reorganization of the five upper physiognomic levels from Version 1) indicate physiognomic characteristics that reflect geographically widespread (global) topographic and edaphic factors. The middle three levels, which are new to the NVCS hierarchy, focus on largely biogeographic and habitat factors along very broad, regional-to-continental topographic, edaphic, and disturbance gradients. The lower two levels, the alliance and association, are used in park mapping and are the same in the first and second versions.

The NVCS provides a framework for levels of classification but does not provide descriptions of vegetation types at all levels. The classification maintained by NatureServe and used by many federal agencies, including the NPS, is the NVC. The NVC includes the plant communities (associations and alliances) defined for the U.S. Work, conducted primarily by TNC through 1999, provided initial definitions of plant communities at each level; NatureServe inherited that documentation when it branched from TNC. NatureServe manages a database of all NVC plant communities. Their online database, NatureServe Explorer (http://www.natureserve.org/explorer/), provides public access to regularly updated versions of the NVC plant community listings and descriptions. NatureServe's documentation of alliances and associations is the most accessible national listing currently available. However, the plant communities within the NVC are not complete, and projects such as the one described in this report constantly add to the documentation and listing of NVC types.

Alliances and associations are based on both the dominant (greatest-canopy-cover) species in the upper strata of a stand and on diagnostic species (those consistently found in some land-cover types but not others). Associations are the most specific classification, and are hierarchically subsumed in alliances. Typically, each association is included in only one alliance, while each alliance may include many associations. Alliance names are generally based on the dominant/diagnostic species in the uppermost stratum of the vegetation, though up to four species may be used if necessary to define the type. Associations define distinct plant compositions that repeat across the landscape, and are generally named using both the dominant species in the uppermost stratum of the vegetation and one or more dominant species in lower strata (or a diagnostic species in any stratum). Documentation from NatureServe (2005) describes the naming conventions and syntax for all NVC names:

- A hyphen with a space on either side (-) separates names of species occurring in the same stratum.
- A slash with a space on either side (/) separates names of species occurring in different strata.
- Species that occur in the uppermost stratum are listed first, followed successively by those in lower strata.
- Order of species names generally reflects decreasing levels of dominance, constancy, or indicator value.
- Parentheses around a species name indicates the species is less consistently found either in all associations of an alliance, or in all occurrences of an association.
- Association names include the dominant species of the significant strata, followed by the class in which they are classified (e.g.,

Forest, Woodland, or Herbaceous).

- Alliance names also include the class in which they are classified (e.g., Forest, Woodland, or Herbaceous), but are followed by the word "Alliance" to distinguish them from associations.

The species nomenclature for all alliances and associations follows Kartesz (1999). Examples of association names from MEVE:

- *Artemisia nova* / *Hesperostipa comata* Shrubland
- *Eriogonum corymbosum* Badlands Sparse Vegetation

Examples of alliance names from MEVE:

- *Pinus ponderosa* Woodland Alliance
- *Amelanchier utahensis* Shrubland Alliance

For more information on the NVC, see the USGS-NPS Vegetation Mapping Program standards (http://biology.usgs.gov/npsveg/standards.html) or Grossman et al. (1998).

In addition to the NVC, NatureServe has created a standardized Ecological Systems Classification for describing sites, based on both vegetation and the ecological processes that drive it. Ecological systems are mid-scale biological communities that

Table 1.4. The National Vegetation Classification Standard, version 2, with definitions and examples.

Level	Level name	Primary basis for classification	Example
Upper level 1	Formation class	Defined by broad combinations of dominant general growth forms adapted to basic moisture, temperature, and/or substrate or aquatic conditions.	Shrubland and grassland
Upper level 2	Formation subclass	Defined by 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 or aquatic conditions.	Temperate and boreal shrubland and grassland
Upper level 3	Formation	Defined by combinations of dominant and diagnostic growth forms that reflect global macroclimatic conditions as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	Temperate shrubland and grassland
Mid-level 4	Division	Defined by combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	North American great plains grassland and shrubland
Mid-level 5	Macrogroup	Defined by combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental-to-regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Great Plans tall grassland and shrubland
Mid-level 6	Group	Defined by combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	Great Plans mesic tallgrass prairie
Lower level 7	Alliance	Defined by characteristic range of species composition, habitat conditions, physiognomy, and diagnostic species, typically at least one of which is found in the uppermost or dominant stratum of the vegetation. They reflect regional-to-subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	Wet-mesic tallgrass prairie
Lower level 8	Association	Defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy. They reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.	Central wet-mesic tallgrass prairie

Adopted from Federal Geographic Data Committee (2008)

occur in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. They are not conceptually a unit within the NVCS but are rather a vegetation mapping concept. However, NVC associations occur within ecological systems. An association may occur in any number of ecological systems, limited only by the range of ecological settings in which that association occurs. Ecological systems are broad-scale, and can embody any number of highly specific associations that might be found in a particular setting.

1.5 Park Environment

Mesa Verde National Park is part of the plateau country of southwestern Colorado, and is located between the towns of Cortez and Mancos. The Ute Mountain Tribal Park borders the park on the south and southwest, and Ute Mountain Ute tribal lands border MEVE on the west (Figure 1.5-1).

The park's Far View Visitor Center is about 24 km (15 mi) from the park entrance at U.S. Highway 160 (Figure 1.5-2). Approximately halfway to the visitor center is Park Point Lookout, with a fire lookout and a spectacular view of the Four Corners region. Two winding roads lead from Far View: one to Wetherill Mesa, and the other to Chapin Mesa. Three of the park's major cliff structures are located at Chapin Mesa, along with an archeological museum. Numerous overlooks along the roads allow visitors to view most of the major structures.

1.5.1 Park establishment

European travelers and American settlers wrote of the extensive structures of prehistoric habitation found within what is now Mesa Verde National Park beginning in the 19th century. A team headed by William Henry Jackson, who photographed some of these sites in 1874, made the first organized exploration (Wenger 1980). Organized tourism and artifact gathering began under the guidance of a local ranching family, the Wetherills, in the 1890s (Lamb 2001). Among the occasional tourists was a young Swede by the name of Gustaf Nordenskiöld, who took numerous photographs during his explorations and eventually produced the first book about the sites, *The Cliff Dwellers of the Mesa Verde* (Nordenskiöld 1979).

As visitation to the prehistoric structures increased, so did impacts, such as vandalism, souvenir hunting, and trash accumulation. Increasing wear and tear on the sites spurred a local preservation effort that eventually led to the establishment of a national park in 1906. Along with the designation came stricter rules to preserve the structures and habitats of MEVE. UNESCO selected the park as a World Heritage Cultural Site in 1978.

1.5.2 Pre-park history

There is little evidence of human activity in the immediate vicinity of MEVE prior to the arrival of people called the Basketmakers around 1 A.D. (Wenger 1980). They did not live within what is now Mesa Verde National Park. Ancestral Pueblo people from the Four Corners area first settled MEVE in approximately 750 A.D., and lived and flourished in the canyons until approximately 1300 A.D. (Flint-Lacey 2003, Wenger 1980). They built elaborate, stone-walled communities in alcoves within canyons and atop the mesas. There were approximately 600 cliff dwellings and 3,900 archeological sites documented in the park as of 1980 (Wenger 1980).

By around 1270, Ancestral Pueblo cliff dwellers dispersed from the settlements for reasons that remain sources of speculation among archeologists, but may have included an extended period of drought (Lamb 2001). Within a century, a hunter-gatherer group, the Utes, moved into and settled the region.

Spanish explorers, accompanied by miners and missionaries, arrived in the area from the Rio Grande Valley by 1760, and reported the structures in their dispatches. Americans hunters and trappers began entering the area by the early 1800s, and prospectors arrived by the late 1850s. Mining activity in the nearby San Juan Mountains was ongoing by the 1870s, and trains and towns were established during the 1880s. Ranches spread out across the region, while farming was concentrated in the river valleys. By 1889, domestic grazing reached MEVE, but was phased out starting around 1930.

1.5.3 Climate

The climate of the Mesa Verde region is semi-arid, although MEVE itself has a relatively mild climate compared to its surroundings (Doesken and McKee 2003). This is due to the park's topography and elevation of well over 1.6 km (1 mile). The park landscape is roughly bowl-shaped and tilted toward the south, an aspect that makes for

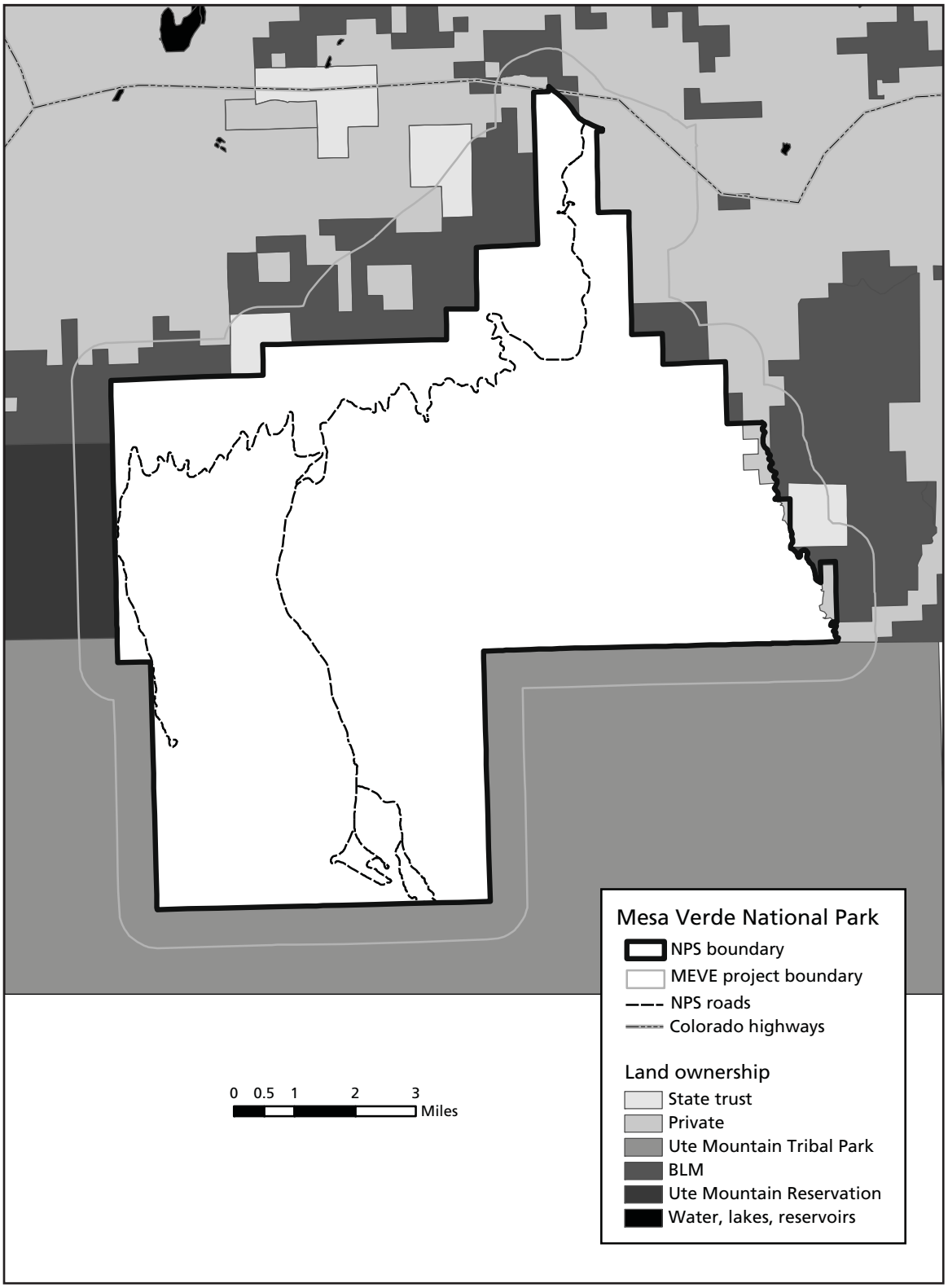


Figure 1.5-1. Mesa Verde National Park, the project environs, and surrounding land owners.

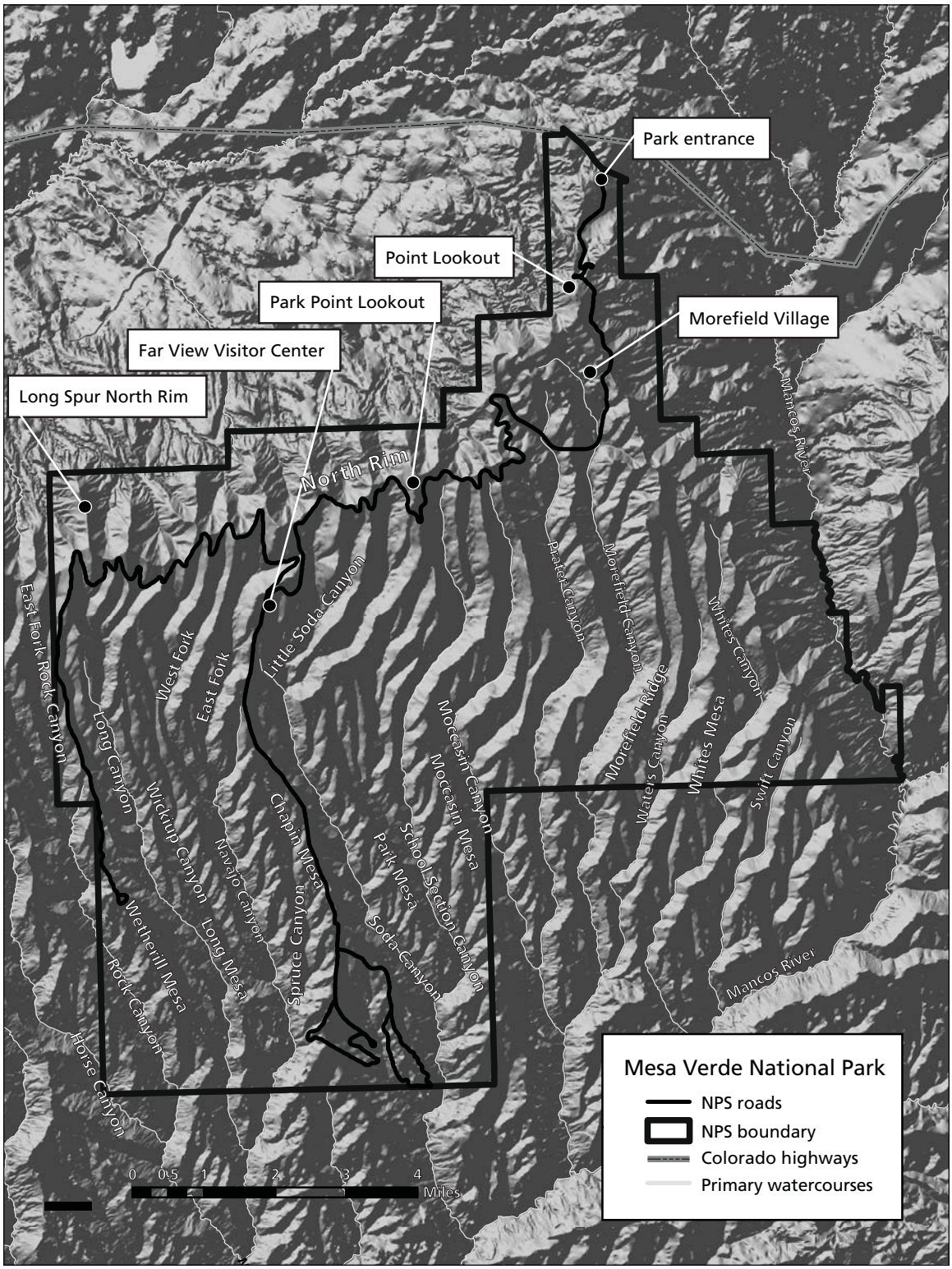


Figure 1.5-2. Geographic places within Mesa Verde National Park.

milder winters than are typical of that elevation and latitude. The park's elevation also protects it from the summer heat of the surrounding valleys. The frost-free growing season averages between 161 and 171 days (Wenger 1980). January is the coldest month, July the warmest.

Rains are generally dependable and bimodal in their annual distribution, although some rain can fall in any month. Average annual precipitation totals 45.2 cm (17.81 in) as measured near the headquarters on Chapin Mesa (http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?comesa). Large, cyclonic fronts deliver winter rains that originate in the Pacific Ocean. The rains and snows of winter help recharge the groundwater. June is the driest month and presages the arrival of the summer rainy season, when moisture pumps into the region from the south and southeast. The combination of heat and orographic uplift create towering thunderstorms that can produce heavy rains and brief flash floods. The summer rainy season lasts from early July until early September, although rains can continue through the fall and into winter.

1.5.4 Geology, hydrology, and topography

Mesa Verde National Park is a cuesta—a tilted, bowl-shaped mesa (monocline) dissected by numerous canyons that empty into the Mancos River (Gilliam 2003). Elevations range from approximately 1,829 m (6,000 ft) to 2,613 m (8,572 ft) at the highest point, Park Point Lookout. Many of the larger alcoves in the canyons are located where an impermeable layer of shale meets the Cliff House sandstone (Griffiths 1990). This contact, and the water flow along it, weaken the sandstone through chemical and mechanical erosion. Otherwise, there are no perennial streams within the mesa, and ephemeral flow down the canyons generally occurs only during storms or snowmelt. There are numerous springs and seeps, particularly within some of the alcoves.

The oldest exposed rock formation within the park is the Mancos Shale, with exposures near the park entrance (Griffiths 1990). Lying atop the Mancos shale is the dominant formation exposed within the park, the Mesa Verde Group. This geological unit consists of three members: the Point Lookout Sandstone, the Menefee Formation, and the Cliff House Formation. The Point Lookout Sandstone, derived from ancient Cretaceous seabeds, lies immediately on top of the Mancos Shale. This sandstone also occurs near the park entrance. The Menefee Formation originated as ancient floodplains, contains coal beds, and is exposed in canyon walls. The Cliff House Formation is the youngest member of the Mesa Verde Group. It erodes into the alcoves that hold many of the park's cliff dwellings.

During the mid-Tertiary, mountains were uplifted in the region and granites emplaced. Beginning 32 million years ago, the San Juan Mountains to the northeast were uplifted, eroded flat, and then uplifted again. This was a period of massive igneous activity with volcanism and granitic intrusions. Many of the mountains in the area are composed of these exposed-granite intrusions. Small dikes are the only evidence of volcanism at MEVE. It was during one of the uplifts in the Quaternary Period that the Mesa Verde region raised and tilted. The tilt, toward the south, increased erosion over the past two million years and was the genesis for the canyons in the park.

There are three major types of soil within MEVE (Ramsey 2003). Throughout much of the park, the soil is a rich loam containing red loess. This windblown loess accumulated at various intervals during the past 100,000 years. Canyon-bottom soils are generally a sandy loam. They are deep and coarse-textured. Colluvial deposits are found on slopes, with a sparse cover on upper slopes that deepens on lower slopes.

1.5.5 Wildlife

Mesa Verde National Park provides habitat for a diverse assemblage of mammals, avifauna, and herpetofauna.*

1.5.5.1 Mammals

Odocoileus hemionus (mule deer) are common in the piñon-juniper woodlands and open sagebrush of MEVE. Other large mammals include *Ursus americanus* (black bear), *Puma concolor* (mountain lion), *Lynx rufus* (bobcat), *Canis latrans* (coyote), *Urocyon cinereoargenteus* (gray fox), *Erethizon dorsatum* (porcupine), and *Mephitis mephitis* (striped skunk). Among the numerous small mammal species are *Peromyscus maniculatus* (deer mice), which help spread the seeds of both piñon and juniper trees. Other small mammals include the midden-building *Neotoma*

*Information used for this section is taken from Chung-MacCoubrey and Bogan; Hanna and Graham; San Miguel and Colyer; and Sommers, Hanna, and Colyer *in* Floyd (2003).

mexicana (Mexican woodrat), *Neotoma cinerea* (bushy-tailed woodrat), *Peromyscus boylii* (brush mouse), *Peromyscus truei* (piñon mouse), *Spermophilus variegatus* (rock squirrel), *Thomomys talpoides* (northern pocket gopher), *Tamias minimus* (least chipmunk), *Sylvilagus nuttalii* (Nuttal's cottontail), *Sylvilagus audubonii* (Audubon's cottontail), and *Lepus californicus* (black-tailed jackrabbit). The more common bat species include *Myotis evotis* (long-eared myotis), *Myotis volans* (long-legged myotis), and *Corynorhinus townsendii* (Townsend's big-eared bat).

1.5.5.2 Avifauna

Year-round resident species that make their homes on Mesa Verde include the raptors *Accipter gentilis* (northern goshawk), *Buteo jamaicensis* (red-tailed hawk), *Aquila chrysaetos* (golden eagle), and *Strix occidentalis lucida* (Mexican spotted owl). *Meleagris gallopavo* (wild turkey) roam the slopes and meadows. Birds whose life histories are to varying degrees tied to the piñon tree include *Gymnorhinus cyanocephalus* (piñon jay) and *Aphelocoma californica* (western scrub jay). Other year-round residents include *Picoides villosus* (hairy woodpecker), *Colaptes auratus* (northern flicker), *Cyanocitta stelleri* (Steller's jay), *Poecile atricapillus* (mountain chickadee), *Psaltriparus minimus* (bushtit), *Sitta carolinensis* (white-breasted nuthatch), *Catherpes mexicanus* (canyon wren), *Sialia mexicana* (western bluebird), and *Pipilo maculates* (spotted towhee).

Birds that migrate into the park to breed during the spring and summer include *Cathartes aura* (turkey vulture), *Falco peregrinus* (peregrine falcon), *Archilochus alexandri* (black-chinned hummingbird), *Selasphorus platycercus* (broad-tailed hummingbird), *Myiarchus cinerascens* (ash-throated flycatcher), and *Sialia currucoides* (mountain bluebird). Other summer visitors are *Contopus sordidulus* (western wood pewee), *Turdus migratorius* (American robin), *Vireo plumbeus* (plumbeous vireo), *Piranga ludoviciana* (western tanager), *Spizella passerine* (chipping sparrow), and *Carduelis psaltria* (lesser goldfinch). Migrants that generally are just passing through the park include *Columba fasciata* (band-tailed pigeon), *Selasphorus rufus* (rufous hummingbird), *Sitta pygmaea* (pygmy nuthatch), *Regulus calendula* (ruby-crowned kinglet), and *Zonotrichia leocophrys* (white-crowned sparrow).

1.5.5.3 Reptiles and amphibians

The herpetofauna of MEVE are not as well known as other groups of animals (Hanna and Graham 2003). The park has conducted some inventories, but there is still more to be learned. *Bufo punctatus* (red-spotted toad) and *Bufo woodhousii* (Woodhouse's toad) are the most common toads in the piñon-juniper woodlands. Both occur near rock formations that can absorb heat, and both breed in temporary pools found in or near canyons. They bury themselves in woodland litter to avoid drying. Thirteen species of lizard occur in the piñon-juniper woodland. *Sceloporus undulatus* (plateau lizard) and *S. graciosus* (sagebrush lizard), which live in piñon trees, are the two most common species. Other species include *Urosaurus ornatus* (tree lizard), *Phrynosoma hernandesi* (short-horned lizard), *Uta stansburiana* (side-blotched lizard), *Crotaphytus collaris* (collared lizard), and *Cnemidophorus velos* (striped plateau whiptail). Petroglyphs and pictographs commonly depict snakes. Those most commonly encountered in the woodlands include *Crotalus viridis* (western rattlesnake), *Pituophis catenifer* (gopher snake), *Masticophis taeniatus* (striped whipsnake), and *Thamnophis elegans vagrans* (western terrestrial garter snake).

1.5.6 Vegetation

The dominant vegetation cover types of the park are piñon-juniper woodlands and shrublands. Woodlands dominated by *Pinus edulis* (Colorado piñon) and *Juniperus osteosperma* (Utah juniper) occur on nearly all of the mesas and slopes of the upper canyons. Scattered stands of old-growth piñon-juniper occur throughout the park (Floyd 2003). Common shrubland communities include *Quercus gambelii* (Gambel oak), *Symphoricarpos oreophilus* (mountain snowberry), *Fendlera rupicola* (cliff fendlerbush), and *Rhus trilobata* (skunkbush) among their dominant species. The eastern side of the park features a patchwork of piñon-juniper woodlands and shrublands.

Upper-elevation canyon habitats host stands of *Pseudotsuga menziesii* (Douglas-fir) and *Pinus ponderosa* (ponderosa pine). *Artemisia tridentata* (big sagebrush) dominates many of the canyon bottoms. It also thrives where fire has opened up the piñon-juniper canopy.

Fire is a significant factor in the recent vegetation ecology of MEVE (Floyd et al. 2003). The high terrain attracts lightning, and during the last two decades, there has been an average of eight small fires (generally a single tree or less than a few hectares) each year. Large wildfires may occur under

extreme weather conditions, such as drought or high winds. These intense crown fires, which burn large swaths of vegetation, are the natural culmination of a 400-year fire cycle (Floyd et al. 2004). What were once piñon-juniper woodlands have been replaced by shrublands dominated by species that can re-sprout after fire. In the short term, there is evidence that piñon and juniper are not returning to many of these burned sites, and that about 75 years are required for conifers to re-establish in these burns (Floyd et al. 2003). The shrublands will continue to increase in extent if the fire frequency continues at the current pace or increases.

Mesa Verde National Park has had several park-wide vegetation-mapping efforts. The first vegetation map, completed in 1930, used a USGS topographic map as a base, at a scale of 1:31,250. No information on methodology or vegetation classification exists for that vegetation map. The second vegetation-mapping effort, completed in 1967, used aerial photography with transparent, polyester-sheet overlays, and identified nine different vegetation classes (park resource management, pers. comm.). This mapping effort also has no known supporting documentation on vegetation classification or mapping procedures. In 1975, Purdue University's Laboratory for Applications of Remote Sensing produced a vegetation map using satellite imagery. In 1993, Floyd-Hanna and others (1994) classified MEVE vegetation types into 47 unique classes using Landsat Thematic Mapper satellite imagery acquired in May 1990. Some of the vegetation field data collected to support this 1993 vegetation map, especially in the unburned piñon-juniper woodlands, were used in the quantitative classification of plant communities for this project.

Many of the previous vegetation studies for MEVE were conducted to establish fire history and document post-fire vegetation recovery. The park has had several large fires in the past 20 years. Several studies have monitored vegetation-community succession within these burned areas (Adams 1991 and 1993, Floyd et al. 2000, Floyd et al. 2004). Floristic inventories of the park began as early as 1932, and have been periodically updated (Bader 1932, Welsh and Erdman 1964). Floyd et al. (2006) recently completed a study predicting the areas most susceptible to weed invasions after wildfires. Moore (2005a, 2005b) reported on inventories and status of populations of ponderosa pine (*Pinus ponderosa*) and other plant species of interest to park managers.

Researchers and park staff have published a book on Mesa Verde's old-growth piñon and juniper, including descriptions and ecological characteristics of old-growth woodlands in the park and surrounding areas, as well as analyses of potential future vegetation changes in the park and the region (Floyd 2003). This volume is an excellent summary of much that is known about important components of the park's vegetation, the processes that sustain it, and potential sources of change.

Chapter 2
Identification and Classification of Plant Communities

2.1 Methods

The classification team, consisting of ecologists M. L. Floyd and M. L. McTeague, identified and classified plant communities of Mesa Verde National Park at the finest floristic level possible. They used three approaches: (1) reanalysis of existing relevé data collected in 1993*, (2) new field-data collection, analysis, and quantitative classification, and (3) direct field observation during photointerpretation (see Chapter 3). All plant communities, whether identified through quantitative classification or direct observation, were reconciled with the current NatureServe Explorer registry of provisional NVC alliances and associations and reviewed for compatibility by K. Schulz of NatureServe. New plant-community types were classified as park specials if they were not supported by sufficient observation data to be identified to an existing alliance or association level.

2.1.1 Relevé data

2.1.1.1 Existing data

Piñon-juniper vegetation at MEVE tends to be old-growth, having developed over multiple disturbance-free centuries (Floyd et al. 2004). Because this stable vegetation type shows little floristic change over the course of a decade—barring fire or other disturbance—and Floyd-Hanna et al. (1994) had extensively sampled the park's piñon-juniper communities in 1993 to produce a vegetation map, the classification team did not feel it necessary to sample these types intensely in 2004. Thus, cover and abundance data from 69 piñon-juniper relevé samples collected in 1993 were available for use in this project. McTeague reinterpreted the 1993 vegetation-community nomenclature to concur with NVC nomenclature by using vegetation descriptions for the 1993 communities and comparing the 1993 relevés to the classification field data collected for these types in 2004.

2.1.1.2 Newly collected data

In 2004, a field team led by M. Floyd collected plant-community data in the form of cover/abundance values of individual plant species in 147 relevé plots (Mueller-Dombois and Ellenburg 2002). The sampling design stratified the park landscape into unique biophysical types for relevé allocation. The biophysical-types approach assumed that environmental variables drive vegetation patterns at MEVE, and that a stratification based on environmental variables would lead to adequate sampling across the range of plant-community variability on the ground. The biophysical types were created by layering spatial data for geology, streams, fire history, slope, and aspect in a GIS environment and identifying each unique combination as one type. The number of polygons targeted for sampling within each biophysical type was proportional to the total area and frequency of occurrence of that type within the park. The team planned to conduct field sampling at the centroid of each selected polygon. The field team did not sample any biophysical types represented by data retained from the 1993 sampling effort.

At each sample site, the field team established a 400-m^2 square relevé (or 225 m^2 in dense shrub vegetation). In addition to plant species cover/abundance, the field crew collected environmental data (Table 2.1.1.2). The classification team examined the field data iteratively during the collection period to determine if adequate numbers of relevés were sampled for each expected and observed community type. Plant communities underrepresented in the stratified sampling design were sampled opportunistically at the end of the 2004 field season.

*A relevé is a vegetation sample using a quadrant that can be square, rectangular, or even circular. Size varies according to the type of vegetation being sampled. Relevés are usually placed non-randomly in a uniform and representative sample of the vegetation being sampled. They are distinguished from line-transects and completely random sampling (Kent and Coker 1992).

Table 2.1.1.2. Summary of data collected within 2004 classification relevés.

Type of information	Items noted
Plot documentation	Plot location and identification, geographic references, plot size, picture documentation
Environmental description	Elevation, slope, aspect, position, landform, geology, soil texture
Surface cover	Fine particles, gravel, cobble, stone, boulders, bedrock; litter, duff, moss, lichen, biotic crust; animal use; human/natural disturbance
Vegetation description	Leaf phenology, leaf type, physiognomic class
Vegetation strata	Height, cover class, and dominant species (each strata)
Plant species	Observed plant species on survey site
Other vegetation characteristics	Mortality, nurse plant function, etc.

2.1.1.3 Quantitative data analysis

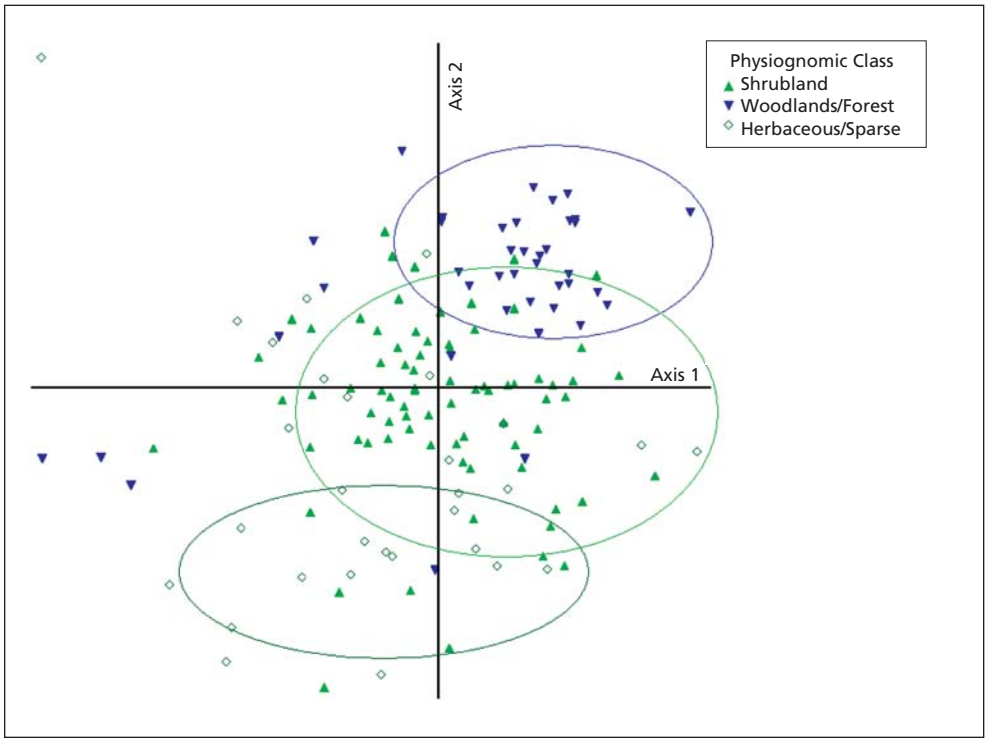
Data from the 2004 classification relevés were entered into a Microsoft Access 2000 database and quality checked. The classification team imported the data into an Excel spreadsheet and formatted it for use in PC-Ord, a multivariate statistical analysis program (McCune and Mefford 1999).

The classification team began its analysis by determining descriptive statistics on the relevé dataset and examining whether there were statistical differences in compositional heterogeneity among the physiognomic groups represented in the relevé data. The team initially used three-dimensional, non-metric multi-dimensional scaling (NMS) ordination (which provides a view of community organization in multi-dimensional space) to analyze the entire dataset of 147 relevé sites from the 2004 field efforts (Figure 2.1.1.3-1). The resulting descriptive statistics showed high beta diversity ($\beta>2$), indicating a high degree of compositional heterogeneity. The team attempted to minimize relevé heterogeneity by dividing the data into three physiognomic groups (strata): Woodlands/Forest, Shrubland, and Herbaceous/Sparse. All analyses were then re-run on each stratum. Species occurring only once within a stratum were usually removed from the dataset in order to reduce noise. However, if a species occurred only once but was the dominant species in a relevé, it was retained because of its influence within the plant community.

The team also conducted an outlier analysis to identify any outlying relevés that might skew the analysis. When it was determined that the outlier relevés were actually unique plant communities, the team retained those relevés (despite their introducing noise to the dataset) due to their importance in the community analysis.

The team then conducted a cluster analysis—a hierarchical, agglomerative classification of objects—for each stratum. Cluster analysis produces a dendrogram with relevés clustered within its levels, as illustrated for the shrubland stratum in Figure 2.1.1.3-2. To choose "stopping points" in the cluster analysis dendrogram, the team used indicator species analysis (ISA) scores, which can identify species that characterize a group of relevés (Dufrêne and Legendre 1997, McCune and Grace 2002). The team used a method described by McCune and Grace (2002) to maximize the effectiveness of ISA scores as a means to characterize relevé groups. Using the assumption that indicator scores peak at an intermediate level of clustering, they used the change in the number of significant indicators as the criterion for grouping relevés. The team calculated ISA scores and p-values for each successive level of the cluster analysis, and plotted the number of significant indicators against the number of clusters at each level of the dendrogram (Decker and Coles 2003), as illustrated in Figure 2.1.1.3-3 for the shrubland stratum. This was done for each stratum to create a graphic the team could use to evaluate and choose the optimal level at which to group the relevés for that stratum. The stopping point for each group was interpreted as the finest level of ecological meaning for a cluster of relevés.

The team analyzed the optimal groupings by looking at the statistically significant indicator species determined in the ISA, and identifying species with a p-value of <0.5 and indicator values of >30. Only dominant and common native species were used; if the indicator species were exotic species or infrequent, ephemeral species that were not likely long-term community indicators, they were



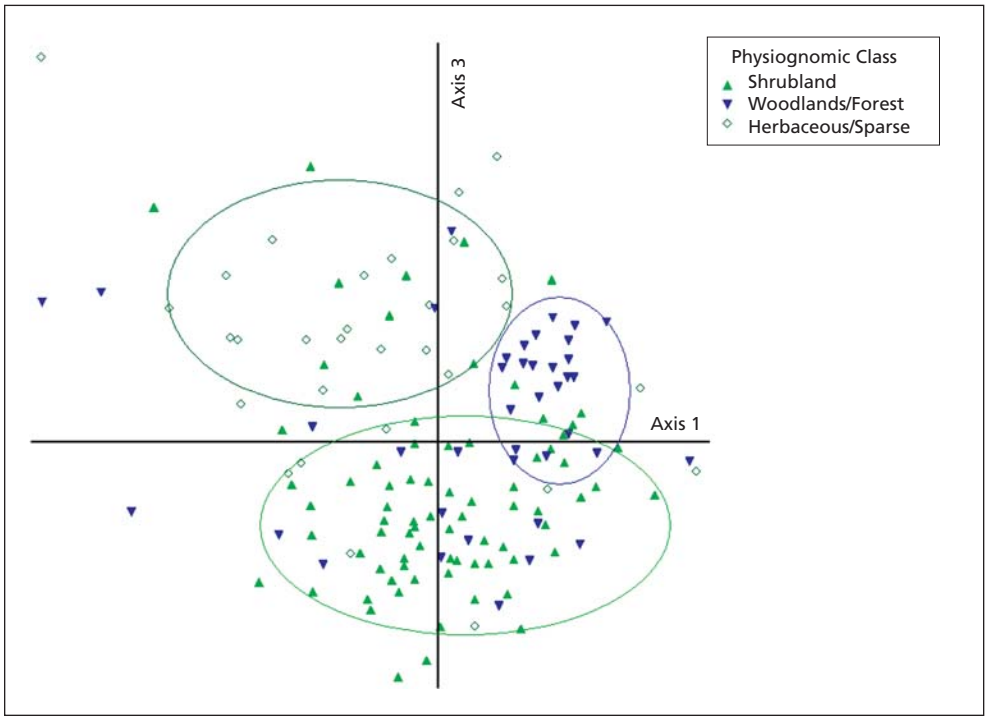


Figure 2.1.1.3-1. Non-metric multi-dimensional scaling (NMS) ordination of 147 classification relevés collected in 2004. The relevés are highly clustered by their physiognomic or strata class.

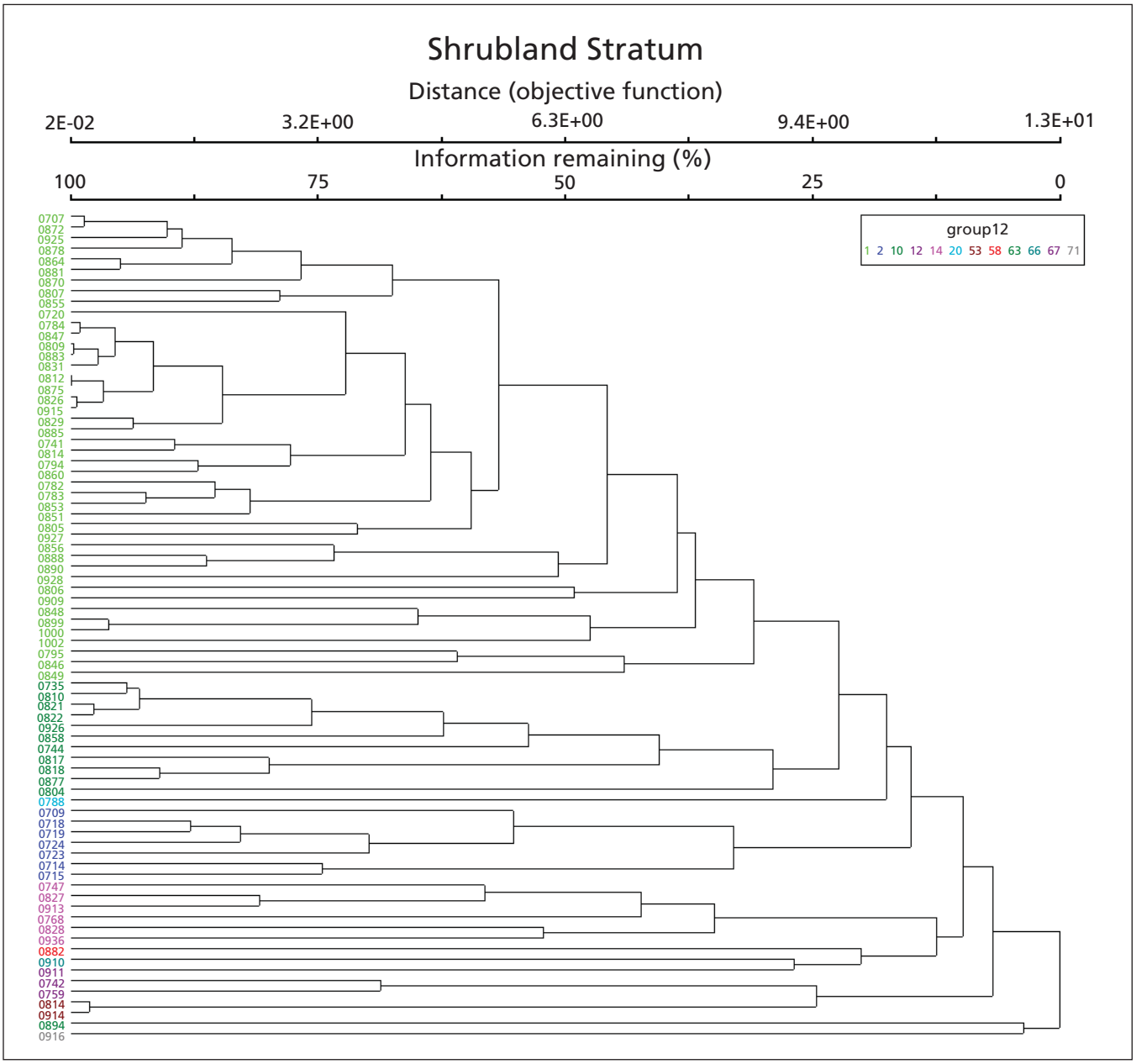


Figure 2.1.1.3-2. Cluster analysis of relevés produces a dendrogram that separates relevés by information content. The dendrogram shows different levels at which the clusters might be grouped. This example shows provisional relevés for the shrubland stratum based on the 2004 data. The final classification was based on this quantitative analysis as well as information from the 1993 relevés and field observations provided by the photointerpreter.

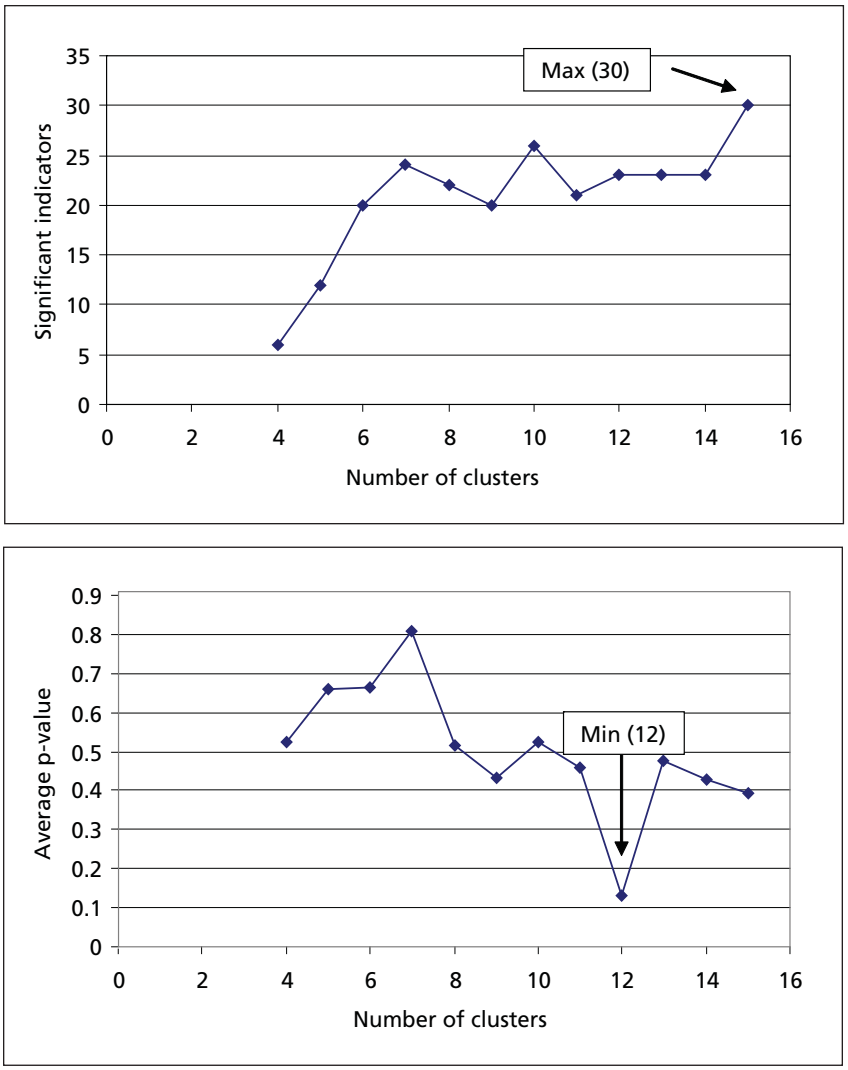


Figure 2.1.1.3-3. The number of significant indicators and the p-value for indicator species analysis scores, calculated for each level of the cluster dendrogram (see Figure 2.1.1.3-2) and plotted against the number of clusters in the dendrogram for that level. The peak score for the number of significant indicators and the minimum score for the average p-value were used to determine the number of clusters that represented the best classification of the relevés. Scores for the shrubland stratum are shown here.

eliminated from the analysis. The classification team interpreted these groupings to represent provisional NVC vegetation associations.

The classification team also looked at the potential groups of relevés to cross-check with established NVC associations. During this analysis, they assigned each relevé an initial association name using previously defined association nomenclature (when available) listed in NatureServe's Explorer website, http://www.natureserve.org/explorer/. If needed, the team developed new, provisional association names. After each stratum had a provisional association name, the team compared the results among strata and determined whether there was overlap between associations assigned to each stratum. If there was overlap, and relevés represented an association with relevés in multiple strata, the relevés were reassigned to the normative stratum for the association. For instance, sometimes the dominant vegetation in a relevé was herbaceous, but the indicator species were woodland species and the relevé was similar to existing woodland associations in species composition. These herbaceous wooded relevés were reassigned to a woodland association characterized by high herbaceous cover.

2.1.2 Photointerpreter observations

In 2005, collaborators met to review the developing plant community classification and identify plant communities that were not well represented in the 2004 sampling but were observed in the field by the photointerpretation team.

In late April 2006, MEVE resource manager Marilyn Colyer conducted field reconnaissance in the Mancos River Valley at the request of photointerpreter Lindsay Ogden. Colyer made notes of dominant vegetation species and their

locations on hard copies of digital orthophoto quarter quadrangle (DOQQ) images. Each new plant community was assigned an NVC association name when the nomenclature already existed, or was designated as a park special and provided a plant community name when not described in the NVC.

2.1.3 NVC nomenclature

NatureServe reviewed the first iteration of plant community names and reconciled them with the NVC alliances and associations in their Biotics database (http://www.natureserve.org/prodServices/biotics.jsp). The SBSC and NatureServe teams consulted on the NVC nomenclature for each plant community before the naming was finalized.

2.2 Results

The team used the results of the reinterpretation of the 1993 classification relevés, quantitative classification of the 2004 relevés, and photointerpreter observations to identify 47 plant communities at MEVE (Table 2.2; see end of this chapter). Full descriptions of these communities can be found in Appendix C.

2.2.1 Field documentation for plant communities

Thirty-four of the plant communities were based on field data newly collected in 2004 (147 relevés) (Figure 2.2.1) and/or from the 1993–1994 effort (69 relevés). Thirteen additional plant communities were identified during photointerpretation field visits. Table 2.2 lists the strength of documentation for all plant communities. Many plant communities were also field-documented during accuracy assessment (see Chapter 4). The corresponding relevé and observation numbers are documented in Appendix B. Several of the plant communities derived from photointerpreter observation do not have any documenting field data: *Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland, *Pinus Ponderosa* Woodland Alliance, *Pinus edulis - Juniperus osteosperma* / *Pleuraphis jamesii* Woodland, *Juniperus scopulorum* / *Bromus inermis* (*Pascopyrum smithii*) Woodland (park special), *Artemisia tridentata* ssp. *triden-*

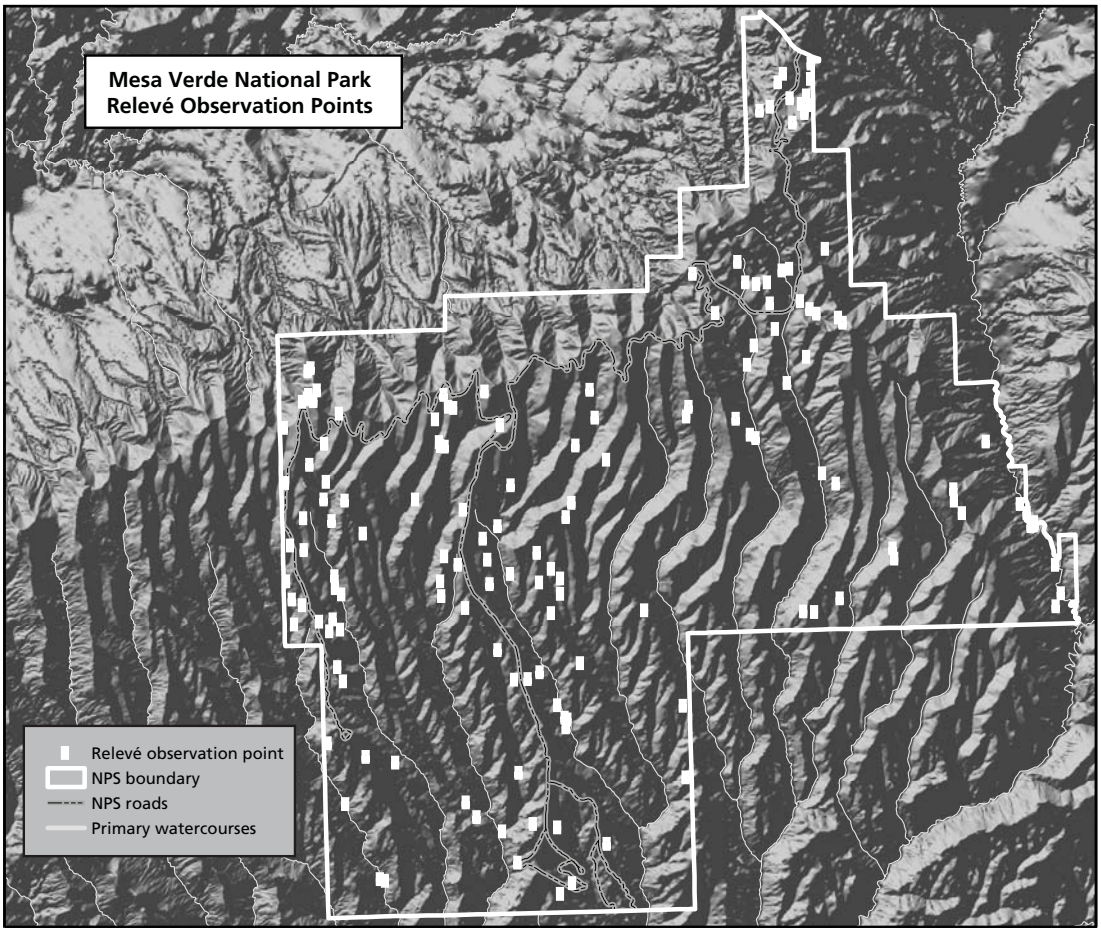


Figure 2.2.1. Locations of 147 classification relevés measured in 2004 and used to quantify 34 plant communities at Mesa Verde National Park.

tata / *Pleuraphis jamesii* Shrubland, and *Bouteloua gracilis* Herbaceous Vegetation.

2.2.2 Plant community characteristics

Thirty-five of the plant communities at MEVE were associations, all of which had been described previously in the NatureServe database and/or at other locations, except for *Cercocarpus montanus - Fendlera rupicola* Shrubland, which was newly described from the park. This plant community will remain a provisional association in the NVC until NatureServe receives additional data from other studies. One plant community, *Pinus ponderosa* Woodland, was classified only to the alliance level. Ponderosa pine, the dominant tree of this alliance, occurs only in small stands throughout the park. Eleven plant communities were classified as park specials. Their uniqueness does not imply rarity, but rather that they are assemblages of plant species for which there are insufficient data to develop new NVC types.

The plant communities identified represented all major physiognomic types: Forest, Woodland, Shrubland, Herbaceous, and Sparse. There was only one forest association. There were 13 woodland associations within four alliances. The *Pinus edulis* - (*Juniperus* spp.) Woodland Alliance had the most associations (nine total), and was the dominant woody plant community in the park. Shrublands were diverse, represented by 17 associations within nine alliances. Shrubland communities occurred in higher-elevation, montane environments, as well as in lower-elevation canyon bottoms. Herbaceous plant communities had five associations among five alliances. Seven park specials also described herbaceous vegetation. Finally, there was one sparse vegetation type at the park, represented by one alliance with one corresponding association and one park special. Sparse plant communities typically occurred in Mancos Shale-derived soils or in areas with a high percentage of sandstone bedrock. Appendix C contains detailed discussion of the expression of each plant community in the park and as it occurs elsewhere.

Invasive, non-native plants influenced the expression of some communities. For example, *Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation and *Bromus tectorum* Semi-natural Herbaceous Vegetation were dominated by non-native perennial and annual grasses, respectively. The expression of these non-native grasses depends not only on the total annual rainfall, but also upon adequate cool-season moisture. These plant communities will be very noticeable in some years and not in others.

Juniperus scopulorum (Rocky Mountain juniper) woodlands were represented by the park special, *Juniperus scopulorum / Bromus inermis (Pascopyrum smithii)* Woodland. However, areas that have high Rocky Mountain juniper cover were likely undersampled, because the classification plots established for this project did not sufficiently sample lower reaches of the canyons and the Mancos River Valley, where park staff have observed Rocky Mountain juniper.

2.3 Discussion

The *Populus*-dominated plant communities at MEVE have a somewhat confusing nomenclature. Three *Populus* species are found at the park: *Populus fremontii*, *P. angustifolia* (narrowleaf cottonwood), and *Populus* x *acuminata* (lanceleaf cottonwood), a hybrid between *P. angustifolia* and *P. deltoides* (Marilyn Colyer, pers. comm). At MEVE, the *Populus angustifolia / Bromus inermis* Semi-natural Woodland has *Populus* x *acuminata* as the dominant tree. Rather than separate this local type into a new NVC association, NatureServe determined to include it within an existing association. At MEVE, all three cottonwood species can occur in *Populus angustifolia / Bromus inermis* Semi-natural Woodland and *Populus angustifolia - Juniperus scopulorum* Woodland. However, other taxonomic authorities (University of Colorado herbarium and NatureServe) have suggested that the broadleaf cottonwood at MEVE is *Populus deltoides* ssp. *wislizeni* (Janet Coles, pers. comm.).

Recent fires on the Mesa Verde cuesta have resulted in dynamic vegetation patterns, both spatially and temporally, with plant assemblages that are early successional and, in some cases, dominated by invasive, non-native plants (Floyd et al. 2006). Field observers found that the number of resprouting and regenerating shrubs in burned areas, and their rapid growth in these early successional communities just during the duration of the project, caused some problems in the classification, photointerpretation, and accuracy assessment, particularly for Post-Fire Mixed Herbaceous Vegetation. The Post-Fire Mixed Herbaceous Vegetation type is dynamic, heterogeneous in cover and composition, and could not be distinguishable spatially at the scale used by mapping collaborators. It represents a mix of native and non-native early successional species with

a similar ecological history. Even within the duration of the park-mapping project, some of these herbaceous communities may have converted to shrublands because of resprouting and establishment of fast-growing pioneer species. Hanna led further research in a subsequent project to characterize the Post-Fire Herbaceous Vegetation at a finer scale (Hanna et al. 2008).

Appendix D lists species found within the classification relevés and accuracy assessment sites. The key used to identify plant communities and map classes in the field is shown in Appendix E. Graphic results from the quantitative classification of the 2004 relevés for all plant community strata—Woodland, Forest, Shrubland, Herbaceous, and Sparse—are included in the DVD that accompanies this report; see Appendix A for location information.

Table 2.2. Plant communities at Mesa Verde National Park, and source of supporting field documentation.

NVC alliances	NVC associations	Park specials	NatureServe database code	Number of supporting field plots			Observed during photointerpretation
				2004 relevés	1993 relevés	2006 accuracy assessment	
Forest							
1 *Pseudotsuga menziesii* Forest Alliance	*Pseudotsuga menziesii* / *Quercus gambelii* Forest	-	CEGL000452	2	1	10	-
Woodland							
2 *Pinus edulis* - (*Juniperus* spp.) Woodland Alliance	*Pinus edulis* - (*Juniperus monosperma*, *Juniperus osteosperma*) / *Hesperostipa comata* Woodland	-	CEGL000797	-	-	1	Yes
3 *same as 2*	*Pinus edulis* - *Juniperus osteosperma* / *Amelanchier utahensis* Woodland	-	CEGL002329	2	-	20	-
4 *same as 2*	*Pinus edulis* - *Juniperus osteosperma* / *Artemisia nova* Woodland	-	CEGL002331	-	-	-	Yes
5 *same as 2*	*Pinus edulis* - *Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland	-	CEGL000776	2	-	16	-
6 *same as 2*	*Pinus edulis* - *Juniperus osteosperma* / *Pleuraphis jamesii* Woodland*	-	CEGL002379	-	-	-	Yes
7 *same as 2*	*Pinus edulis* - *Juniperus* spp. / *Cercocarpus montanus* Mixed Shrubs Woodland	-	CEGL000780	-	2	20	-
8 *same as 2*	*Pinus edulis* - *Juniperus* spp. / *Poa fendleriana* Woodland	-	CEGL000787	1	-	16	-
9 *same as 2*	*Pinus edulis* - *Juniperus* spp. / *Quercus gambelii* Woodland	-	CEGL000791	8	14	27	-
10 *same as 2*	*Pinus edulis* / *Purshia tridentata* Woodland	-	CEGL000789	14	25	19	-
11 *Pinus ponderosa* Woodland Alliance		-	A.530	-	-	-	Yes
12 *Populus angustifolia* Temporarily Flooded Woodland Alliance	*Populus angustifolia* - *Juniperus scopulorum* Woodland	-	CEGL002640	-	-	2	Yes

Table 2.2. Plant communities at Mesa Verde National Park, and source of supporting field documentation, cont.

NVC alliances	NVC associations	Park specials	NatureServe database code	Number of supporting field plots			Observed during photointerpretation
				2004 relevés	1993 relevés	2006 accuracy assessment	
Woodland, cont.							
13 *Populus angustifolia* Temporarily Flooded Woodland Alliance	*Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland	-	CEGL005847	2	3	-	-
14 *Pseudotsuga menziesii* Woodland Alliance	*Pseudotsuga menziesii* / *Acer negundo* Woodland	-	CEGL002754	1	-	1	-
15 -	-	*Juniperus scopulorum* / *Bromus inermis* (*Pascopyrum smithii*) Woodland*	none	-	-	-	Yes
16 -	-	*Pinus edulis* - *Juniperus* spp. / Shale Sparse Woodland	none	-	-	14	Yes
Shrubland							
17 *Amelanchier utahensis* Shrubland Alliance	*Amelanchier* (*utahensis, alnifolia*) - *Cercocarpus montanus* Shrubland	-	CEGL001070	6	-	14	-
18 *same as 17*	*Amelanchier utahensis* - *Fendlera rupicola* Shrubland	-	CEGL003817	4	-	13	-
19 *same as 17*	*Amelanchier utahensis* Shrubland	-	CEGL001067	6	-	8	-
20 *Artemisia tridentata* Shrubland Alliance	*Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland	-	CEGL003820	1	-	13	-
21 *same as 20*	*Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii* - (*Elymus lanceolatus*) Shrubland*	-	CEGL007017	-	-	1	Yes
22 *same as 20*	*Artemisia tridentata* ssp. *tridentata* / *Pleuraphis jamesii* Shrubland*	-	CEGL001015	-	-	-	Yes
23 *same as 20*	*Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland	-	CEGL001051	1	-	-	-
24 *Artemisia nova* Shrubland Alliance	*Artemisia nova* / *Hesperostipa comata* Shrubland	-	CEGL001425	3	-	5	-

Table 2.2. Plant communities at Mesa Verde National Park, and source of supporting field documentation, cont.

NVC alliances	NVC associations	Park specials	NatureServe database code	Number of supporting field plots			Observed during photointerpretation
				2004 relevés	1993 relevés	2006 accuracy assessment	
Shrubland, cont.							
25 *Cercocarpus montanus* Shrubland Alliance	*Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional]	-	CEGL003820	1	-	9	-
26 *Prunus virginiana* Shrubland Alliance	*Prunus virginiana* - (*Prunus americana*) Shrubland	-	CEGL001108	2	-	2	-
27 *Purshia tridentata* Shrubland Alliance	-	*Purshia tridentata / Achnatherum hymenoides - Poa fendleriana* Shrubland	CEGL001058	1	-	-	-
28 *Quercus gambelii* Shrubland Alliance	*Quercus gambelii - Amelanchier utahensis* Shrubland	-	CEGL001110	34	-	47	-
29 *same as 28*	*Quercus gambelii - Cercocarpus montanus* / (*Carex geyeri*) Shrubland	-	CEGL001113	1	-	8	-
30 *same as 28*	*Quercus gambelii / Symphoricarpos oreophilus* Shrubland	-	CEGL001117	7	11	17	-
31 *same as 28*	*Quercus gambelii* Shrubland	-	CEGL002477	5	-	10	-
32 *Salix* (*exigua*, *interior*) Temporarily Flooded Shrubland Alliance	*Salix exigua* / Mesic Forbs Shrubland	-	CEGL001202	1	-	2	-
33 *Sarcobatus vermiculatus* Intermittently Flooded Shrubland Alliance	*Sarcobatus vermiculatus - Artemisia tridentata* Shrubland	-	CEGL001359	1	-	6	-
Herbaceous							
34 *Bouteloua gracilis* Herbaceous vegetation*	*Bouteloua gracilis* Herbaceous Vegetation	-	CEGL001760	-	-	-	Yes
35 *Bromus inermis* Semi-natural Herbaceous Alliance	*Bromus inermis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation	-	CEGL005264	3	-	9	-

Table 2.2. Plant communities at Mesa Verde National Park, and source of supporting field documentation, cont.

NVC alliances	NVC associations	Park specials	NatureServe database code	Number of supporting field plots: 2004 relevés	1993 relevés	2006 accuracy assessment	Observed during photointerpretation
Herbaceous, cont.							
36 *Bromus tectorum* Semi-natural Herbaceous Alliance	*Bromus tectorum* Semi-natural Herbaceous Vegetation	-	CEGL003019	9	-	4	-
37 *Juncus balticus* Seasonally Flooded Herbaceous Alliance	*Juncus balticus* Herbaceous Vegetation	-	CEGL001838	2	-	4	-
38 *Leymus cinereus* Herbaceous Alliance	*Leymus cinereus* Herbaceous Vegetation	-	CEGL001479	1	-	-	-
39 -	-	*Eurybia glauca* Herbaceous Vegetation	none	1	-	-	-
40 -	-	*Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation	none	1	-	-	-
41 -	-	*Ericameria nauseosa / Bromus inermis* (*Pascopyrum smithii)* Shrub Herbaceous Vegetation	none	-	-	22	Yes
42 -	-	Mixed Weedy Herbaceous Vegetation	none	-	-	6	Yes
43 -	-	Mixed Wetland Herbaceous Vegetation	none	-	-	1	Yes
44 -	-	Post-Fire Mixed Herbaceous Vegetation	none	18	-	29	-
45 -	-	*Stanleya pinnata* Shale Herbaceous Vegetation	none	4	-	2	-
Sparse							
46 Painted Desert Sparsely Vegetated Alliance	*Eriogonum corymbosum* Badlands Sparse Vegetation	-	CEGL002979	1	-	17	-
47 -	-	Sandstone *Pinus edulis - Juniperus osteosperma* Barrens	none	1	-	5	-

*Determined by Colyer's 2006 field reconnaissance
Numbers are included for ease of comparability across tables.

Chapter 3
Base Map Class Development

3.1 Methods

3.1.1 Overview

To create the base map classes, the mapping team, consisting primarily of Beverly Friesen (RMGSC) and Lindsay Ogden (FORT), developed GIS polygons and labeled them to the finest floristic level possible using a hybrid modeling and photointerpretation approach. While the initial planning document for this project called for the use of standard photointerpretation to create vegetation polygons, the SCPN wanted a means to augment or replace the labor-intensive process of manual photointerpretation, in which polygons are delineated manually on transparent, polyester-sheet overlays on printed orthophotos (and subsequently scanned), or are delineated digitally through an onscreen computer process termed "heads-up digitizing." The project team modified this approach by combining automated modeling of polygons and manual photointerpretation to label the polygons.

The resultant base polygons are the finest-scale spatial data in the GIS database. Ideally, each polygon represents a map class that consists of one plant community—either an association, alliance, or park special. However, one-to-one correspondence of map class to plant community was not always possible because mixed or indistinguishable photosignatures on the aerial photography made it difficult for the photointerpreter to distinguish every plant community. In such cases, the map class assigned represents a group of associations, alliances, and/or park specials.

The mapping team created polygons by using Definiens Professional software and remotely sensed imagery of the park. Definiens Professional uses human-defined parameters (color statistics, size, shape, texture, and context) to extract information from imagery to create polygons of potentially meaningful features. This process reduces the "salt-and-pepper" look of traditional image classification methods that use a pixel-based approach. In this project, eCognition (as Definiens Professional was then known) was used to derive homogeneous units based on both spectral and spatial elements that were subsequently exported to a shapefile for further processing.

A photointerpreter edited and labeled the resulting polygons in a GIS program, using aerial photographs as a primary reference. Some labels and new polygons were provided by direct field mapping. The edited polygons form the basic structure of the vegetation map database. The group and management map classes described in Chapter 4 derive from the base map classes described in this chapter.

3.1.2 Base data and imagery

3.1.2.1 Imagery

The SCPN acquired new aerial photography of MEVE through the U.S. Department of Agriculture's Aerial Photography Field Office (APFO). APFO subcontractor Foto Flight Geomatics, of Tucson, Arizona, acquired the imagery on July 10, 2003, and July 2, 2004. Because of dry and excessively windy conditions during 2003, they did not complete the flights until 2004. The imagery was taken in true color, at a scale of 1:12,000, with 20–40% sidelap and 50–60% overlap. The APFO provided two sets of 9 × 9-in contact prints to the SCPN. The FORT and RMGSC mapping team used the images for reference during polygon delineation and labeling. At project completion, one set of contact prints will reside at MEVE and one at the SCPN. Figure 3.1.2.1 shows the flight lines and photo centers.

The U.S. Bureau of Reclamation's Remote Sensing and GIS Group assisted the SCPN in obtaining DOQQ images through a contract with Horizons Inc., Rapid City, South Dakota. True-color DOQQs at 1:12,000-scale were acquired on September 15, 2003.

3.1.2.2 Ancillary data for photointerpretation

Thematic information supplied by MEVE included soil, geology, and fire data. Elevation data were obtained from 10-m digital elevation models from the USGS Seamless Data Distribution System (http://seamless.usgs.gov/). Slope (in percent) and aspect (in degrees) were derived from these data using the Spatial Analyst extension in ArcMap.

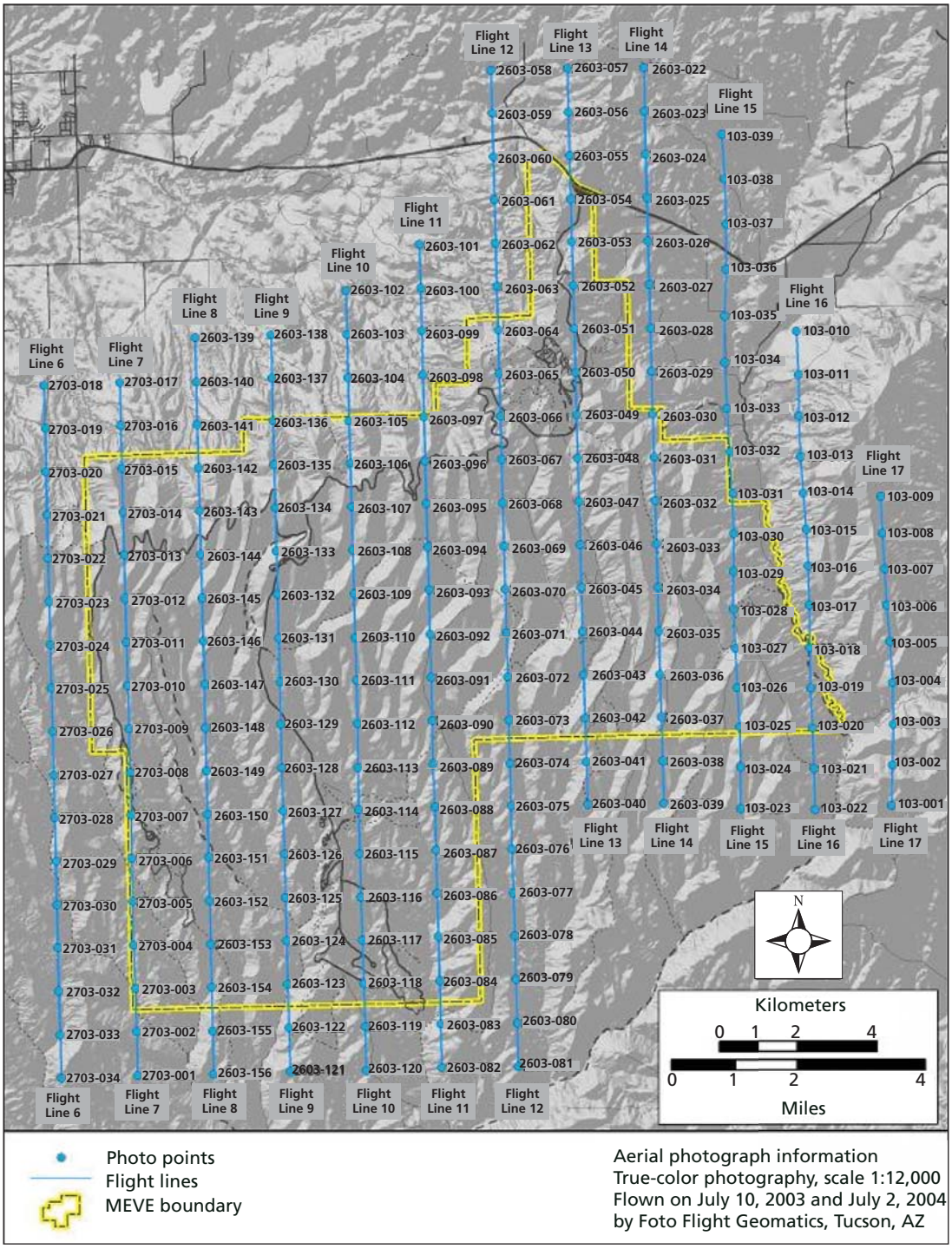


Figure 3.1.2.1. Flight lines and photo centers for true-color aerial photography acquired for the Mesa Verde National Park vegetation mapping project.

The park also provided a coarse vegetation strata map created by in-house GIS staff in 2003 for a fire management plan, based on color infrared (CIR) imagery from 2002 (EMERGE, 1-meter resolution).

3.1.3 Modeling polygons

3.1.3.1 Field reconnaissance

The RMGSC modeler conducted a field trip in the fall of 2004 with SCPN ecologist Anne Cully and NatureServe ecologist Janet Coles. The field-trip team compared site-based vegetation conditions with photosignatures on the project's aerial photography and discussed environmental drivers that influenced vegetation patterns and identifying information in the project imagery. They made field notes directly onto paper copies of orthoimagery prepared prior to the trip. Following the field visit, this information was entered into a GIS annotation layer that the FORT photointerpreter used for reference when assigning base map class labels to polygons.

3.1.3.2 Definiens Professional modeling

Definiens Professional software was used to segment the true-color DOQQs from 2003 into image objects (preliminary polygons). Four iterations were attempted, each using different parameters for the Definiens Professional segmentation. The mapping team evaluated the segmentations, and the segmentation that best provided the most homogeneous objects and spatial detail (54,258 image objects) was further processed.

The size of the project area, coupled with the processing requirements of Definiens Professional, created challenges with computing capacity. The adopted solution for this project was to create three separate sections (or project areas) for polygon development, using road boundaries within the park and extending beyond roads where necessary to complete the division (Figure 3.1.3.2). The second section, and the largest, required the use of the large, dataset-handling version of Definiens Professional. This version requires roughly six times the amount of processing time than is required for the standard version of the software.

While image size is a factor in the computational requirements for Definiens Professional, segmentation parameters, heterogeneity of the imagery, number of layers, and kind of objects being defined all contribute to the computational requirements. Because of the memory demands of Definiens Professional and the size of the three project areas, the software did not prove efficient for continued classification.

Several attempts were made to automate the labeling of the Definiens Professional-derived image objects. The mapping team intersected the classification relevé locations in a GIS program with elevation and ancillary data to provide elevation, slope, aspect, geology, and soils information for each relevé location. They intersected the locations again with the Definiens Professional-derived polygons to provide additional site-specific attributes. However, no consistent vegetation patterns emerged.*

The RMGSC/FORT team decided to export the polygons as shapefiles and continue processing the polygons in a GIS program. The polygons were saved as a GIS shapefile with the following

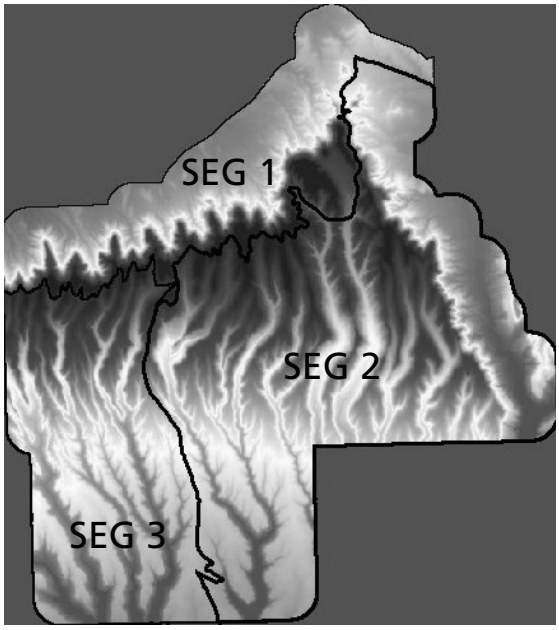


Figure 3.1.3.2. Mesa Verde National Park DOQQs were divided into three sections to develop map units.

* One potential advantage of the semi-automated method was the possibility of providing initial map class labels through modeling. However, this labeling approach requires a sufficient number of field observations to characterize the spectral range and variability of vegetation classes on the ground, and the 2004 field-data collection was designed for collection of data for quantitative classification of plant community structure and composition on the ground—not the spectral variability of the plant community. For example, 15 of the map classes had only one field observation and five map classes were represented by just two observation points, respectively. This did not supply sufficient field data for the Definiens Professional modeling.

attributes: spectral means, brightness, maximum difference, standard deviations, and ratios of the three image bands. These procedures were completed for the three project areas, and the shapefiles were sent to FORT for further refinement and labeling.

3.1.4 Base map class labels

3.1.4.1 Field reconnaissance

FORT photointerpreter Lindsay Ogden and SCPN ecologist Anne Cully visited MEVE on September 26–30, 2005; February 27–March 4, 2006; and April 6–12, 2006, to verify and/or assign map classes to Definiens Professional-delineated polygons. Field sites (Figure 3.1.4.1) were chosen based on accessibility (to increase efficiency), the need to ground-truth difficult photosignatures, and the relative availability of existing field data for the photosignatures. The FORT photointerpreter used a tablet computer and real-time geographic positioning system (GPS) to locate her position within each polygon, and attributed each visited polygon on-site.

3.1.4.2 Assigning base map class labels

The FORT photointerpreter labeled the Definiens Professional-generated polygons with a base map class using imagery interpretation and referring to the 1993 and 2004 relevés, field reconnaissance observations, the 2003 fire management map, and supporting ancillary data. Three sets of imagery assisted with assignment of base map classes: the 2003 DOQQs, the 2003–2004 true-color aerial photos, and 2002 CIR imagery for signature comparison. The 2003 true-color DOQQ imagery was the primary reference.

The base map classes consisted of associations, alliances, and park specials identified by the quantitative plant community classifications or groupings, Anderson et al. (1976) Level II land-use classes, and additional land-cover types and communities identified during the photointerpretation process. The mapping team consulted the SBSC team and NatureServe as base map classes were developed and applied.

After all polygons had map class labels, the team

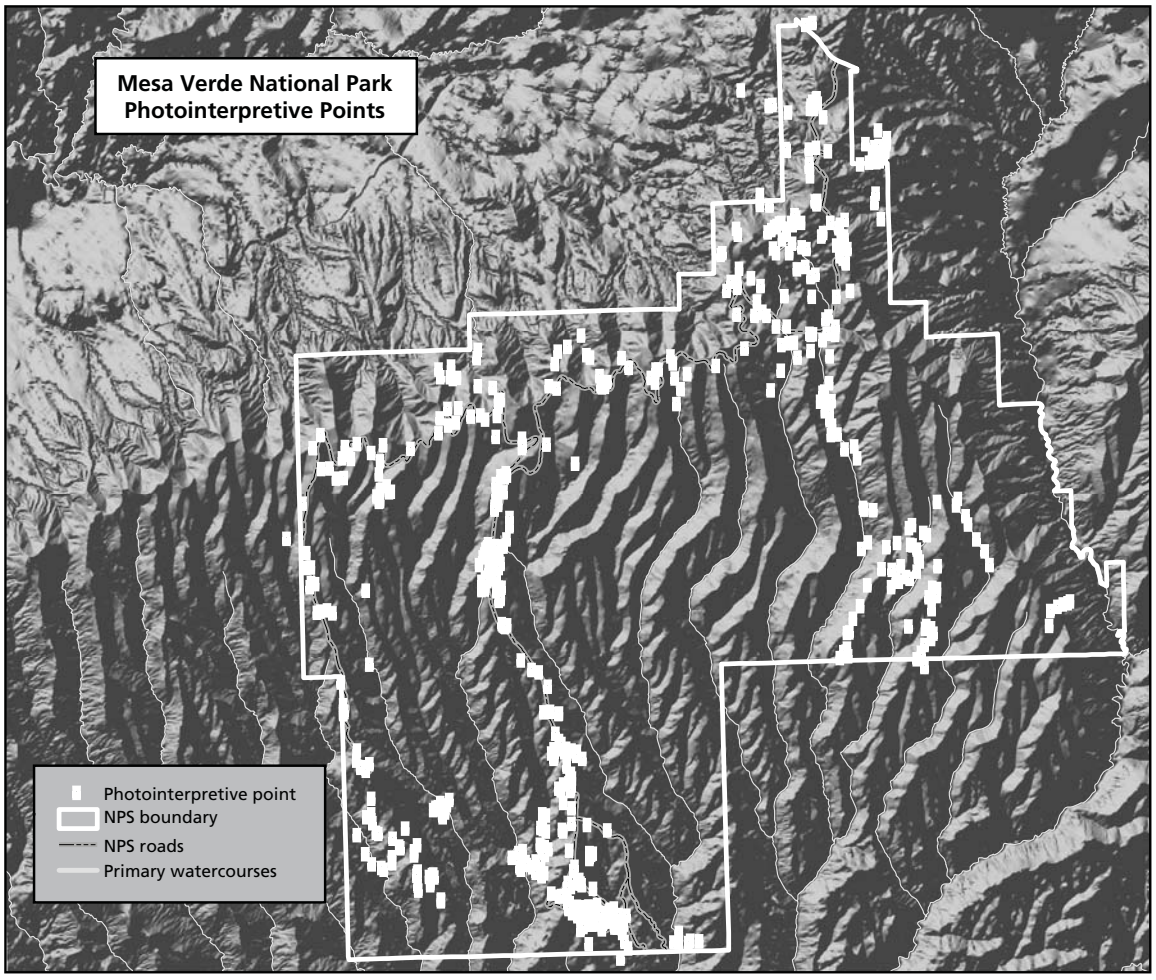


Figure 3.1.4.1. Location of photointerpretation observation sites visited in late 2004.

reviewed them for mistakes, consistency, and labeling errors. Adjacent polygons with the same label were aggregated. Polygons smaller than the minimum mapping unit of 0.5 ha were merged into adjacent larger polygons and checked for consistency. A number of exceptions were made to the aggregations; in these cases, the original polygons were maintained regardless of size. These excepted map classes represent land-use classes that have distinct signatures and typically occur at less than 0.5 ha, or plant communities that naturally occur in small patches.

3.2 Results

There are 46 base map classes in the vegetation map database for Mesa Verde National Park (Figure 3.2, Table 3.2-1, Appendix F). These include 5 classes describing infrastructure, 3 describing land cover and geology types, 2 describing sparse vegetation, 11 describing herbaceous vegetation, 11 describing shrublands, and 14 describing woodlands and forests. The vegetation map database is georeferenced to Universal Transverse Mercator (UTM) projection North American Datum of 1983 (NAD 83).

The vegetation map database consists of 5,007 polygons, of which 2,048 (41%) are smaller than 0.5 ha (Table 3.2-2). The majority of the vegetated polygons smaller than 0.5 ha in size occur in three base map classes:

1. Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation (911 polygons),
2. Douglas-fir / Gambel Oak Forest (212 polygons), and
3. Colorado Pinyon - Utah Juniper Sandstone Barrens (167 polygons).

In all but five map classes, the map class labels have a one-to-one relationship to an alliance, association, or park special. The exceptions are Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland (with two associations), Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland (two associations), Big Sagebrush Shrubland (two associations), Gambel Oak - Mixed Montane Shrubland (three associations), and Mixed Montane Shrubland (three associations). Associations were combined in a base map class when they could not be individually distinguished on aerial photography. One plant community, *Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation, occurred on only one classification relevé. This association is not identifiable on the aerial photography, and is included within the larger, identifiable vegetation community surrounding the known location of the relevé.

As noted in Chapter 2, the association *Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland is locally dominated by *Populus* x *acuminata*. This causes some confusion in naming conventions, as the base map class name uses the common name of the dominant cottonwood (Lanceleaf Cottonwood Riparian Woodland) and not the common name of the underlying plant community (narrowleaf cottonwood).

A summary of base map class distribution, as well as the distribution of management and group map classes, can be found in Chapter 4. A key to the base map classes, crosswalked to plant community, as well as group and management map classes, is presented in Appendix E. Appendix G contains photosignature examples for most of the base map classes, as well as summaries of the characteristics of each base map class.

3.3 Discussion

This project examined the use of Definiens Professional software as a method to map vegetation for the SCPN for the first time. In future applications of this approach, the team recommends that more extensive field observations of map class occurrence, perhaps by the photointerpreter, would provide sufficient input for characterizing the spectral variability of preliminary map classes. The learning curve for Definiens Professional is steep, and the segmentation process is more efficient if the interpreter is an expert user of the software and has either direct experience or adequate information on the landscape of interest.

For example, using a segmentation approach to developing polygons makes it possible to create a much larger number of potential polygons than would normally occur with traditional manual approaches. The Definiens Professional segmentation used for MEVE resulted in more than 54,000 image objects that were refined to 5,007 polygons. The sheer number of polygons required the photointerpreter to join many polygons together into larger polygons and confounded the efficiency of labeling the polygons by photointerpretation.

Because many map classes are heterogeneous and the Definiens Professional-derived image objects

in this study were homogeneous, there was not a one-to-one relationship between the number of image objects and map classes (some of which were smaller than the minimum mapping unit). Although it may seem logical for the number of image objects to correspond closely to the minimum mapping unit, important information—particularly with small map classes—can be lost early in the process if the image objects are size-restrictive. Nonetheless, a goal for future projects using this technology is to produce fewer polygons to achieve a balance between too much detail and sufficient vegetation information.

Finally, another challenge found in both the automated and manual interpretation of imagery was the rough topography of MEVE. Sunlight cast on steep cliffs of the park resulted in deep shadows on north-facing slopes, making the interpretation of plant composition and density in those areas difficult. As access to these steep, sloped areas also was very difficult, the photointerpreter was often less familiar with the vegetation in these shadowed areas. Limitations of the imagery in situations of rough terrain confound application of automated approaches.

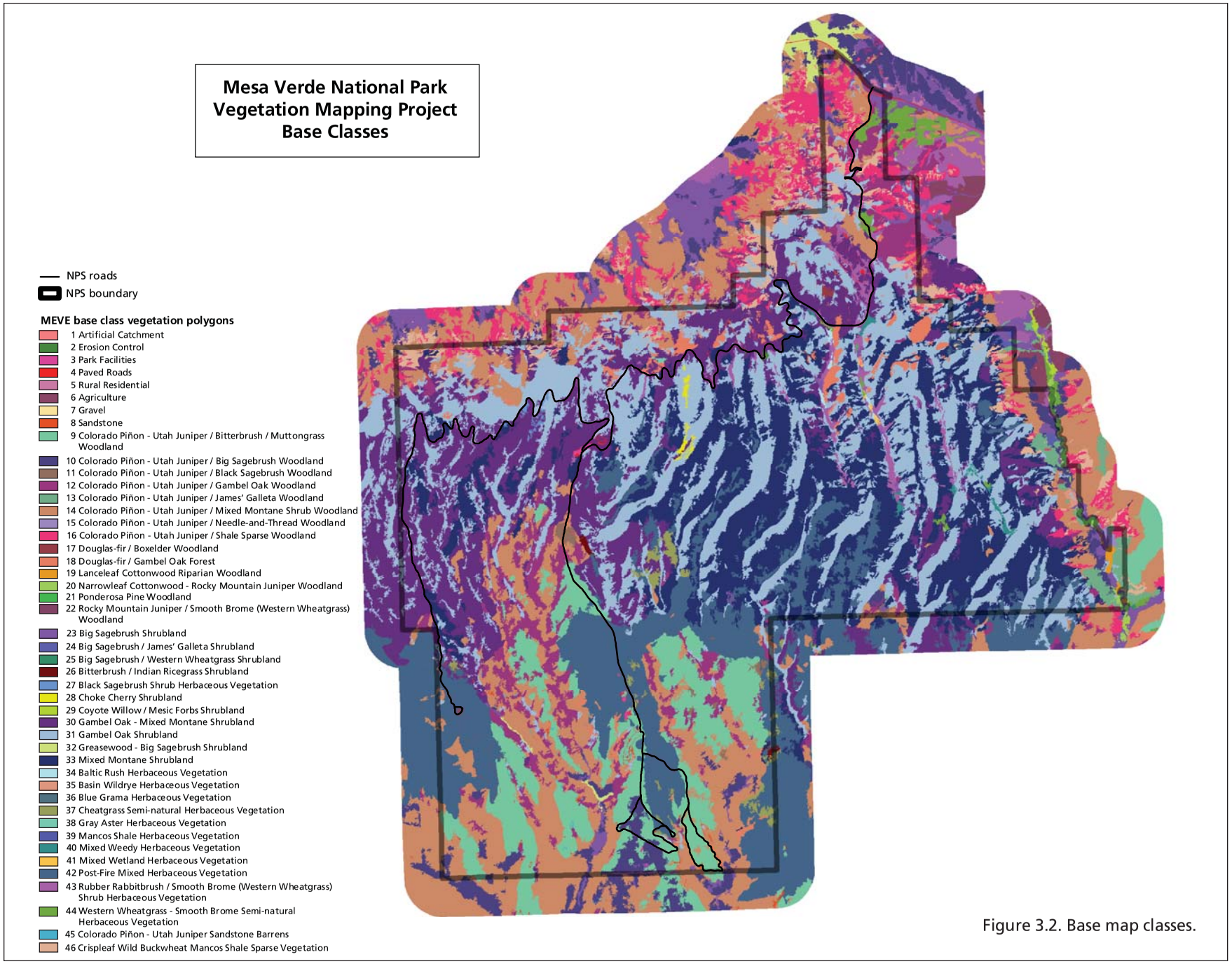


Figure 3.2. Base map classes.

Table 3.2-1. Base map classes at Mesa Verde NP and the plant communities they represent.

Cover type / Base map class		Plant community represented		Type
Infrastructure				
1	Artificial Catchment			
2	Erosion Control			
3	Park Facilities			
4	Paved Roads			
5	Rural Residential			
Land Cover and Geology				
6	Agriculture			
7	Gravel			
8	Sandstone			
Woodland and Forest				
9	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	8 10	(1) *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland (2) *Pinus edulis* / *Purshia tridentata* Woodland	A
10	Colorado Piñon - Utah Juniper / Big Sagebrush Woodland	5	*Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana)* Woodland	A
11	Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	4	*Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland	A
12	Colorado Piñon - Utah Juniper / Gambel Oak Woodland	9	*Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland	A
13	Colorado Piñon - Utah Juniper / James' Galleta Woodland	6	*Pinus edulis - Juniperus osteosperma* / *Pleuraphis jamesii* Woodland	A
14	Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland	7 3	(1) *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* Mixed Shrub Woodland (2) *Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis* Woodland	A
15	Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland	2	*Pinus edulis* - (*Juniperus monosperma, Juniperus osteosperma)* / *Hesperostipa comata* Woodland	A
16	Colorado Piñon - Utah Juniper / Shale Sparse Woodland	16	*Pinus edulis - Juniperus* spp. / Shale Sparse Woodland	PS
17	Douglas-fir / Boxelder Woodland	14	*Pseudotsuga menziesii* / *Acer negundo* Woodland	A
18	Douglas-fir / Gambel Oak Forest	1	*Pseudotsuga menziesii* / *Quercus gambelii* Forest	A
19	Lanceleaf Cottonwood Riparian Woodland	13	*Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland	A
20	Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland	12	*Populus angustifolia - Juniperus scopulorum* Woodland	A
21	Ponderosa Pine Woodland	11	*Pinus ponderosa* Woodland Alliance	Al
22	Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland	15	*Juniperus scopulorum* / *Bromus inermis* (*Pascopyrum smithii*) Woodland	PS
Shrubland				
23	Big Sagebrush Shrubland	23 20	(1) *Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland (2) *Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland	A

Table 3.2-1. Base map classes at Mesa Verde NP and the plant communities they represent, cont.

Cover type / Base map class		Plant community represented		Type
24	Big Sagebrush / James' Galleta Shrubland	22	*Artemisia tridentata* ssp. *tridentata* / *Pleuraphis jamesii* Shrubland	A
Shrubland, cont.				
25	Big Sagebrush / Western Wheatgrass Shrubland	21	*Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii* - (*Elymus lanceolatus*) Shrubland	A
26	Bitterbrush / Indian Ricegrass Shrubland	27	*Purshia tridentata* / *Achnatherum hymenoides* - *Poa fendleriana* Shrubland	PS
27	Black Sagebrush Shrub Herbaceous Vegetation	24	*Artemisia nova* / *Hesperostipa comata* Shrubland	A
28	Choke Cherry Shrubland	26	*Prunus virginiana* - (*Prunus americana*) Shrubland	A
29	Coyote Willow / Mesic Forbs Shrubland	32	*Salix exigua* / Mesic Forbs Shrubland	A
30	Gambel Oak - Mixed Montane Shrubland	28 29 30	(1) *Quercus gambelii* - *Amelanchier utahensis* Shrubland (2) *Quercus gambelii* - *Cercocarpus montanus* / *(Carex geyeri)* Shrubland (3) *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland	A
31	Gambel Oak Shrubland	31	*Quercus gambelii* Shrubland	A
32	Greasewood - Big Sagebrush Shrubland	33	*Sarcobatus vermiculatus* - *Artemisia tridentata* Shrubland	A
33	Mixed Montane Shrubland	17 19 18 25	(1) *Amelanchier* (*utahensis, alnifolia*) - *Cercocarpus montanus* Shrubland (2) *Amelanchier utahensis* Shrubland (3) *Amelanchier utahensis* - *Fendlera rupicola* Shrubland (4) *Cercocarpus montanus* - *Fendlera rupicola* Shrubland [Provisional]	A
Herbaceous				
34	Baltic Rush Herbaceous Vegetation	37	*Juncus balticus* Herbaceous Vegetation	A
35	Basin Wildrye Herbaceous Vegetation	38	*Leymus cinereus* Herbaceous Vegetation	A
36	Blue Grama Herbaceous Vegetation	34	*Bouteloua gracilis* Herbaceous Vegetation	A
37	Cheatgrass Semi-natural Herbaceous Vegetation	36	*Bromus tectorum* Semi-natural Herbaceous Vegetation	A
38	Gray Aster Herbaceous Vegetation	39	*Eurybia glauca* Herbaceous Vegetation	PS
39	Mancos Shale Herbaceous Vegetation	45	*Stanleya pinnata* Shale Herbaceous Vegetation	PS
40	Mixed Weedy Herbaceous Vegetation	42	Mixed Weedy Herbaceous Vegetation	PS
41	Mixed Wetland Herbaceous Vegetation	43	Mixed Wetland Herbaceous Vegetation	PS
42	Post-Fire Mixed Herbaceous Vegetation	44	Post-Fire Mixed Herbaceous Vegetation	PS
43	Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation	41	*Ericameria nauseosa* / *Bromus inermis* (*Pascopyrum smithii*) Shrub Herbaceous	PS
44	Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation	35	*Bromus inermis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation	A
Sparse				
45	Colorado Piñon - Utah Juniper Sandstone Barrens	47	Sandstone *Pinus edulis* - *Juniperus osteosperma* Barrens	PS
46	Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation	46	*Eriogonum corymbosum* Badlands Sparse Vegetation	A

A = Association, Al = Alliance, PS = Park special
See Table 2.2 for corresponding plant-community numbers.

Table 3.2-2. Base map classes at Mesa Verde NP occurring in polygons smaller than the MMU size.

Base map class		% area <MMU	# polygons less than MMU	# all polygons	Total area (ha)
7	Gravel	100.0%	1	1	0
45	Colorado Piñon - Utah Juniper Sandstone Barrens	95.0%	167	168	15
39	Mancos Shale Herbaceous Vegetation	82.1%	55	56	5
1	Artificial Catchment	74.3%	51	54	7
8	Sandstone	68.6%	457	474	49
3	Park Facilities	41.7%	46	51	10
5	Rural Residential	30.6%	40	44	16
21	Ponderosa Pine Woodland	28.2%	11	13	3
2	Erosion Control	28.0%	12	15	5
46	Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation	14.8%	911	1,113	633
19	Lanceleaf Cottonwood Riparian Woodland	8.9%	20	24	19
38	Gray Aster Herbaceous Vegetation	8.7%	3	4	4
18	Douglas-fir / Gambel Oak Forest	7.0%	212	282	271
20	Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland	6.4%	23	36	42
41	Mixed Wetland Herbaceous Vegetation	3.5%	2	6	6
34	Baltic Rush Herbaceous Vegetation	1.3%	2	9	15
9	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	0.1%	5	79	1,911
43	Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation	0.1%	6	100	595
11	Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	0.1%	1	12	45
35	Basin Wildrye Herbaceous Vegetation	0.1%	1	2	10
31	Gambel Oak Shrubland	0.0%	2	516	5,127
30	Gambel Oak - Mixed Montane Shrubland	0.0%	9	325	3,879
42	Post-Fire Mixed Herbaceous Vegetation	0.0%	7	143	3,665
12	Colorado Piñon - Utah Juniper / Gambel Oak Woodland	0.0%	2	278	1,437
23	Big Sagebrush Shrubland	0.0%	1	138	928
4	Paved Roads	0.0%	1	3	81

MMU = minimum mapping unit of .5 ha

Chapter 4
Accuracy Assessment and Additional Map Classes

The SBSC team completed the vegetation map database by coordinating field collection of accuracy assessment observations, developing the accuracy statistics for the base map classes, developing the group and management map classes, and developing additional accuracy assessment statistics for those map schemas. In this step, the team used the accuracy assessment guidelines and protocols developed by the USGS-NPS Vegetation Mapping Program (ESRI et al. 1994). They developed the accuracy assessment by comparing the performance of base map class polygons, as mapped, with field-collected data at the location of those polygons.

4.1 Methods

To conduct the accuracy assessment, the team (1) developed a sampling design, (2) collected field data with on-the-ground field sampling (reference data), and (3) developed map performance statistics. As is common practice when measuring uncertainty in mapped classes, a sample of polygon locations representing each map class (the sample data) was compared to the reference data. The higher-level group and management map classes consist of aggregations of map classes. They were assessed using the same reference data as for the base map. Finally, the team developed summary statistics describing the characteristics of the base, group, and management map classes.

4.1.1 Field sampling design

The map database with base map classes was made available to the SBSC team for accuracy assessment in three separate shapefiles, each representing a part of the final composite database (1/6, 1/6, and 2/3, respectively). Although it is ideal to develop a sampling design using a complete map database, the full map database was not available until the later summer months, whereas field sampling needed to be conducted during the summer, while the weather was favorable. Prior to developing the sample design, the SBSC team checked the topology and data structure of each map section for node and label errors.

The team generally limited accuracy assessment sampling to within park boundaries, although the field team was able to access some areas outside the park boundary on Bureau of Land Management and private lands with permission. With the approval of park managers, the field team did not field-assess land use and geology map classes. These map classes are well known and often easier to identify on the aerial photography than the vegetated classes, and the field team had limited field-season time to sample the vegetated map classes. All vegetated map classes, including park specials and those based on photointerpretation alone, were included in the sampling design.

The SBSC team used the "scenario" table recommended by the Vegetation Mapping Program (ESRI et al. 1994) to estimate the number of sample sites needed for each map class in order to achieve a statistical measure of class accuracy with a confidence level of 90% and an acceptable sample error of 10%. Each scenario was based on the number of polygons and total area of a map class. The team assigned each map class to one of five different scenarios to determine the target number of sampling sites needed (Table 4.1.1). Depending upon its scenario assignment, a map class could include from 1 to 30 sampling sites.

The team developed the sampling design for each section of the park as the database for that section became available. To compensate for each section's containing only a portion of all park polygons, the team reduced the number of sample sites for that section by multiplying the portion of the total map that the section represented (1/6 or 2/3) by the number of target sample sites determined through the scenario table. This allowed the team to make the best estimate for the appropriate number of sampling points in that section. The team did not assume that the map classes were evenly distributed. The team

Table 4.1.1. Sampling design scenarios to determine target number of field accuracy assessment observation sites.

Scenario	Class	Area	Number of map units	Sample size
A	Abundant	≥50 ha	≥30	30
B	Relatively Abundant	≥50 ha	<30	20
C	Relatively Rare	<50 ha	>30	20
D	Rare	<50 ha	≥5 and ≤30	5
E	Very Rare	<50 ha	≥5	visit every map unit

Source: ESRI et al. 1994

collected more samples of a particular class if they thought the map class was more abundant in a particular section.

When the SBSC team received the third, and largest, section of the map database, they used the composite map database to re-estimate the number of target sample sites. Despite having estimated the proportion of map classes in each section, the team found that some map classes were under- or oversampled based on the new estimate. The team sampled underrepresented map classes in the final section of the map and eliminated map classes that were oversampled. Several map classes were only located in areas that the field team had already sampled in the first two parts of the map. Sites for these map classes were selected from the map sections that were already sampled, and the field team revisited areas previously sampled.

The location of each accuracy assessment site was determined randomly using Hawth's Analysis Tools v3.26 (http://www.spatialecology.com/htools/tooldesc.php). In addition to the targeted number of polygons sampled for each class, there were 5–20 extra polygons per map class included in the random sample, in case the field team could not access the originally targeted polygons. Polygons larger than 0.5 ha (the MMU) had priority as field sampling sites. Accuracy assessment sites were 15 m or more from the edge of the polygon.

4.1.2 Field data collection

A dichotomous key to plant communities and map classes was developed to assist with map accuracy assessment in the field (Appendix E). SBSC ecologist Monica McTeague visited the park on June 26–28, 2006, to review the plant community/map class key and the accuracy assessment field sampling methodologies. During this trip, she revised the plant community/map class key to better reflect the field expression of associations and map class relationships.

The SBSC accuracy assessment field crew began their work in July 2006, and completed sampling by October. The SBSC project coordinator trained the field crew in order to familiarize them with the park, logistical concerns, and field methodologies. Targeted accuracy assessment sites were identified as either primary or secondary. The crew attempted to access all primary sites. If they were not accessible, the crew sampled secondary sites.

Each field team of two members carried a GPS unit (Garmin 5, Garmin 3+, or Garmin GPSMAP 76 (WAAS enabled)) pre-loaded with the geographic coordinates for the designated sampling sites. In addition, each team had a hard-copy list of the geographic coordinates for each target site, area and perimeter length of the polygon containing the target site, and distance to the nearest edge of an adjacent polygon, as well as two sets of maps to help orient them to the site. The first map was a large area map with all of the sampling sites drawn on a 1:24,000 scale topographic base. The second set of maps showed each site within its associated polygon outline on a DOQQ base. These fine-scale maps allowed each field team to locate specific polygons on the ground and to visualize the size and shape of the polygon they were assessing.

The field team navigated to each site and then examined the polygon, using the field maps as a guide to the polygon's shape. They recorded site data (Table 4.1.2) and generally took at least one photo from the site waypoint. They determined the plant community found on the ground and the corresponding base map class using the plant community/map class key. The evaluator assigned confidence in base map classes using a categorical

Table 4.1.2. Summary of data collected within accuracy assessment observation sites, 2006.

Type of information	Items noted
Site documentation	Site identification, georeferencing, photo, elevation
Map class	Base map class of the site
Confidence in map class	Evaluator's confidence in base map class assignment
Plant community	Association, alliance, or park special at site
Confidence in plant community	Evaluator's confidence in plant community assignment
Vegetation description	Cover class, dominant species by strata

scale: exact, good (some problems), poor, or none that fit. If the evaluator's confidence was less than exact, then the reasons were documented. If additional map classes or plant communities were present in the polygon, the evaluator listed alternate map classes. During the accuracy assessment fieldwork, the field crew and SBSC project leaders refined the plant community/map class key and some of the plant community descriptions. Fieldwork terminated when rain and snow made field access difficult or impossible.

Initially, the field teams sampled all polygons, regardless of size; the sample design for the first available section of the map (1/6 of the park) did not eliminate polygons of less than 0.5 ha from the sample pool. However, those initial field assessments revealed that the field sampling design should take into consideration the large number of small polygons and the associated difficulty in ensuring the correct field georeferencing of these small polygons (i.e., polygons smaller than 0.5 ha could not be located accurately with available GPS units).

Therefore, after the first rotation, all polygons smaller than 0.5 ha (the MMU) were eliminated from the sampling design and field crews were directed only to polygons larger than the MMU. The SBSC team did not consider polygons smaller than 0.5 ha in the sampling design for the other two sections and did not include most of the reference data collected in polygons of less than 0.5 ha when developing the accuracy statistics. The decision to eliminate the small polygons reduced the available number of polygons the field crew could sample for several map classes existing mostly in polygons smaller than the MMU.*

4.1.3 Field data processing and accuracy assessment statistics

Data from 420 sampling locations were entered into a Microsoft Access database designed by SBSC for the accuracy assessment effort at MEVE. The SBSC team rigorously quality-checked the data, including comparing the entered data with the original data sheets.

The SBSC team developed accuracy assessment statistics by comparing the reference map class (the map class determined in the field during accuracy assessment) to the map class in the vegetation map database (the map class assigned by the photointerpreter) at the sampled waypoint. In some cases, if the field crew could not access a sample location, they made observations from a removed location. When this occurred, the geographic coordinates of the target sample site, as determined during development of the sampling design, were the geographic location for the reference data. The team listed all sites where there was a difference in the sample and reference comparison (apparent error). The field data sheet for each apparent error was re-examined and the alternate map class accepted if it matched the reference data.

The team developed a contingency table (also known as an error matrix) to summarize the reference and sample-data comparisons for each map class. The SBSC team used methods described in the Vegetation Mapping Program guidelines (ESRI et al. 1994) to calculate user and producer accuracy (see Glossary) for individual map classes, as well as overall accuracy and a Kappa Index, which accounts for correct classifications due to chance (Foody 1992, TNC and ESRI 1994a). The

*The team also eliminated a number of reference observations collected for multiple sites within the same polygon or collected too close to the map boundary. These problems occurred because some targeted sample sites were assigned the wrong datum during development of the sampling design, causing the field crew to oversample or undersample some map classes, or sample the targeted map class near the polygon boundary.

Kappa Index was calculated for map classes that were assigned target sites; map classes that were observed in the field, but were not targeted for accuracy assessment, such as a land-cover class observed as a reference observation but not targeted as a sample, were not included in the calculation of the Kappa Index. Statistics were derived using the JMP v5.1 statistical application. The two-tailed, 90% confidence intervals for user, producer, and overall accuracy were calculated using Score Confidence Interval Tables, which have better coverage probabilities with smaller sample sizes (Agresti and Coull 1998).

4.1.4 Group and management map classes

After assessment statistics were calculated for the base map classes, the SBSC team developed two aggregated map-class schemas, the group and management map classes. The group map-class schema is an aggregation of base map classes based on the concept of the group level of the NVCS version 2 (FGDC 2008) (see Table 1.4). The SBSC team used the ecological-system assignments for associations developed by NatureServe as a substitute for assignment of group map classes, which were not available in final form at the time this project was completed.

Management map classes reflect base map-class performance and resource management needs. User and producer accuracy statistics for each map class, as well as confusion among map classes as shown on the base map contingency table, were used to develop recommendations for aggregations of commonly confused and floristically or ecologically similar map classes. MEVE resource management staff reviewed these map-class recommendations at a meeting held at the park on April 24, 2007. They made additional recommendations using management goals for particular vegetation types and vegetation classes of particular interest, regardless of their assessed accuracy performance.

The SBSC team created a crosswalk between the base map classes and each aggregated map class. The crosswalks were used to add the group and management map classes to the map database. The team also created a crosswalk between the reference data for the accuracy assessment and the group and management map classes to conduct an accuracy assessment of each aggregated map class. The number of polygons and the area of each map class within the base, group, and management map-class schemas were calculated within a GIS program.

4.2 Results

4.2.1 Accuracy assessment samples

In 2006, 420 accuracy assessment locations were sampled (Figure 4.2.1). Data from 315 of these locations were used in the accuracy assessment analysis. As described above, accuracy assessment sites were eliminated from analysis if the sampled polygon was less than 0.5 ha in size, multiple sites were erroneously sampled in the same polygon, or the sample waypoint was too close to the polygon boundary to ensure that the assessment was not of a transition zone.

4.2.2 Base map class accuracy and summary statistics

4.2.2.1 Accuracy

The overall accuracy of the 46 base map classes was 43.5%; Kappa Index was 43.8% +/- 0.03. As the Kappa Index and its standard error use only map classes with both sample and corresponding reference data, it is slightly greater than the overall accuracy. The contingency table for base map class accuracy is presented in Appendix H.

The five infrastructure and three land-use and geology map classes were not assessed (Table 4.2.2.1-1). Eight vegetated map classes were not accuracy assessed. These map classes either occurred predominantly outside park boundaries, had few polygons, or were reported directly by Colyer in 2006. All of the unassessed map classes totaled less than 0.1% of the park total land cover.

Two map classes, Douglas-fir / Boxelder Woodland and Gray Aster Herbaceous Vegetation, had both 100% user and producer accuracy. Another seven map classes met the 80% accuracy standard for either user or producer accuracy, but not both.

When the most extensive map classes were considered (Tables 4.2.2.1-1 and 4.2.2.2), accuracy was poor, with the exception of user accuracy for Gambel Oak - Mixed Montane Shrubland (70.8%) and Post-fire Mixed Herbaceous Vegetation (94.7%). However, producer accuracy was poor for both, implying that both map classes were undermapped.

4.2.2.2 Summary statistics

Seven base map classes individually contributed 2% or more to the vegetated land cover of the park; together, they constituted just over 89% of

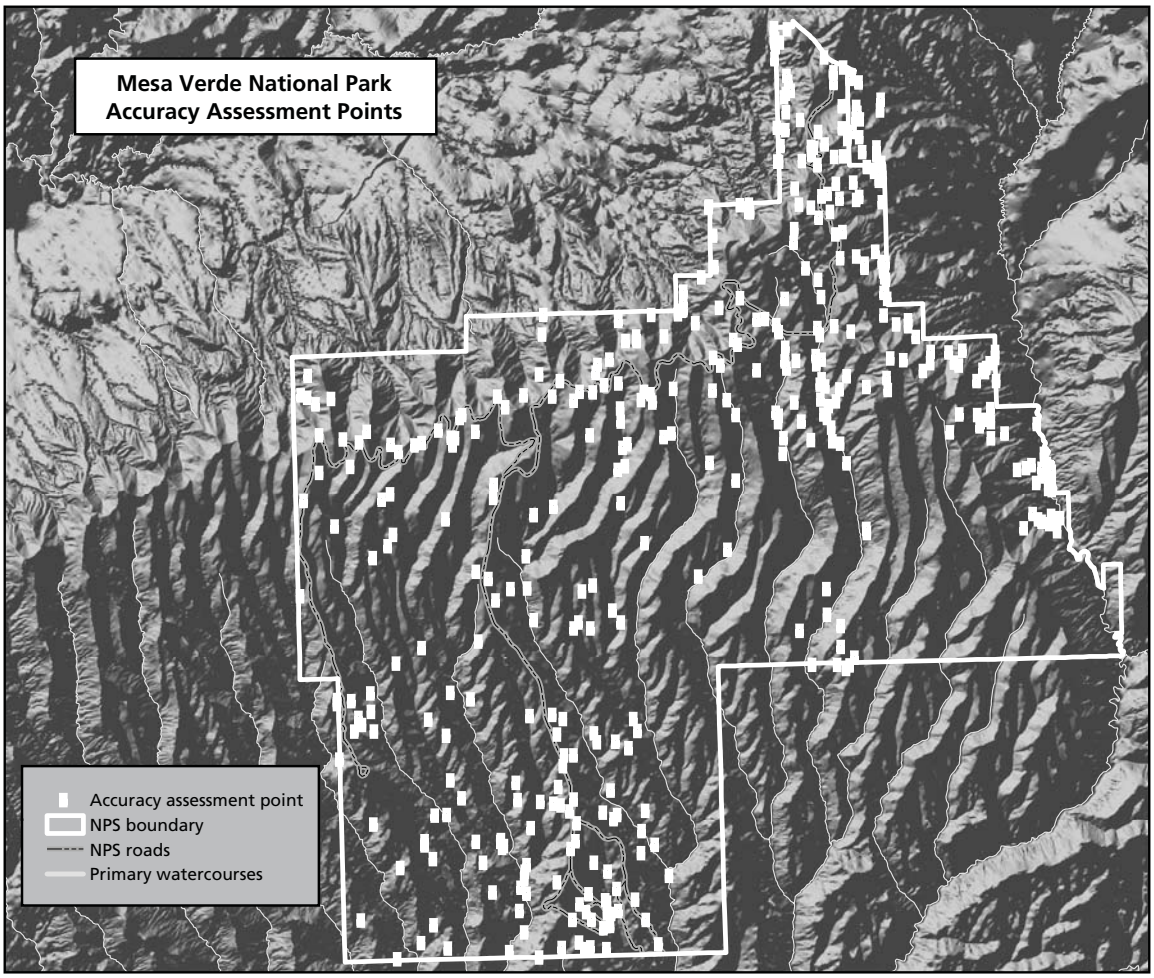


Figure 4.2.1. Location of accuracy assessment sites observed in 2006.

the total park land cover (Table 4.2.2.2). The most abundant map classes were:

l) Gambel Oak Shrubland (21.6%, Figure 4.2.2.2-1),

2) Mixed Montane Shrubland (18.1%, Figure 4.2.2.2-2);

3) Gambel Oak - Mixed Montane Shrubland (14.4%, Figure 4.2.2.2-3),

4) Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland (11.3%, Figure 4.2.2.2-4),

5) Post-Fire Mixed Herbaceous Vegetation (10.8%, Figure 4.2.2.2-5),

6) Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland (7.6%, Figure 4.2.2.2-6), and

7) Colorado Piñon - Utah Juniper / Gambel Oak Woodland (5.3%, Figure 4.2.2.2-7).

Fifteen classes contributed less than 0.05% cover each (0.0% in Table 4.2.2.2). Two map classes occurred only within the project environs: Big Sagebrush / Western Wheatgrass Shrubland and Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland. For 14 other map classes, more than half of their mapped occurrence was outside park boundaries. Additional information on the distribution of each map class can be found in Appendix G.

Table 4.2.2.1-1. Base map class accuracy statistics.

Cover type/Base map class	User accuracy[1] (%)	90% CI[2] (%)	Producer accuracy[1] (%)	90% CI[2] (%)
Infrastructure				
1 Artificial Catchment	NS	NS	0.0	NA
2 Erosion Control	NS	NS	0.0	NA
3 Park Facilities	NS	NS	0.0	NA
4 Paved Roads	NS	NS	0.0	NA
5 Rural Residential	NS	NS	0.0	NA
Land Cover and Geology				
6 Agriculture	NS	NS	0.0	NA
7 Gravel	NS	NS	0.0	NA
8 Sandstone	NS	NS	0.0	NA
Woodland and Forest				
9 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	90.5	74.9–96.8	67.9	52.3–80.2
10 Colorado Piñon - Utah Juniper / Big Sagebrush Woodland	25.0	11.8–45.5	36.4	17.5–60.6
11 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	0.0	NA	0.0	NA
12 Colorado Piñon - Utah Juniper / Gambel Oak Woodland	33.3	19.2–51.3	41.2	24.1–60.7
13 Colorado Piñon - Utah Juniper / James' Galleta Woodland	0.0	NA	NS	NS
14 Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland	42.9	26.9–60.4	32.1	19.8–47.7
15 Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland	NS	NS	0.0	NA
16 Colorado Piñon - Utah Juniper / Shale Sparse Woodland	27.8	14.2–47.1	45.5	24.2–68.5
17 Douglas-fir / Boxelder Woodland	100.0	27.0–100.0	100.0	27.0–100.0
18 Douglas-fir / Gambel Oak Forest	75.0	46.0–91.3	100.0	68.9–100.0
19 Lanceleaf Cottonwood Riparian Woodland	NS	NS	0.0	NA
20 Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland	50.0	12.1–87.9	100.0	27.0–100.0
21 Ponderosa Pine Woodland	0.0	NA	NS	NS
22 Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland	NS	NS	0.0	NA
Shrubland				
23 Big Sagebrush Shrubland	40.0	24.2–58.1	57.1	36.0–75.9
24 Big Sagebrush / James' Galleta Shrubland	NS	NS	0.0	NA
25 Big Sagebrush / Western Wheatgrass Shrubland	NS	NS	0.0	NA
26 Bitterbrush / Indian Ricegrass Shrubland	0.0	NA	NS	NS
27 Black Sagebrush Shrub Herbaceous Vegetation	16.7	3.8–50.2	33.3	7.8–74.6
28 Choke Cherry Shrubland	20.0	4.6–56.5	50.0	12.1–87.9
29 Coyote Willow / Mesic Forbs Shrubland	NS	NS	0.0	NA
30 Gambel Oak - Mixed Montane Shrubland	70.8	54.1–83.3	31.5	22.2–42.5
31 Gambel Oak Shrubland	10.0	4.1–22.6	60.0	27.2–85.7
32 Greasewood - Big Sagebrush Shrubland	50.0	12.1–87.9	20.0	4.6–56.5
33 Mixed Montane Shrubland	36.0	22.3–52.4	26.5	16.1–40.3
Herbaceous				
34 Baltic Rush Herbaceous Vegetation	40.0	14.3–72.8	66.7	25.3–92.2
35 Basin Wildrye Herbaceous Vegetation	NS	NS	0.0	NA
36 Blue Grama Herbaceous Vegetation	NS	NS	0.0	NA

Table 4.2.2.1-1. Accuracy statistics for the base map classes, cont.

Cover type/Base map class		User accuracy[1] (%)	90% CI[2] (%)	Producer accuracy[1] (%)	90% CI[2] (%)
Herbaceous, cont.					
37	Cheatgrass Semi-natural Herbaceous Vegetation	11.1	2.5–37.7	100.0	27.0–100.0
38	Gray Aster Herbaceous Vegetation	100.0	27.0–100.0	100.0	27.0–100.0
39	Mancos Shale Herbaceous Vegetation	NS	NS	0.0	NA
40	Mixed Weedy Herbaceous Vegetation	0.0	NA	0.0	NA
41	Mixed Wetland Herbaceous Vegetation	25.0	57.9–64.4	33.3	7.8–74.6
42	Post-Fire Mixed Herbaceous Vegetation	94.7	79.6–98.8	56.3	41.9–69.6
43	Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation	45.0	28.4–62.8	42.9	26.9–60.4
44	Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation	30.0	12.7–55.8	37.5	16.1–65.2
Sparse					
45	Colorado Piñon - Utah Juniper Sandstone Barrens	100.0	27.0–100.0	25.0	5.8–64.4
46	Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation	64.3	42.6–81.4	90.0	65.2–97.7

[1]Accuracy estimate
[2]Accuracy value (range)
CI = confidence interval
NS = map class not sampled
NA = not applicable; statistic could not be calculated

Table 4.2.2.2. Base map class summary statistics.

Cover type/Base map class	Number of polygons	Project area			Park area			Occurrence outside park boundaries
		Ha	Ac	% project area land cover	Ha	Ac	% park land cover	
Infrastructure								
1 Artificial Catchment	54	7	18	0.0%	3	7	0.0%	63.1%
2 Erosion Control	15	5	13	0.0%	5	13	0.0%	0.0%
3 Park Facilities	51	10	25	0.0%	10	25	0.0%	0.0%
4 Paved Roads	3	81	201	0.3%	71	175	0.3%	12.9%
5 Rural Residential	44	16	39	0.1%	0	1	0.0%	98.3%
Land Cover and Geology								
6 Agriculture	14	202	498	0.6%	12	29	0.1%	94.2%
7 Gravel	1	0	1	0.0%	0	1	0.0%	0.0%
8 Sandstone	474	49	120	0.2%	41	102	0.2%	14.9%
Woodland and Forest								
9 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	79	1,911	4,722	6.2%	1,639	4,051	7.6%	14.2%
10 Colorado Piñon - Utah Juniper / Big Sagebrush Woodland	141	1,133	2,801	3.6%	360	890	1.7%	68.2%
11 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	12	45	112	0.1%	44	108	0.2%	3.5%
12 Colorado Piñon - Utah Juniper / Gambel Oak Woodland	278	1,437	3,552	4.6%	1,154	2,852	5.3%	19.7%
13 Colorado Piñon - Utah Juniper / James' Galleta Woodland	20	195	481	0.6%	126	311	0.6%	35.3%
14 Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland	295	4,957	12,249	16.0%	2,444	6,040	11.3%	50.7%
15 Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland	2	11	28	0.0%	5	13	0.0%	51.1%
16 Colorado Piñon - Utah Juniper / Shale Sparse Woodland	223	1,101	2,721	3.5%	332	821	1.5%	69.8%
17 Douglas-fir / Boxelder Woodland	1	6	16	0.0%	6	16	0.0%	0.0%
18 Douglas-fir / Gambel Oak Forest	282	271	670	0.9%	250	618	1.2%	7.8%
19 Lanceleaf Cottonwood Riparian Woodland	24	19	46	0.1%	16	40	0.1%	13.2%
20 Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland	36	42	105	0.1%	20	50	0.1%	52.8%
21 Ponderosa Pine Woodland	13	3	7	0.0%	1	3	0.0%	51.1%
22 Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland	1	1	2	0.0%	-	-	0.0%	100.0%
Shrubland								
23 Big Sagebrush Shrubland	138	928	2,293	3.0%	189	467	0.9%	79.6%

Table 4.2.2.2. Base map class summary statistics, cont.

Cover type/Base map class	Number of polygons	Project area			Park area			Occurrence outside park boundaries
		Ha	Ac	% project area land cover	Ha	Ac	% park land cover	
Shrubland, cont.								
24 Big Sagebrush / James' Galleta Shrubland	4	21	52	0.1%	19	46	0.1%	11.7%
25 Big Sagebrush / Western Wheatgrass Shrubland	1	2	4	0.0%	-	-	0.0%	100.0%
26 Bitterbrush / Indian Ricegrass Shrubland	3	14	34	0.0%	12	30	0.1%	12.6%
27 Black Sagebrush Shrub Herbaceous Vegetation	6	16	39	0.1%	16	39	0.1%	0.0%
28 Choke Cherry Shrubland	5	22	54	0.1%	22	54	0.1%	0.0%
29 Coyote Willow / Mesic Forbs Shrubland	9	29	71	0.1%	5	12	0.0%	82.6%
30 Gambel Oak - Mixed Montane Shrubland	325	3,879	9,586	12.5%	3,114	7,694	14.4%	19.7%
31 Gambel Oak Shrubland	516	5,127	12,669	16.5%	4,671	11,542	21.6%	8.9%
32 Greasewood - Big Sagebrush Shrubland	6	121	299	0.4%	14	34	0.1%	88.5%
33 Mixed Montane Shrubland	268	4,133	10,212	13.3%	3,913	9,670	18.1%	5.3%
Herbaceous								
34 Baltic Rush Herbaceous Vegetation	9	15	36	0.0%	15	36	0.1%	0.0%
35 Basin Wildrye Herbaceous Vegetation	2	10	24	0.0%	10	24	0.0%	0.0%
36 Blue Grama Herbaceous Vegetation	1	1	4	0.0%	1	4	0.0%	0.0%
37 Cheatgrass Semi-natural Herbaceous Vegetation	29	114	282	0.4%	105	258	0.5%	8.2%
38 Gray Aster Herbaceous Vegetation	4	4	9	0.0%	4	9	0.0%	0.0%
39 Mancos Shale Herbaceous Vegetation	56	5	12	0.0%	3	8	0.0%	31.1%
40 Mixed Weedy Herbaceous Vegetation	10	36	89	0.1%	36	89	0.2%	0.0%
41 Mixed Wetland Herbaceous Vegetation	6	6	14	0.0%	6	14	0.0%	0.0%
42 Post-Fire Mixed Herbaceous Vegetation	143	3,665	9,056	11.8%	2,344	5,792	10.8%	36.0%
43 Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation	100	595	1,471	1.9%	225	556	1.0%	62.2%
44 Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation	22	177	436	0.6%	50	124	0.2%	71.6%
Sparse								
45 Colorado Piñon - Utah Juniper Sandstone Barrens	168	15	36	0.0%	13	33	0.1%	7.9%
46 Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation	1,113	633	1,564	2.0%	320	792	1.5%	49.4%
Total*	**5,007**	**31,068**	**76,772**		**21,648**	**53,494**		

*Totals are not exact due to rounding.









Clockwise from top left (this page):
Figure 4.2.2.2-1. Gambel Oak Shrubland (base map class 31).
Figure 4.2.2.2-2. Mixed Montane Shrubland (base map class 33).
Figure 4.2.2.2-3. Gambel Oak - Mixed Montane Shrubland (base map class 30).
Figure 4.2.2.2-4. Colorado Pinyon - Utah Juniper / Mixed Montane Shrub Woodland (base map class 14).







Clockwise from top left (this page):
Figure 4.2.2.2-5. Post-Fire Mixed Herbaceous Vegetation (base map class 42).
Figure 4.2.2.2-6. Colorado Pinyon - Utah Juniper / Bitterbrush / Muttongrass Woodland (base map class 9).
Figure 4.2.2.2-7. Colorado Pinyon - Utah Juniper / Gambel Oak Woodland (base map class 12).

4.2.3 Group map class accuracy and summary statistics

4.2.3.1 Accuracy

Fourteen group map classes (Figure 4.2.3.1, Appendix F) were created by aggregating the base map classes (Table 4.2.3.1-1). The overall accuracy of the group map classes (Table 4.2.3.1-2, Appendix H) was 80.3%; the Kappa Index was 76.6%± 2.8. Four of the group map classes were not assessed, as they were either infrastructure, land use, or geologically dominated cover types. The Southern Rocky Mountain Ponderosa Pine Woodland group map class was also not assessed; it consisted of a single polygon. Two of the group map classes (Colorado Plateau Piñon-Juniper Woodland and Inter-Mountain Basins Semi-Desert Grassland) met the 80% standard for both user and producer accuracy. All of the remaining vegetation types met the standard for either user or the producer accuracy, but not both. Inter-Mountain Basins Big Sagebrush Shrubland was below 80% accuracy for both the user and producer categories.

4.2.3.2 Summary statistics

The group map classes consist of five non-vegetated and nine vegetated map classes (Table 4.2.3.2). Within the park, the three most abundant group map classes were Rocky Mountain Gambel Oak-Mixed Montane Shrubland (54.2%), Colorado Plateau Piñon-Juniper Woodland (26.7%), and Inter-Mountain Basins Big Sagebrush Shrubland (12.8%). Together, they constituted 93.7% of the park's vegetated cover.

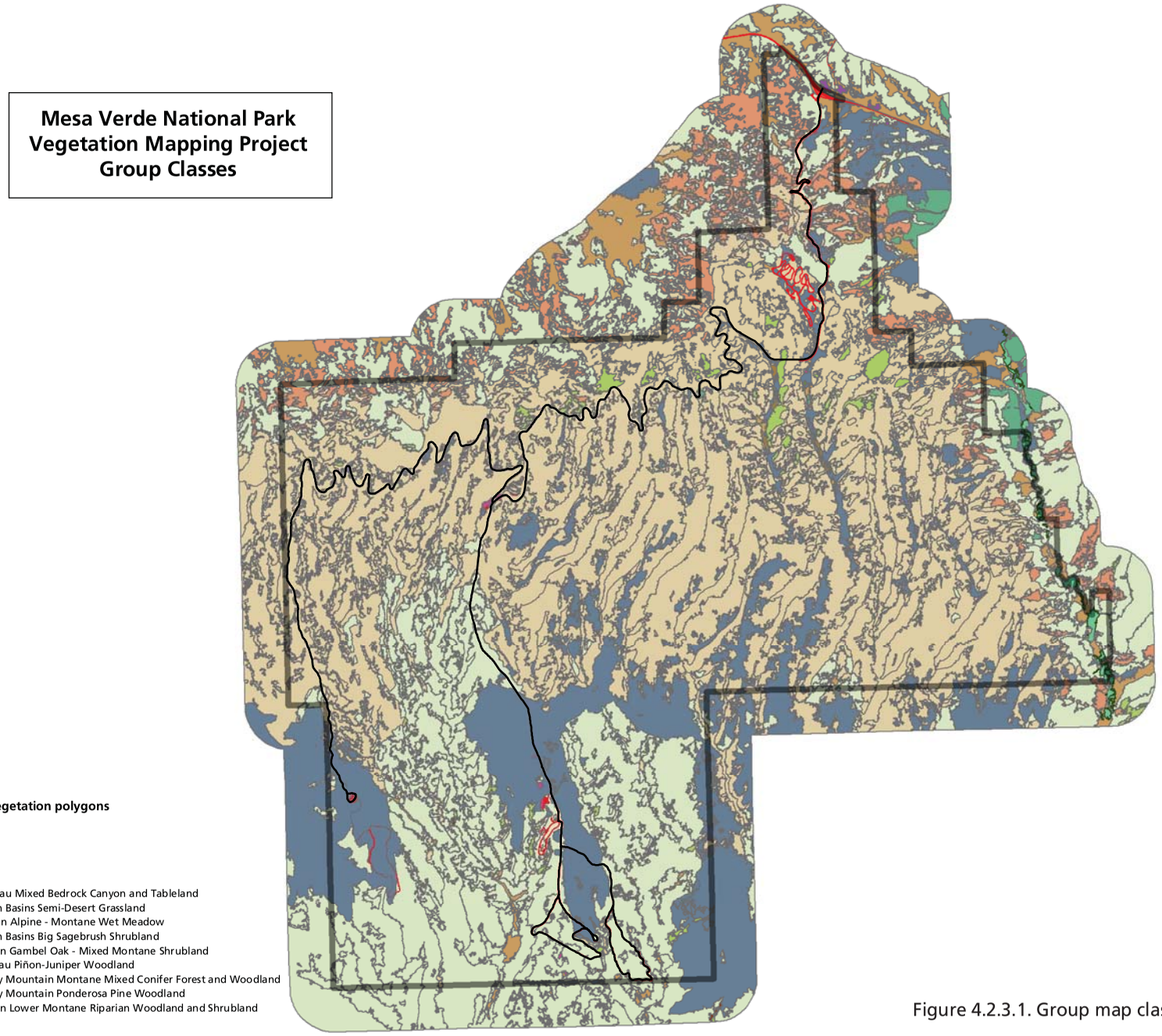


Figure 4.2.3.1. Group map classes.

Table 4.2.3.1-1. Crosswalk of group map classes and base map classes.

Group map class		Base map class	
Non-vegetated			
1	Agriculture	1	Artificial Catchment
		2	Erosion Control
		6	Agriculture
2	Park Facilities	3	Park Facilities
3	Transportation	4	Paved Roads
4	Residential	5	Rural Residential
5	Barren	7	Gravel
		8	Sandstone
Vegetated			
6	Colorado Plateau Mixed Bedrock Canyon and Tableland	16	Colorado Piñon - Utah Juniper / Shale Sparse Woodland
		38	Gray Aster Herbaceous Vegetation
		39	Mancos Shale Herbaceous Vegetation
		46	Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation
7	Inter-Mountain Basins Semi-Desert Grassland	27	Black Sagebrush Shrub Herbaceous Vegetation
		36	Blue Grama Herbaceous Vegetation
		37	Cheatgrass Semi-natural Herbaceous Vegetation
		40	Mixed Weedy Herbaceous Vegetation
		42	Post-Fire Mixed Herbaceous Vegetation
		43	Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation
		44	Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation
8	Rocky Mountain Alpine - Montane Wet Meadow	34	Baltic Rush Herbaceous Vegetation
		41	Mixed Wetland Herbaceous Vegetation
9	Inter-Mountain Basins Big Sagebrush Shrubland	23	Big Sagebrush Shrubland
		24	Big Sagebrush / James' Galleta Shrubland
		25	Big Sagebrush / Western Wheatgrass Shrubland
		32	Greasewood - Big Sagebrush Shrubland
		35	Basin Wildrye Herbaceous Vegetation
10	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	26	Bitterbrush / Indian Ricegrass Shrubland
		28	Choke Cherry Shrubland
		30	Gambel Oak - Mixed Montane Shrubland
		31	Gambel Oak Shrubland
		33	Mixed Montane Shrubland
11	Colorado Plateau Piñon-Juniper Woodland	9	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland
		10	Colorado Piñon - Utah Juniper / Big Sagebrush Woodland
		11	Colorado Piñon - Utah Juniper / Black Sagebrush Woodland
		12	Colorado Piñon - Utah Juniper / Gambel Oak Woodland
		13	Colorado Piñon - Utah Juniper / James' Galleta Woodland
		14	Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland
		15	Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland
		22	Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland
		45	Colorado Piñon - Utah Juniper Sandstone Barrens
12	Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland	17	Douglas-fir / Boxelder Woodland
		18	Douglas-fir / Gambel Oak Forest
13	Southern Rocky Mountain Ponderosa Pine Woodland	21	Ponderosa Pine Woodland
14	Rocky Mountain Lower Montane Riparian Woodland and Shrubland	19	Lanceleaf Cottonwood Riparian Woodland
		20	Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland
		29	Coyote Willow / Mesic Forbs Shrubland

Table 4.2.3.1-2. Group map class accuracy statistics.

Group map class		User accuracy[1] (%)	90% CI[2] (range in %)	Producer accuracy[1] (%)	90% CI[2] (range in %)
Non-vegetated					
1	Agriculture	NS	NS	0.0	NA
2	Park Facilities	NS	NS	0.0	NA
3	Transportation	NS	NS	0.0	NA
4	Residential	NS	NS	0.0	NA
5	Barren	NS	NS	0.0	NA
Vegetated					
6	Colorado Plateau Mixed Bedrock Canyon and Tableland	63.6	49.3–75.9	87.5	72.5–94.9
7	Intermountain Basins Semi-Desert Grassland	83.3	74.5–89.5	80.9	71.9–87.5
8	Rocky Mountain Alpine - Montane Wet Meadow	66.7	39.8–85.8	100.0	68.9–100.0
9	Intermountain Basins Big Sagebrush Shrubland	54.5	37.6–70.5	63.2	44.4–78.6
10	Rocky Mountain Gambel Oak - Mixed Montane Shrubland	89.4	82.7–93.7	79.2	71.6–85.4
11	Colorado Plateau Piñon-Juniper Woodland	85.2	77.9–90.4	84.3	76.9–89.6
12	Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland	77.8	50.4–92.3	100	72.1–100.0
13	Southern Rocky Mountain Ponderosa Pine Woodland	0.0	NA	NS	NS
14	Rocky Mountain Lower Montane Riparian Woodland and Shrubland	50	12.1–87.9	100	27.0–100.0

[1]Accuracy estimate
[2]Accuracy value (range)
CI = confidence interval
NS = map class not sampled
NA = not applicable; statistic could not be calculated

Table 4.2.3.2. Group map class summary statistics.

Group map class	Number of polygons	Project area			Park area			Occurrence outside park boundaries
		Ha	Ac	% project area land cover	Ha	Ac	% project area land cover	
Non-vegetated								
1 Agriculture	83	213.9	528.6	0.7%	19.4	48.0	0.1%	90.9%
2 Park Facilities	51	10.0	24.7	0.0%	10.0	24.7	0.0%	0.0%
3 Transportation	3	81.3	201.0	0.3%	70.8	174.9	0.3%	12.9%
4 Residential	44	15.9	39.3	0.1%	0.3	0.7	0.0%	98.3%
5 Barren	475	49.1	121.3	0.2%	41.8	103.3	0.2%	14.8%
Vegetated								
6 Colorado Plateau Mixed Bedrock Canyon and Tableland	1,396	1,742.6	4,306.2	5.6%	659.6	1,629.9	3.0%	62.1%
7 Inter-Mountain Basins Semi-Desert Grassland	311	4,604.3	11,377.4	14.8%	2,777.3	6,862.9	12.8%	39.7%
8 Rocky Mountain Alpine - Montane Wet Meadow	15	20.3	50.2	0.1%	20.3	50.2	0.1%	0.0%
9 Inter-Mountain Basins Big Sagebrush Shrubland	151	1,081.0	2,671.2	3.5%	231.1	571.2	1.1%	78.6%
10 Rocky Mountain Gambel Oak - Mixed Montane Shrubland	1,117	13,174.4	32,554.7	42.4%	11,731.7	28,989.7	54.2%	11.0%
11 Colorado Plateau Piñon-Juniper Woodland	996	9,705.1	23,981.9	31.2%	5,786.7	14,299.1	26.7%	40.4%
12 Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland	283	277.6	686.0	0.9%	256.4	633.6	1.2%	7.6%
13 Southern Rocky Mountain Ponderosa Pine Woodland	13	2.9	7.1	0.0%	1.4	3.5	0.0%	51.1%
14 Rocky Mountain Lower Montane Riparian Woodland and Shrubland	69	90.0	222.3	0.3%	41.3	102.0	0.2%	54.1%

4.2.4 Management map class accuracy and summary statistics

4.2.4.1 Accuracy

Twenty-two management map classes were created by aggregating the base map classes (Figure 4.2.4.1, Table 4.2.4.1-1, Appendix F). The overall accuracy of the management map classes (Table 4.2.4.1-2, Appendix H) was 73.3%; Kappa Index was 70.8% +/-0.03. Seven non-vegetated map classes were not assessed. In addition, Colorado Piñon - Utah Juniper / Black Sagebrush Woodland was not assessed (because of logistical difficulties); nor was Ponderosa Pine Woodland, which comprised less than 0.05% of the project area land cover. Five of the management map classes met the 80% standard for user accuracy, and six met the standard for producer accuracy. Only the Disturbed Semi-natural Vegetation and Douglas-fir / Box Elder Woodland management map classes were above 80% for both user and producer accuracy.

4.2.4.2 Summary statistics

The 22 management map classes consist of seven non-vegetated classes and 15 vegetated classes (Table 4.2.4.2). Within the park, the three most abundant classes were Mixed Montane Shrubland (54.2%), Colorado Piñon - Utah Juniper / Mixed Montane Shrubland (16.6%), and Disturbed Semi-natural Vegetation (11.3%). These constituted 82.1% of the park vegetation.

4.3 Discussion

4.3.1 Challenges

The accuracy assessment effort at Mesa Verde National Park was difficult for several reasons:

1. The map database for accuracy assessment arrived in three sections. As a result, the sampling design was developed independently for each section, and adjustments made only after all three sections were compiled. This led to inefficiencies in field-crew logistics and in developing the overall sampling design.

2. The field season at Mesa Verde is short. Inefficiencies in start-up could not be compensated for at the end of the field season because of weather conditions. Another constraint on field sampling was limited access to some sites because of safety concerns or lack of permission for access.

3. Accurate field assessment of polygon boundaries could not be completed for polygons smaller than the MMU and with highly convoluted polygon perimeters, as developed by Definiens Professional modeling. The location error in these cases, as determined by GPS, was often greater than the distance to the mapped polygon boundary. The SBSC team either could not include these polygons in the accuracy assessment sampling design or had to eliminate sample point data due to lack of certainty of the field assessment in relation to the polygon boundaries.

However, the accuracy assessment metrics presented here allow a user of the vegetation map database to evaluate the performance of each map-class schema and of the individual map classes within that schema. Additional information on the sources of confusion between map classes using the contingency tables can be found in Appendix H.

Ancillary products related to accuracy assessment include Appendix D (all field species including those identified within accuracy assessment observation sites) and Appendix E (field sheets used for observations).

4.3.2 Uses and limitations of the vegetation map database and affiliated products

The vegetation map database provides three representations of MEVE vegetation. The finest spatial resolution, represented by the base map classes, offers the best spatial detail with the lowest accuracy. Both the group and management map classes represent the vegetation at coarser resolution but with greater accuracy. Each representation provides information, and the representation chosen for any particular objective should be evaluated using the accuracy assessment and summary statistics tables provided in this report.

The vegetation map database and ancillary products produced during the project can provide both background and direct input to a number of park and SCPN activities. Other national park units have used products from vegetation classification, distribution, and mapping projects to conduct activities related to resource management, environmental compliance, planning (locating new features), fire management planning, habitat modeling, education and interpretation, inventory and monitoring (placement of sample sites), research, and cooperative work with adjacent land owners.

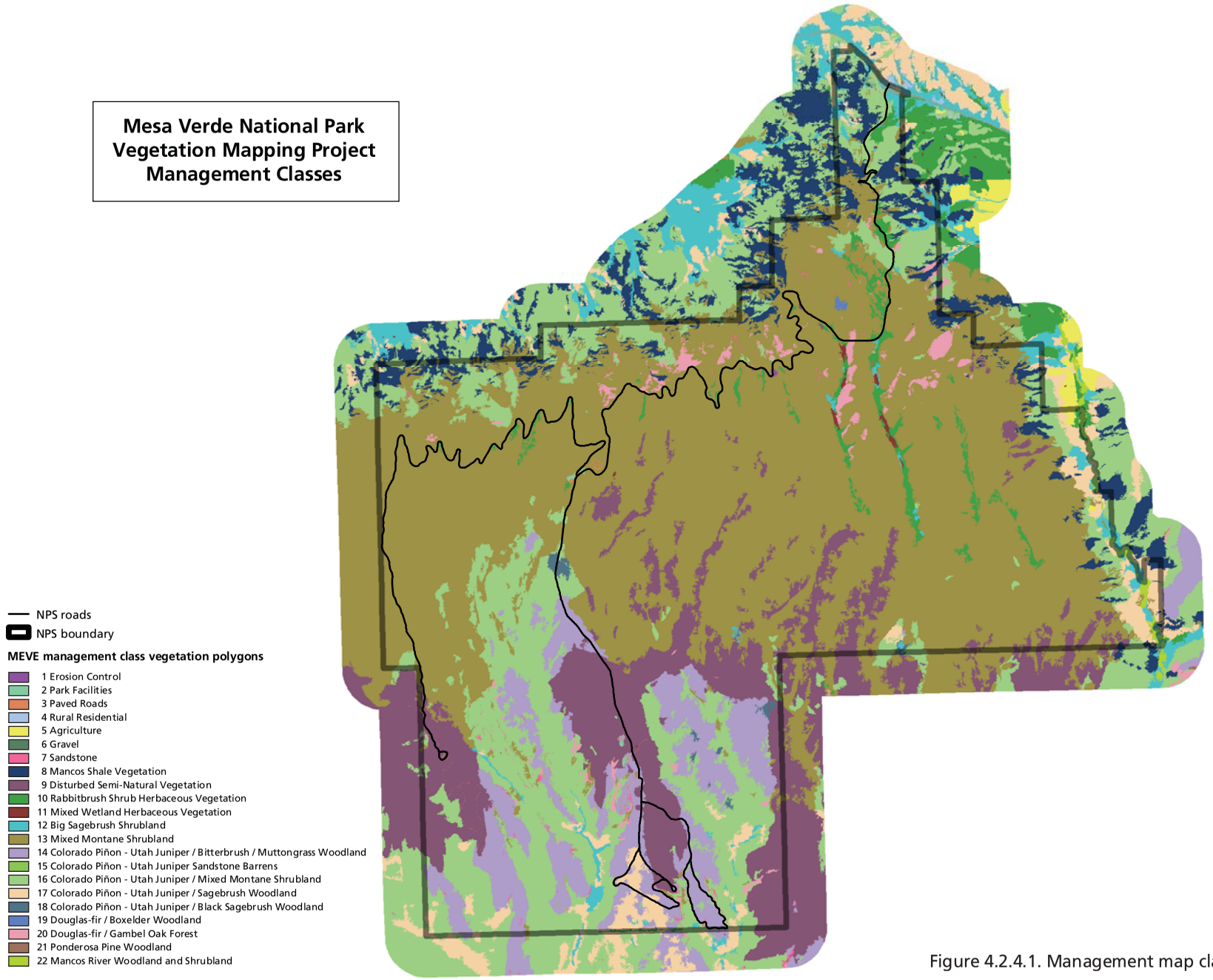


Figure 4.2.4.1. Management map classes.

Table 4.2.4.1-1. Crosswalk of management map classes and base map classes.

Management map class		Base map class
Non-vegetated		
1	Erosion Control	2 Erosion Control
2	Park Facilities	3 Park Facilities
3	Paved Roads	4 Paved Roads
4	Rural Residential	5 Rural Residential
5	Agriculture	6 Agriculture
6	Gravel	7 Gravel
7	Sandstone	8 Sandstone
Vegetated		
8	Mancos Shale Vegetation	16 Colorado Piñon - Utah Juniper / Shale Sparse Woodland 38 Gray Aster Herbaceous Vegetation 39 Mancos Shale Herbaceous Vegetation 46 Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation
9	Disturbed Semi-natural Vegetation	37 Cheatgrass Semi-natural Herbaceous Vegetation 42 Post-Fire Mixed Herbaceous Vegetation
10	Rabbitbrush Shrub Herbaceous Vegetation	27 Black Sagebrush Shrub Herbaceous Vegetation 40 Mixed Weedy Herbaceous Vegetation 43 Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation 44 Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation
11	Mixed Wetland Herbaceous Vegetation	1 Artificial Catchment 34 Baltic Rush Herbaceous Vegetation 41 Mixed Wetland Herbaceous Vegetation
12	Big Sagebrush Shrubland	23 Big Sagebrush Shrubland 24 Big Sagebrush / James' Galleta Shrubland 25 Big Sagebrush / Western Wheatgrass Shrubland 32 Greasewood - Big Sagebrush Shrubland 35 Basin Wildrye Herbaceous Vegetation
13	Mixed Montane Shrubland	26 Bitterbrush / Indian Ricegrass Shrubland 28 Choke Cherry Shrubland 30 Gambel Oak - Mixed Montane Shrubland 31 Gambel Oak Shrubland 33 Mixed Montane Shrubland
14	Colorado Pinon - Utah Juniper / Sagebrush Woodland	10 Colorado Pinon - Utah Juniper / Big Sagebrush Woodland 13 Colorado Pinon - Utah Juniper / James' Galleta Woodland 15 Colorado Pinon - Utah Juniper / Needle-and-Thread Woodland 36 Blue Grama Herbaceous Vegetation
15	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	9 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland
16	Colorado Piñon - Utah Juniper Sandstone Barrens	45 Colorado Piñon - Utah Juniper Sandstone Barrens
17	Colorado Piñon - Utah Juniper / Mixed Montane Shrubland	12 Colorado Piñon - Utah Juniper / Gambel Oak Woodland 14 Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland 22 Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland
18	Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	11 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland
19	Douglas-fir / Boxelder Woodland	17 Douglas-fir / Boxelder Woodland
20	Douglas-fir / Gambel Oak Forest	18 Douglas-fir / Gambel Oak Forest
21	Ponderosa Pine Woodland	21 Ponderosa Pine Woodland
22	Mancos River Woodland and Shrubland	19 Lanceleaf Cottonwood Riparian Woodland 20 Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland 29 Coyote Willow / Mesic Forbs Shrubland

Table 4.2.4.1-2. Management map class accuracy statistics.

Management map class	User accuracy[1] (%)	90% CI[2] (range in %)	Producer accuracy[1] (%)	90% CI[2] (range in %)
Non-vegetated				
1 Erosion Control	NS	NS	0.0	NA
2 Park Facilities	NS	NS	0.0	NA
3 Paved Roads	NS	NS	0.0	NA
4 Rural Residential	NS	NS	0.0	NA
5 Agriculture	NS	NS	0.0	NA
6 Gravel	NS	NS	0.0	NA
7 Sandstone	NS	NS	0.0	NA
Vegetated				
8 Mancos Shale Vegetation	63.6	49.3–75.9	87.5	72.5–94.9
9 Disturbed Semi-Natural Vegetation	92.9	80.6–97.6	81.3	67.6–90.0
10 Rabbitbrush Shrub Herbaceous Vegetation	68.4	55.2–79.2	72.2	58.7–82.6
11 Mixed Wetland Herbaceous Vegetation	77.8	50.4–92.4	100.0	72.1–100.0
12 Big Sagebrush Shrubland	54.5	37.6–70.5	63.2	44.4–78.6
13 Mixed Montane Shrubland	89.4	82.7–93.7	79.2	71.6–85.1
14 Colorado Piñon - Utah Juniper / Sagebrush Woodland	33.3	19.2–51.3	63.6	39.4–82.5
15 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	90.5	74.9–96.8	67.9	52.3–80.2
16 Colorado Piñon - Utah Juniper Sandstone Barrens	100.0	27.0–100.0	25.0	5.8–64.4
17 Colorado Piñon - Utah Juniper / Mixed Montane Shrubland	66.7	54.0–77.3	62.2	50.0–73.1
18 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	0.0	NA	0.0	NA
19 Douglas-fir / Boxelder Woodland	100.0	27.0–100.0	100.0	27.0–100.0
20 Douglas-fir / Gambel Oak Forest	75.0	46.0–91.3	100.0	68.9–100.0
21 Ponderosa Pine Woodland	0.0	NA	NS	NS
22 Mancos River Woodland and Shrubland	50.0	12.1–87.9	100.0	27.0–100.0

[1]Accuracy estimate
[2]Accuracy value (range)
CI = confidence interval
NS = map class not sampled
NA = not applicable; statistic could not be calculated

Table 4.2.4.2. Management map class summary statistics.

Management map class	Number of polygons	Project area			Park area			Occurrence outside park boundaries
		Ha	Ac	% project area land cover	Ha	Ac	% project area land cover	
Non-vegetated								
1 Erosion Control	15	5.1	12.5	0.0%	5.1	12.5	0.0%	0.0%
2 Park Facilities	51	10.0	24.7	0.0%	10.0	24.7	0.0%	0.0%
3 Paved Roads	3	81.3	201.0	0.3%	70.8	174.9	0.3%	12.9%
4 Rural Residential	44	15.9	39.3	0.1%	0.3	0.7	0.0%	98.3%
5 Agriculture	14	201.5	498.0	0.6%	11.6	28.8	0.1%	94.2%
6 Gravel	1	0.3	0.8	0.0%	0.3	0.8	0.0%	0.0%
7 Sandstone	474	48.7	120.4	0.2%	41.5	102.5	0.2%	14.9%
Vegetated								
8 Mancos Shale Vegetation	1,396	1,742.6	4,306.2	5.6%	659.6	1,629.9	3.0%	62.1%
9 Disturbed Semi-Natural Vegetation	172	3,778.7	9,337.3	12.2%	2,448.6	6,050.6	11.3%	35.2%
10 Rabbitbrush Shrub Herbaceous Vegetation	138	824.1	2,036.5	2.7%	327.3	808.7	1.5%	60.3%
11 Mixed Wetland Herbaceous Vegetation	69	27.6	68.3	0.1%	23.0	56.9	0.1%	16.7%
12 Big Sagebrush Shrubland	151	1,081.0	2,671.2	3.5%	231.1	571.1	1.1%	78.6%
13 Mixed Montane Shrubland	1,117	13,174.4	32,554.7	42.4%	11,731.7	28,989.7	54.2%	11.0%
14 Colorado Piñon - Utah Juniper / Sagebrush Woodland	164	1,340.7	3,312.9	4.3%	492.1	1,218.3	2.3%	63.3%
15 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland	79	1,910.9	4,722.0	6.2%	1,639.3	4,050.9	7.6%	14.2%
16 Colorado Piñon - Utah Juniper Sandstone Barrens	168	14.6	36.0	0.0%	13.4	33.2	0.1%	7.9%
17 Colorado Piñon - Utah Juniper / Mixed Montane Shrubland	574	6,395.0	15,802.4	20.6%	3,598.5	8,892.1	16.6%	43.7%
18 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland	12	45.4	112.2	0.1%	43.8	108.3	0.2%	3.5%
19 Douglas-fir / Boxelder Woodland	1	6.4	15.9	0.0%	6.4	15.9	0.0%	0.0%
20 Douglas-fir / Gambel Oak Forest	282	271.2	670.1	0.9%	250.0	617.7	1.2%	7.8%
21 Ponderosa Pine Woodland	13	2.9	7.1	0.0%	1.4	3.5	0.0%	51.1%
22 Mancos River Woodland and Shrubland	69	90.0	222.3	0.3%	41.3	102.0	0.2%	54.1%

Chapter 5
Literature Cited

Adams, K. R. 1991. Mesa Verde fire effects: An ecological and ethnobotanical study of vegetation recovery after the Long Mesa Fire of July 1989. Crow Canyon Archaeological Center, Cortez, Colorado. Report submitted to Mesa Verde National Park, Mesa Verde, Colorado.

——. 1993. Mesa Verde fire effects: An ecological and ethnobotanical study of vegetation recovery after the Long Mesa Fire of July 1989. Crow Canyon Archaeological Center, Cortez, Colorado. Report submitted to Mesa Verde National Park, Mesa Verde, Colorado.

Agresti, A., and B. A. Coull. 1998. Approximate is better than 'exact' for interval estimation of binomial parameters. The American Statistician **52**:119–126.

Anderson. J., E. Hardy, J. Roach, and R. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional paper 964. Washington, D.C.: U.S. Government Printing Office.

Bader, E. H. 1932. The vegetation of the Mesa Verde National Park, Colorado: A preliminary study. Unpublished thesis, University of Colorado, Boulder, Colorado.

Chung-MacCoubrey, A. L., and M. A. Bogan. 2003. Bats of the piñon-juniper woodlands of southwestern Colorado. Pages 131–150 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. Ecological systems of the United States: A working classification of the U.S. terrestrial systems. Arlington, Va.: NatureServe.

Decker, K., and J. Coles. 2003. Preliminary vegetation classification for Arches National Park. Draft report by Engineering-Environmental Management, Inc., and Colorado Natural Heritage Program for the National Park Service.

Doesken, N. J., and T. B. McKee. 2003. The climate history of southwestern Colorado. Pages 247–258 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Synder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. U.S. Forest Service Miscellaneous Publication 1439. Washington, D.C.: U.S. Forest Service.

Dufrêne, M., and P. Legendre. 1997. Species assemblages and indicator species: The need for a flexible asymmetrical approach. Ecological Monographs **67**(3):345–366.

Environmental Systems Research Institute (ESRI), National Center for Geographic Information and Analysis, and The Nature Conservancy. 1994. Accuracy assessment procedures. NBS/NPS Vegetation Mapping Program. Report to U.S. Department of Interior National Biological Survey and National Park Service. http://biology.usgs.gov/npsveg/classification/index.html.

Federal Geographic Data Committee (FGDC). 1997. Vegetation classification standard. http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/vegclass.pdf.

——. 2008. National Vegetation Classification Standard, Version 2. http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS_V2_FINAL_2008-02.pdf

Flint-Lacey, P. R. 2003. The Ancestral Puebloans and their piñon-juniper woodlands. Pages 309–320 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Floyd, L. 2003. Ancient piñon-juniper woodlands: A natural history of Mesa Verde coun-

try. Boulder: University Press of Colorado.

Floyd, M. L., D. D. Hanna, and W. H. Romme. 2004. Historical and recent fire regimes in piñon-juniper woodlands on Mesa Verde, USA. Forest Ecology and Management **198**:269–289.

Floyd, M. L., D. Hanna, W. H. Romme, and T. E. Crews. 2006. Predicting and mitigating weed invasions to restore natural post-fire succession in Mesa Verde National Park, Colorado, USA. *International Journal of Wildland Fire* **15**(2):247–259.

Floyd-Hanna, M. L., W. H. Romme, and D. D. Hanna. 1994. Vegetation of Mesa Verde National Park. Unpublished report on file at Mesa Verde National Park, Colorado.

Floyd, L., W. H. Romme and D. D. Hanna. 2000. Fire history and vegetation pattern in Mesa Verde National Park, Colorado, USA. Ecological Applications **10**(6):1666–1680.

Floyd, M. L., W. H. Romme, and D. D. Hanna. 2003. Fire history. Pages 261–278 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Foody, G. M. 1992. Classification accuracy assessment: Some alternatives to the kappa coefficient for nominal and ordinal level classifications. Remote sensing from research to operation. Nottingham, U.K.: Remote Sensing Society.

Gilliam, M. L. 2003. Landforms and surficial deposits. Pages 197–212 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Griffiths, M. O. 1990. Guide to the geology of Mesa Verde National Park. Salt Lake City, Ut.: Lorraine Press.

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodlin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: Terrestrial vegetation of the United States, Volume I. The National Vegetation Classification System: Development, status, and applications. Arlington, Va.: The Nature Conservancy.

Hanna, D. D., and T. B. Graham. 2003. Reptiles and amphibians of the piñon-juniper woodlands. Pages 151–166 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Hanna, D. D., L. Floyd-Hanna, and D. Hanna. 2008. Mapping successional communities in post-fire vegetation, Mesa Verde National Park. Final Report submitted to the National Park Service.

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* Kartesz, J. T., and C. A. Meacham. Synthesis of the North American flora [computer program]. Version 1.0. Chapel Hill, N.C.: North Carolina Botanical Garden.

Kent, M., and P. Coker. 1992. Vegetation description and analysis: A practical approach. New York: John Wiley & Sons, 362.

Lamb, S. 2001. Mesa Verde National Park: Life, earth, sky. Mariposa, Ca.: Sierra Press.

McCune, B., and M. J. Mefford. 1999. PC-ORD. Multivariate analysis of ecological data, ver. 4. MjM Software Design. Gleneden Beach, Oregon.

McCune, B., and J. B. Grace. 2002. Analysis of ecological communities. MjM Software Design. Gleneden Beach, Oregon.

Moore, L. 2005a. Inventory and monitoring of select species of concern: Mesa Verde National Park, final report. Windom Floristics, Casper, Wyoming. Report on file, Mesa Verde National Park, Colorado.

——. 2005b. Post-fire monitoring of ponderosa pine (*Pinus ponderosa* P & C Lawson), Mesa Verde National Park, Colorado. Windom Floristics, Casper, Wyoming. Report on file, Mesa Verde National Park, Colorado.

Mueller-Dombois, D., and H. Ellenberg. 2002. Aims and methods of vegetation ecology. Caldwell, N.J.: Blackburn Press.

National Park Service (NPS). 1999. Natural resource challenge: The National Park Service's action plan for preserving natural resources. Washington, D.C.: U.S. Department of the Interior, National Park Service Natural Resource Stewardship and Science. http://www.nature.nps.gov/challengedoc.

Nordenskiöld, G. 1979. The cliff dwellers of the Mesa Verde, Southwestern Colorado: Their pottery and implements. Translated by L. Morgan. Glorieta, N.M.: Rio Grande Press.

Ramsey, D. 2003. Soils of Mesa Verde country. Pages 213–222 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

San Miguel, G. L. and M. Colyer. 2003. Mesa Verde country's woodland avian community. Pages 89–110 *in* L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Sommers, P., D. D. Hanna, M. Colyer, and M. L. Floyd. 2003. Mammals of the old-growth piñon-juniper. Pages 111–130 in L. Floyd, ed., Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

The Nature Conservancy and Environmental Systems Research Institute (TNC and ESRI). 1994a. Standardized national vegetation classification system. Report to U.S. Department of Interior National Biological Survey and National Park Service. http://biology.usgs.gov/npsveg/classification/index.html.

——. 1994b. Field methods for vegetation mapping: NBS/NPS Vegetation Mapping Program (final draft). Report to U.S. Department of Interior National Biological Survey and National Park Service. http://biology.usgs.gov/npsveg/classification/index.html.

——. 1996. Methodology for assessing the utility of existing data for vegetation mapping. Report to U.S. Department of Interior National Biological Survey and National Park Service. http://biology.usgs.gov/npsveg/classification/index.html.

UNESCO. 1973. International classification and mapping of vegetation. Paris: UNESCO.

von Loh et al. 2006. Draft Colorado National Monument vegetation mapping project report. Northern Colorado Plateau Network, National Park Service, Moab, Utah.

Welsh, S. L., and J. A. Erdman. 1964. Annotated checklist of the plants of Mesa Verde, Colorado. Brigham Young University Science Bulletin, Biological Series 4(2):1–32.

Wenger, G. R. 1980. The story of Mesa Verde National Park. Mesa Verde Museum Association, Inc., Mesa Verde National Park, Colorado.

Glossary

Glossary modified from USGS-NPS Vegetation Mapping Program
http://biology.usgs.gov/npsveg/glossary.html

Accuracy: The closeness of results of observations, computations, or estimates to the true values or to values that are accepted as being true (Rabchevsky 1984). In the USGS-NPS Vegetation Mapping Program there are two aspects of accuracy: thematic and positional accuracy.

Accuracy assessment: The process of determining the positional and thematic accuracy of the spatial vegetation community data. This is an independent process performed after the vegetation mapping and classification is complete.

Accuracy assessment point: A location where accuracy assessment data are collected.

Aerial photography: Analog imagery taken from an airplane. The optical axis is oriented perpendicular to the earth's surface so that the film is parallel to the surface being photographed. (also Vertical Aerial Photography). A sequence of aerial photographs will overlap so the photos can be used in stereoscopic analysis (stereo pairs). The overlap is referred to as "endlap" (top-to-bottom area in common, same flightline) and "sidelap" (side-to-side area in common, different flightlines) (portions from Rabchevsky 1984). Aerial photography used in the program is 9 × 9-inch vertical, stereoscopic, color or color infrared photography.

Alliance: A physiognomically uniform group of associations sharing one or more diagnostic (dominant, differential, indicator, or character) species that, as a rule, are found in the uppermost stratum of the vegetation (FGDC 1997). This is the second-finest level in the National Vegetation Classification Standard hierarchy. See the table under USNVC.

Anderson Classification System: A land cover/land use classification system developed for use with remote sensing systems in the 1970s adopted for the USGS-NPS Vegetation Mapping Program to map cultural land cover (Anderson et al. 1976).; see next page.

Association: The finest level of the National Vegetation Classification Standard. The association is a physiognomically uniform group of vegetation stands that share one or more diagnostic (dominant, differential, indicator, or character) overstory and understory species. These elements occur as repeatable patterns of assemblages across the landscape, and are generally found under similar habitat conditions (FGDC 1997). See table under USNVC an example. Within the program association is the preferred term, but it is also synonymous with community, community type, plant community, type, vegetation community, and vegetation type.

Attribute: (digital data) A numeric, text, or image data field in a relational database table (such as a GIS) that describes a spatial feature (point, line, polygon, cell) (ESRI 1994).

Automate: The process of entering data into a computer. Synonymous with digitize.

Base map: The source or control from which all spatial data are developed and geo-referenced to. Photo interpreted data are transferred to a base to rectify and register the data. For this program, base maps consist of USGS DOQQs or specially made orthophotos.

Class: The level in the National Vegetation Classification Standard hierarchy based on the structure of the vegetation and determined by the relative percentage of cover and the height of the dominant, uppermost life forms (Grossman et al. 1998). See the table under USNVC.

Classification accuracy: How closely the map classes match the vegetation communities found on the landscape. This is determined by accuracy assessment protocols. See "Producing rigorous

Anderson Classification System.

Level I	Level II
Urban or Built-up Land	Residential Commercial and Services Industrial Transportation, Communications, and Utilities Industrial and Commercial Complexes Mixed Urban or Built-up Land Other Urban or Built-up Land
Agricultural Land	Cropland and Pasture Orchard, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas Confined Feeding Operations Other Agricultural Lands
Water (nonvegetated portion)	Streams and Canals Lakes Reservoirs Bays and Estuaries
Barren Land	Dry Salt Flats Beaches Sandy Areas other than Beaches Strip Mines, Quarries, and Gravel Pits Transitional Areas Mixed Barren Lands
Perennial Snow or Ice	Perennial Snowfields Glaciers

Note: This is not the complete Anderson Level II Classification. Areas of natural vegetation are classified under the NVCS.

and consistent accuracy assessment procedures" at http://biology.usgs.gov/npsveg/aa/index.html for more information. Also see producer and user accuracy.

Community: An assemblage of species that co-occur in defined areas at certain times and have the potential to interact with one anther (Grossman et al. 1998). May also refer to an association in the USNVC, but this is not preferred.

Contingency table: A table that compares mapped data with ground data to determine accuracy. The "known" classes derived from accuracy assessment plots are compared to the classes derived from photo interpretation. The results are then tabulated in the form of a contingency table to determine the degree of misclassification that has occurred between classes. Also referred to as error matrix, confusion matrix, or misclassification matrix. For an example of a contingency table see http://biology.usgs.gov/npsveg/scbl/aa_matrix.html.

Cover: The area of ground covered by the vertical projection of the aerial parts of plants of one or more species. (FGDC 1997).

Cover type: A designation based upon the plant species forming a plurality of composition within a given area (e.g., Oak–Hickory) (FGDC 1977). Also refers to an alliance or group of alliances in the USNVC.

Coverage: A file format used by Arc/Info software for vector spatial data.

Crosswalk: Relationship between the elements of two classification systems. For example, there is a crosswalk between map classes and units of the NVCS. This relationship is often shown in a look up table (LUT).

Datum: A mathematical model that describes the size and shape of the ellipsoid (Earth is not a sphere, but an ellipsoid distorted by rotation about its axis, with the globe bulging at the equator and flattened at the poles). The flattening is not uniform around the Earth due to the influence of the continents location (Snyder 1982). Using the wrong datum in relation to geographic coordinates can result in errors of hundreds of meters in position. This Program uses the North American Datum (NAD) of 1983 or NAD83.

Density: Density is the relationship between the area covered by the overstory of a vegetation community and the total area of a polygon in which the community is found. One of the physiognomic modifiers classified in the USGS-NPS Vegetation Mapping Program. Density in map units is classified as Closed/Continuous >60 %, Discontinuous 40–60%, Dispersed 25–40%, Sparse 10–25%, Rare 2–10%. Compare with pattern and height.

Dichotomous field key: A document that identifies vegetation communities on the basis of exclusive characteristics. An example of exclusive characteristics is forested versus non-forested. Also known as vegetation field key and vegetation key. This key is an important product of each vegetation-mapping project. For an example of a dichotomous field key visit http://biology.usgs.gov/npsveg/agfo/report.pdf#vegkey.

Digital orthophoto quarter quadrangle (DOQQ)**:** USGS digital product derived from high altitude aerial photography. These digital images are rectified and registered to locations on the earth and cover approximately one quarter of a 7.5-minute quadrangle. Also called 3.75-minute DOQ. DOQs are often used as base maps to register the photo interpreted data in this program.

Digitize: The process of entering data into a computer. There are several methods of entering spatial data into a computer including manual digitizing, scan digitizing, and soft copy photogrammetric methods. Synonymous with automate.

Division: The highest level in the NVCS separating Earth cover into either vegetated or non-vegetated categories (FGDC 1997). See table under USNVC.

Dominance: The extent to which a given species or life form predominates in a community because of its size, abundance or cover, and affects the fitness of associated species (FGDC 1997).

Error: The distance of results of observations, computations, or estimates from the true values or to values that are accepted as being true. Also refers to the misclassification of thematic data. Contrast with accuracy.

Error matrix: See contingency table.

Federal Geographic Data Committee (FGDC)**:** Coordinates the development of the National Spatial Data Infrastructure (NSDI). The NSDI encompasses policies, standards, and procedures for organizations to cooperatively produce and share geographic data. The 17 federal agencies that make up the FGDC are developing the NSDI in cooperation with organizations from state, local and tribal governments, the academic community, and the private sector. The program complies with FGDC standards for vegetation classification, metadata, spatial data transfer, and positional accuracy.

Field reconnaissance: Preliminary field visits by photo interpreters and vegetation classification experts to gain an overview of the vegetation of the project area and how it relates to the NVCS. Communication between photo interpreters and vegetation classification experts during this fieldwork is key to developing an accurate classification system. Observation point data are collected during this reconnaissance.

Field verification: Field visits by photo interpreters after photo interpretation is complete to check for correctness of photo interpretation. At this point changes may be made to the photo interpretation. This occurs prior to accuracy assessment.

Flight line: Refers to a line or strip of aerial photography. Usually designated on the film as "flightline number – photo number". Technical: A line connecting the principal points of sequential vertical aerial photographs (portions from Rabchevsky 1984)

Floristics: The kinds and number of plant species in particular areas and their distribution.

Formation: A level in the National Vegetation Classification Standard hierarchy below subgroup which represents vegetation types that share a definite physiognomy or structure within broadly defined environmental factors, relative landscape positions, or hydrologic regimes (Grossman et al. 1998). See table under USNVC.

Geographic information system (GIS)**:** An organized collection of geographically (spatially) referenced information (portions from ESRI 1994).

Georeference: The process of converting a map or image into real-world coordinates. A

non-georeferenced map or image is said to be in "digitizer-inches" or "scanner-inches," that is, it has no real-world coordinates.

Global positioning system (GPS): A system of satellites, ground receiving stations and hand-held receivers that allow accurate measurement of feature coordinates on the face of the earth. GPS receivers are used to measure the location of field plots, reconnaissance points, and accuracy assessment points.

Ground truth: The process of taking aerial photographs into the field to verify the ground condition compared to how that condition appears in the photograph.

Group: The level in the National Vegetation Classification Standard hierarchy below subclass based on leaf characteristics and identified and named in conjunction with broadly defined macroclimatic types to provide a structural-geographic orientation (Grossman et al. 1998). See table under USNVC.

Habitat: The combination of environmental or site conditions and ecological processes influencing a plant community.

Habitat type: (1) a collective term for all parts of the land surface supporting, or capable of supporting, the same kind of climax plant association (Daubenmire 1978); (2) an aggregation of land areas having a narrow range of environmental variation and capable of supporting a given plant association (Gabriel and Talbot 1984).

Hectare: A metric unit of measure equal to 10,000 m^2 or approximately 2.471 acres.

Height: Height of the overstory of a vegetation community. One of the physiognomic modifiers classified in the USGS-NPS Vegetation Mapping Program. Height in map units is classified as <0.5 meters, 0.5–2 meters, 2–5 meters, 5–15 meters, 15–35 meters, 35–50 meters, or >50 meters. Compare with density and pattern.

Integrated Taxonomic Information System (ITIS): A comprehensive, standardized reference for the scientific names, and synonyms and common names, for all the plants and animals and other biological organisms of North America and the surrounding oceans developed and maintained by an international partnership among agencies, organizations, and taxonomic specialists. This database is accessible over the Internet and is used by scientists, resource managers, educators and students, museum curators, conservationists, and the interested public. The PLANTS database is an important ITIS partner providing plant taxonomic information to ITIS. See http://www.itis.usda.gov/.

Land cover classification: A classification of the cultural, physical, and vegetation features that cover the earth, commonly used with remote sensing technology. Vegetation classification is a subset of land cover classification.

Land use classification: A classification of the earth's surface that defines the use that people are making of the land, commonly used with remote sensing technology, and commonly combined with land cover classification. Natural vegetation areas may be classified as "vacant" or "forest," or "grazing".

Land use/Land cover classification (LU/LUC)**:** A combination of a land use classification and land cover classification where the land use classification is used to classify areas that are under a definite land use, such as agriculture, residential, or mining. The land cover classification is used to classify lands that that do not have definite land use, such as areas of bare rock, snow and ice, or open water. The Anderson Classification System is a land cover and land use classification.

Look-up table: A computer file that relates the elements of one classification to another in a crosswalk. The values of a map classification are related to the associations of the NVCS in a park project.

Map accuracy: A measure of the maximum errors permitted in horizontal positions and elevations shown on maps. The National Map Accuracy Standard of the USGS at 1:24,000 scale is the map accuracy standard for the program. This standard is that 90% of well-defined objects should appear within 40 feet (12.2 meters) of their true location. See United States National Map Accuracy Standards.

Map attribute: Collectively the map class (or map unit) code, the physiognomic modifier codes, and special modifiers if they are used: map unit code is that portion of the map attribute code defining the map unit (e.g., AB) the physiognomic modifier code portion of map attribute code defining the vegetation community's structure (e.g. -1A3). The map attribute code is

thus AB-1A3.

Map class: The vegetation units that can be discerned on an aerial photograph. Often associations in an alliance cannot be distinguished on an aerial photograph because the differences are found in the understory, so map classes must be developed. For example, at Devils Tower National Monument, there were five associations in the Ponderosa Pine Woodland Alliance, but it was necessary to create two ponderosa pine map classes because the associations could not be distinguished on the photography. Map classes may be complexes or mosaics of associations or map classes may also be the same as an association if that can be discerned on the photograph. Also known as map unit.

Map unit: See map class.

Map validation: The process of field checking and updating photo interpretation. This step is completed prior to accuracy assessment.

Metadata: Data about data. Metadata describes the content, quality, condition, and other characteristics of data. Its purpose is to help organize and maintain a organization's internal investment in spatial data, provide information about an organization's data holdings to data catalogues, clearinghouses, and brokerages, and provide information to process and interpret data received through a transfer from an external source (FGDC 1997). The FGDC sets standards for metadata content and structure.

Minimum mapping unit (MMU)**:** The smallest area that will be consistently delineated during photo interpretation. The MMU for the USGS-NPS Vegetation Mapping Program is 0.5 hectares.

National Vegetation Classification Standard (NVCS): The Federal Geographic Data Committee's vegetation classification standard. It has been adopted to the formation level (as of June 2001); adoption of the floristic levels is pending. It is based on the Association for Biodiversity Information's United States National Vegetation Classification (USNVC) system. See table under USNVC for comparison and crosswalk.

NatureServe Explorer: A website managed by NatureServe that provides authoritative conservation information in a searchable database for more than 50,000 plants, animals, and ecological communities in the U.S. and Canada. Vegetation community data developed by the USGS-NPS Program is available on NatureServe (URL is http://www.natureserveexplorer.org/).

North American datum (NAD)**:** The datum for map projections and coordinates throughout North America (see also datum). Usually associated with a version, such as 1927 or 1983. This program uses the 1983 datum (NAD83), which is consistent with satellite location systems. The 1983 datum uses the GRS 80 spheroid whereas the 1927 datum uses the Clarke 1866 spheroid (portions from ESRI 1994).

Observation point: A field location point used to support map unit and vegetation classification development. These points are collected during reconnaissance and the mappers' subsequent fieldwork.

Order: The second-highest level in the NVCS hierarchy under Division. The orders within the Vegetated Division are generally defined by dominant life form (tree, shrub, dwarf shrub, herbaceous, or non-vascular). (FGDC 1997). See table under USNVC.

Ortho image: An aerial photograph that has had the distortions due to camera lens, topographic relief, tilt of the aircraft, and other factors common to aerial photography removed and has been registered to locations on the earth. A digital ortho image can be placed in a GIS and have other layers, such as vegetation, overlain on it. Aerial photo interpretation can also be registered to an ortho image in the process of registering and automating the data into a GIS. A DOQ is a digital ortho image covering 3.75 minutes by 3.75 minutes of the earth's surface.

Pattern: Configuration of vegetation features or across a landscape. One of the physiognomic modifiers classified in the USGS-NPS Vegetation Mapping Program. Pattern in map units is classified as Evenly Dispersed, Clumped/Bunched, Gradational/Transitional, Alternating. Compare with density and height.

Photo interpretation: The art and science of identifying and delineating objects on an aerial photograph. Photo interpreters in the USGS-NPS Vegetation Mapping Program are knowledgeable about the vegetation in their project area and highly skilled in identifying vegetation map units accurately and consistently.

Photo interpretation key: A description of the distinguishing features that make up the signature of each map class. This description may include written clues, as well as graphic examples of the signatures.

Photosignature: Characteristics of an item on a photograph by which the item may be identified.

Physiognomy: The structure and life form of a plant community (FGDC 1997).

Plant community: A generic term that references any vegetation lfound in the mapping study and can be any level in the USNVC, association or alliance, or a unique community to the park, a park special.

Positional accuracy: The nearness of a point in a spatial database to its actual location on the earth's surface. The program standard for horizontal positional accuracy meets National Map Accuracy Standards at the 1:24,000 scale. This means that each well-defined object in the spatial database will be within 1/50 of an inch of its actual location or 40 feet (12.2 meters).

Producer accuracy: The probability that a reference sample (the ground data) has been classified correctly, also known as error of omission. This quantity is computed by dividing the number of samples that have been classified correctly by the total number of reference samples in that class (Story and Congalton 1986). Compare with user accuracy.

Projection: A map or a geospatial database is a flat representation of data located on a curved surface. A projection is a device for producing all or part of a round body on a flat sheet. This projection cannot be done without distortion, so the cartographer must choose which characteristic (distance, direction, scale, area, or shape) that is to be emphasized at the expense of the other characteristics (Snyder, 1982). All spatial data in the program are represented in the Universal Transverse Mercator (UTM) coordinate system that is based on the transverse mercator projection applied between 84 degrees north and 80 degrees south latitude.

Quadrangle: A USGS paper map. Typically, a 7.5-minute USGS map. Informally known as quad.

Quarter quadrangle: A map or image that includes ¼ the area of a 7.5-minute quadrangle and is organized in quadrants of the original quadrangle as follows: Northeast, Northwest, Southeast, and Southwest. USGS DOQQs cover ¼ of a 7.5-minute quadrangle. Informally known as quarter quad.

Rectify: Remove distortions common to aerial photographs in the process of automating the photo-interpreted information into a digital database. Distortions on aerial photographs are due to topographic relief on the ground, radial distortion in the geometry of the aerial photography, tip and tilt of the plane, and differences in elevation of the airplane from its nominal scale. This process may be separate or included in the registration process depending on the technology used. See transfer.

Register: The process of correlating objects on an aerial photograph with locations on the surface of the Earth using a defined coordinate system. This is necessary to be able to place the vegetation community data in a GIS with other appropriate data such as transportation, topography, soils, etc. This process may be separate or included in the rectification process depending on the technology used. See transfer.

Scale: The relationship between a distance portrayed on a map and the same distance on the Earth (Dana 1999). A map scale can be defined by a representative fraction (e.g., 1 unit on map / 12,000 units on ground) or by a graphic scale bar.

Spatial Data Transfer Standard (SDTS)**:** A comprehensive transfer standard for Earth-referenced data endorsed by the Federal Geographic Data Committee. Spatial data in SDTS format consists of a group of files each with specific content and format.

Signature: The unique combination of color, texture, pattern, height, physiognomy, and position in the landscape used by an photo interpreters to identify map classes on an aerial photograph.

Stratum: A horizontal layer of vegetation. A stratum may be defined by the life form of the vegetation (tree, shrub, herbaceous), or its actual height.

Structure (Vegetation): The spatial distribution pattern of life forms in a plant community, especially with regard to their height, abundance, or coverage within the individual layers. Synony-

mous with physiognomy.

Subclass: The level in the National Vegetation Classification Standard hierarchy under class based on growth form characteristics (Grossman et al. 1998). See hierarchy under USNVS.

Subgroup: The level in the National Vegetation Classification Standard hierarchy below group which divides each group into either a "natural/semi-natural" or "cultural" (planted/cultivated) subgroup (Grossman et al. 1998). See hierarchy under USNVS.

Transfer: The process of moving photo interpreted data from an aerial photo overlay to an ortho image to register and rectify the data. This process varies depending on the type of technology used.

Transform(ation): The process of converting coordinates (map or image) from one coordinate system to another. This involves scaling, rotation, translation, and warping (images) (ESRI 1994).

Transition zone: An area where the vegetation composition and structure is intermediate between two associations. The transition zone may be small as the associations abruptly change due to a large shift in the landscape, such as a cliff, or it may be large as the physical environment changes gradually. Transition zones often are challenges to properly classify and/or map vegetation.

United States National Map Accuracy Standards (NMAS)**:** USGS accuracy standards for published maps, including horizontal and vertical accuracy, accuracy testing method, accuracy labeling on published maps, labeling when a map is an enlargement of another map, and basic information for map construction as to latitude and longitude boundaries. The table below shows the standard for some common map scales. To meet NMAS maps must have less than 10 percent of the points tested (well-defined points) exceed the standard. Note that the conversion of paper maps into digital data usually creates additional error.

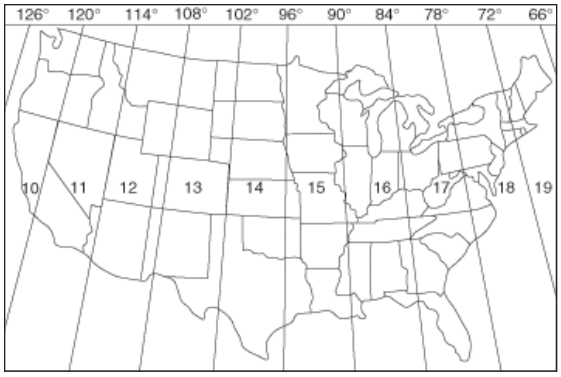
Horizontal accuracy examples.

Scale	Engineering Scale	National Map Accuracy Standard
1:1,200	1″=100′	+/- 3.33 feet
1:2,400	1″=200′	+/- 6.67 feet
1:4,800	1″=400′	+/- 13.33 feet
1:9,600	1″=800′	+/- 26.67 feet
1:10,000		+/- 27.78 feet
1:12,000	1″ = 1000′	+/- 33.33 feet
1:24,000	1″ = 2000′	+/- 40.00 feet
1:63,360	1″ = one mile	+/- 105.60 feet
1:100,000		+/- 166.67 feet

United States National Vegetation Classification (USNVC): The Association for Biodiversity's vegetation classification system. It is the basis for the FGDC National Vegetation Classification Standard.

User accuracy: The probability that a sample from the mapped data actually represents that category on the ground, also known as error of commission. This quantity is computed by dividing the number of correctly classified samples by the total number of samples that were classified as belonging to that category (Story and Congalton 1986). Compare with producer accuracy.

Universal Transverse Mercator (UTM): Map coordinate system (not a map projection) that is defined by the Transverse Mercator projection, which has a set of zones defined by a central meridian as shown in the figure below for the United States (Portions from ESRI 1994). All spatial data products developed by the program (vegetation spatial data, plot and accuracy assessment plot data locations are in this coordinate system.



Vegetation: The collective plant cover over an area (FGDC 1997).

Vegetation characterization: The detailed portrayal of a vegetation association using diagnostic and dominant species, structure, and ecological processes. The program has a formal structure for association description based on the ABI model. Also known as vegetation description. An example of an association characterization can be found at http://biology.usgs.gov/npsveg/agfo/mapclass/scbc.pdf.

Vegetation classification: The process of categorizing vegetation into repeatable and consistent elements. Also a document the lists and organizes the vegetation communities in an area. An example of a vegetation classification can be found at http://biology.usgs.gov/npsveg/agfo/report.pdf#classification.

Vegetation community: See plant community.

Vegetation description: See vegetation characterization.

Vegetation field key: See dichotomous field key

Vegetation key: See dichotomous field key

Vegetation mapping: The process of identifying, labeling, and placing in real world coordinates vegetation communities.

Vegetation plot: See plot.

Vegetation structure: See structure (vegetation).

Vertical aerial photography: See Aerial Photography.

Wetland: A location on the landscape that is characterized by either hydric soils or hydrophytic plants or both. A wetland may be vegetated or non-vegetated. The vegetation description for each association includes it wetland status.

Literature Cited

Anderson, J. R., E. E. Hardy, and J. T. Roach 1976. Land use and land cover classification system for use with remote sensing data. Geological Survey Professional Paper 964. A revision of the land use classification system as presented in US Geological Circular 671. Washington, D.C.: U.S. Government Printing Office.

Dana, P. H. 1999. Map projection overview. http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html.

Daubenmire, R. F. 1978. Plant geography, with special reference to North America. New York: Academic Press.

Environmental Systems Research Institute, Inc. (ESRI). 1994. Understanding GIS: The Arc/Info method. Redlands, Ca.

Federal Geographic Data Committee (FGDC). 1997. Vegetation classification standard. http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/vegclass.pdf.

Gabriel, H. W., and S. S. Talbot. 1984. Glossary of landscape and vegetation ecology for Alaska. Alaska Technical Report 10. U.S. Bureau of Land Management, U.S. Department of the Interior, Washington, D.C.

Grossman, D. H., D. Faber-Langendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landal, K. Metzler, K. Pattterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. Arlington, Va.: The Nature Conservancy.

Grossman, D. H., K. L. Goodin, X. Li, D. Faber-Langendoen, and M. Anderson. Developing and documenting a National Vegetation Classification Standard. 1994. Prepared for the USGS-NPS Vegetation Mapping Program by The Nature Conservancy, Arlington Va., and Environmental Science Research Institute, Redlands, Ca.

Grossman, D. H., K. L. Goodin, X. Li, D. Faber-Langendoen, M. Anderson, and R. Vaughan, Establishing standards for field methods and mapping procedures. 1994. Prepared for the USGS-NPS Vegetation Mapping Program by The Nature Conservancy, Arlington Va., and Environmental Science Research Institute, Redlands, Ca.

Rabchevsky, G. A., ed. 1984. Multilingual dictionary of remote sensing and photogrammetry. Falls Church, Va.: American Society of Photogrammetry.

Snyder, J. P. 1982. Map projections used by the U.S. Geological Survey. 2nd Edition. Washington, D.C.: U.S. Government Printing Office.

Stadelmann, M., A. Curtis, R. Vaughan, and M. Goodchild. 1994. Producing rigorous and consistent accuracy assessment procedures. Prepared for the USGS-NPS Vegetation Mapping Program by The Nature Conservancy, Arlington Va., and Environmental Science Research Institute, Redlands, Ca.

Story, M., and R. G. Congalton. 1986. Accuracy assessment: A user's perspective. Photogrammetric Engineering and Remote Sensing **52**(3):397–399.

Appendix A
List of Project Products

This appendix lists the products developed for the Mesa Verde National Park vegetation mapping project. The report and appendices are available in hard copy and on the project DVD. The vegetation map database, field data locations and plant data, graphics, images, and metadata are also available on the DVD. This appendix lists each product, its file name on the DVD, and the format in which the product is available. The DVD is available with the hard copy report and through the Southern Colorado Plateau Network. These products are also available on the USGS-NPS Vegetation Mapping Program product pages (http://biology.usgs.gov/npsveg/products/meve.html).

Table A. Mesa Verde National Park data products.

Product/File name(s)	Description
Report	
meverpt.pdf	Full report
mevequantclass.doc	Graphics of quantitative classification
meveveg_group.pdf	Low resolution map graphic showing group map classes
meveveg_group_large.pdf	High resolution map graphic showing group map classes
meveplotsclass.pdf meveplotsaa.pdf meveplotspi.pdf	Map graphics of classification, accuracy assessment, and photointerpretation plots
meveveg_mgmt.pdf	Low resolution map graphic showing management map classes
meveveg_mgmt_large.pdf	High resolution map graphic showing management map classes
Aerial Photography	
meveortho.exe	Aerial photo mosaic
metameveortho.txt	Metadata for aerial photo mosaic in text format
mevephotos.exe	Orthorectified photos
metamevephotos.txt	Metadata for orthorectified photos, in text format
Field Data	
mevedata.mdb	Access database that includes all classification and accuracy assessment field data
metamevedata.txt	Metadata for classification and accuracy assessment field data in text format
mevefieldphotos.exe	Field photos: Classification and accuracy assessment
meveplotfieldform.pdf	Classification plots field form
meveaafieldform.pdf	Accuracy assessment plots field form
Classification Spatial Data	
meveplot.exe	Classification plots shapefile and metadata
metamevefield.txt	Metadata for classification plots
Thematic AA Points Spatial Data	
meveaa.exe	Accuracy assessment plots shapefile and metadata
metameveaa.txt	Metadata for accuracy assessment shapefile in text format
Park Boundary Spatial Data	
mevebdy.exe	Park boundary shapefile and metadata
metamevebdy.txt	Metadata for park boundary in text format

Table A.1. Mesa Verde National Park data products, cont.

Product/File name(s)	Description
Project Boundary Spatial Data	
meveprjbdy.exe	Project boundary shapefile and metadata
metameveprjbdy.txt	Metadata for project boundary in text format
Vegetation Map Spatial Data	
meve.exe	Vegetation map shapefile and metadata
metamevespatial.txt	Metadata for vegetation maps in text format
Photointerpretation Sites Spatial Data	
mevephotoplots.exe	Photointerpretation observation locations shapefile and metadata
metamevephotoplots.txt	Photointerpretation sites shapefile metadata in text format

Appendix B
Relevé Numbers

This appendix (see Table B, next page) lists the relevé numbers of ground-based observations for each plant community in this project. Although the 1993 database is not available, data for the 2004 classification relevés and 2006 accuracy assessment observations are available as an Access database and mapped as a GIS shapefile. Images of the 2004 classification relevés and 2006 accuracy assessment observations are also available. The 2004 classification relevé number refers to the field, PlotCode, found in the table, tblPlotDetails, in mevedata.exe. It is crosswalked to the field, Plot_ID, which is used to reference the relevé in all other classification tables in the database. The 2006 accuracy assessment observation number refers to the field, MEVE_AA, found in all four accuracy assessment tables in mevedata.exe. The photointerpreter's observation locations are also mapped as a shapefile. Locations on the DVD for these products, and their corresponding metadata, can be found in Appendix A. The number for the photointerpreter' s observation locations refers to the field, Uniq_ID, in the mevephotoplots shapefile.

Table B. Plot numbers documenting plant communities at Mesa Verde National Park.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Forest				
Pseudotsuga menziesii / *Quercus gambelii* Forest	217	0896, 0923	A4-3, LL344-2, A6-3, A2-3, A17-2, A16-2, H117-2, A1-3, L34-1, A11-2	50, 60, 61, 62, 96, 107, 118, 128, 149, 181, 185, 258, 368, 370, 478, 517, 519, 564
Woodland				
Pinus edulis - (*Juniperus monosperma*, *Juniperus osteosperma*) / *Hesperostipa comata* Woodland	-	-	DD78-1	-
Pinus edulis - *Juniperus osteosperma* / *Amelanchier utahensis* Woodland	-	0921, 0924	E26-1, C10-3, C25-2, D17-3, C15-1, BB78-3, H25-1, C8-3, H100-2, N38-1, N45-1, H40-3, A22-2, N35-1, R191-2, H98-2, LL362-2, AA63-3, LL348-2, BB71-3	Grouped with *Pinus edulis* - *Juniperus* spp. / *Cercocarpus montanus* Mixed Shrub Woodland: 140, 144, 165, 245, 271, 272, 273, 274, 277, 278, 304, 305, 309, 312, 314, 316, 319, 324, 338, 339, 342, 405, 407, 408, 410, 412, 413, 414, 415, 417, 419, 420, 422, 425, 426, 427, 429, 430, 431, 432, 435, 437, 438, 439, 440, 441, 445, 447, 448, 456, 458, 460, 461, 462, 463, 467, 504, 506, 516, 559, 561, 572, 590, 591, 592, 593, 597, 602, 604, 606
Pinus edulis - *Juniperus osteosperma* / *Artemisia nova* Woodland	-	-	-	167, 399, 605
Pinus edulis - *Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland	-	0746, 0906	P55-1, AA56-1, E20-3, N49-1, E26-3, P173-2, J118-2, R192-2, E21-3, J115-2, E61-2, E65-2, F69-2, F71-2, F72-2, R193-2	147, 311, 315, 317, 318, 320, 321, 323, 325, 326, 327, 328, 329, 334, 335, 400, 402, 522, 523, 526, 528, 573, 574, 601
Pinus edulis - *Juniperus osteosperma* / *Pleuraphis jamesii* Woodland	-	Identified by park resource management	-	-
Pinus edulis - *Juniperus* spp. / *Cercocarpus montanus* Mixed Shrubs Woodland	200, 253	-	N41-1, N44-1, A1-2, H102-2, H108-2, H111-2, BB73-1, C29-2, H36-3, LL361-2, C15-3, N132-2, H24-1, C30-2, H39-3, C35-2, N40-1, N149-2, N146-2, N39-1	Grouped with *Pinus edulis* - *Juniperus* spp. / *Amelanchier utahensis* Woodland: 140, 144, 165, 245, 271, 272, 273, 274, 277, 278, 304, 305, 309, 312, 314, 316, 319, 324, 338, 339, 342, 405, 407, 408, 410, 412, 413, 414, 415, 417, 419, 420, 422, 425, 426, 427, 429, 430, 431, 432, 435, 437, 438, 439, 440, 441, 445, 447, 448, 456, 458, 460, 461, 462, 463, 467, 504, 506, 516, 559, 561, 572, 590, 591, 592, 593, 597, 602, 604, 606

Table B. Plot numbers documenting plant communities at Mesa Verde National Park, cont.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Woodland, cont.				
Pinus edulis - Juniperus spp. / *Poa fendleriana* Woodland	-	835	G94-2, D43-2, D46-2, G82-2, G80-2, H103-2, E28-3, G93-2, P170-2, V220-2, G77-2, G28-3, G34-3, G33-3, G29-3, BB276-2	Grouped with *Pinus edulis/ Purshia tridentata* Woodland: 302, 303, 306, 307, 308, 310, 330, 331, 332, 333, 367, 474, 475, 476, 477, 515, 521, 524, 525, 527, 538, 539, 540, 541, 542, 546, 547, 548, 554, 555, 556, 557, 558, 583, 584
Pinus edulis - Juniperus spp. / *Quercus gambelii* Woodland	013,037 168,189 216,238 237,251 252,278 288,297 315,848	0717, 0728, 0764, 0777, 0838, 0839, 1001, 1003	E59-2, F73-2, H99-2, H116-2, C24-2, H37-3, LL355-2, F70-2, C18-1, I45-3, N48-1, H41-3, C32-2, BB275-2, E27-1, E28-1, C31-2, H38-3, N138-2, E56-2, E29-1, H105-2, C9-3, N130-2, C22-2, LL349-2, AA62-3	254, 343, 345, 347, 350, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 366, 473, 482, 486, 494, 520, 534, 563, 566, 580, 582
Pinus edulis / Purshia tridentata Woodland	089,090 104,105 106,107110,11111 2,113114,146147,1 55224,226227,264 268,275281,28231 4,316317	0710, 0711, 0712, 0713, 0716, 0734, 0750, 0761, 0770, 0836, 0903, 0905, 0930, 0931	C26-2, G30-3, O164-2, E52-2, G84-2, G31-3, G32-3, G78-2, G79-2, G81-2, H45-3, P180-2, G83-2, G96-2, G89-2, H42-3, D47-2, G95-2, E54-2	Grouped with *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland: 302, 303, 306, 307, 308, 310, 330, 331, 332, 333, 367, 474, 475, 476, 477, 515, 521, 524, 525, 527, 538, 539, 540, 541, 542, 546, 547, 548, 554, 555, 556, 557, 558, 583, 584
Pinus ponderosa Woodland Alliance	-	Identified by park resource management	-	-
Populus angustifolia - Juniperus scopulorum Woodland	-	-	CC284-2, P182-2	-
Populus angustifolia / Invasive Perennial Grasses Semi-natural Woodland	234, 235, 236	0820, 0907	-	-
Pseudotsuga menziesii / Acer negundo Woodland	-	854	A1-1	81
Juniperus scopulorum / Bromus inermis (*Pascopyrum smithii*) Woodland	-	Identified by park resource management	-	-
Pinus edulis - Juniperus spp. / Shale Sparse Woodland	-	-	E25-1, E60-2, N137-2, H28-1, BB279-2, H104-2, N139-2, A24-2, N133-2, N131-2, LL98-1, LL363-2, LL343-2, N143-2	349, 351, 353, 479, 480, 481

Table B. Plot numbers documenting plant communities at Mesa Verde National Park, cont.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Shrubland				
Amelanchier (*utahensis, alnifolia*) - *Cercocarpus montanus* Shrubland	-	0735, 0744, 0810, 0817, 0821, 0822, 0840	JJ342-2, N134-2, O51-3, BB69-1, O49-1, JJ328-2, O149-2, LL104-1, N145-2, N129-2, JJ325-2, N128-2, A3-1, N36-1	Grouped with *Amelanchier utahensis* Shrubland and *Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional]: 37, 40, 99, 100, 103, 121, 152, 159, 199, 240, 242, 252, 294, 295, 296, 297, 298, 299, 300, 301, 378, 401, 403, 404, 406, 409, 411, 416, 418, 421, 423, 424, 428, 433, 434, 436, 442, 443, 444, 446, 449, 450, 451, 452, 453, 454, 455, 457, 492, 502, 503, 507, 512, 588, 589, 594, 596
Amelanchier utahensis - Fendlera rupicola Shrubland	-	715, 807, 738, 804	LL345-2, AA242-2, AA243-2, O53-3, O50-3, AA67-3, AA245-2, O168-2, S62-3, S61-3, O49-3, S63-3, Y232-2	-
Amelanchier utahensis Shrubland	-	0718, 0719, 0724, 0818, 0877, 0909	C23-2, Z237-2, P179-2, KK95-1, GG86-3, DD77-1, JJ343-2, O52-3	Grouped with *Amelanchier utahensis - Cercocarpus montanus* Shrubland and *Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional]: 37, 40, 99, 100, 103, 121, 152, 159, 199, 240, 242, 252, 294, 295, 296, 297, 298, 299, 300, 301, 378, 401, 403, 404, 406, 409, 411, 416, 418, 421, 423, 424, 428, 433, 434, 436, 442, 443, 444, 446, 449, 450, 451, 452, 453, 454, 455, 457, 492, 502, 503, 507, 512, 588, 589, 594, 596
Artemisia tridentata - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland	-	894	U207-2, E66-2, CC285-2, DD80-3, E58-2, P53-1, H35-1, P189-2, P60-3, P191-2, P57-3, GG287-2, P181-2	Grouped with *Artemisia tridentata ssp. wyomingensis / Hesperostipa comata* Shrubland: 29, 125, 142, 162, 164, 168, 375, 376, 377, 505, 518, 562
Artemisia tridentata ssp. *tridentata / Pascopyrum smithii* - (*Elymus lanceolatus*) Shrubland	-	-	N51-1	-
Artemisia tridentata ssp. *tridentata / Pleuraphis jamesii* Shrubland	-	-	-	-
Artemisia tridentata ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland	-	1004	-	Grouped with *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland: 29, 125, 142, 162, 164, 168, 375, 376, 377, 505, 518, 562

Table B. Plot numbers documenting plant communities at Mesa Verde National Park, cont.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Shrubland. cont.				
Artemisia nova / Hesperostipa comata Shrubland	-	850, 708, 709	GG86-1, GG286-2, P59-3, O157-2, S58-3	-
Cercocarpus montanus - Fendlera rupicola Shrubland [Provisional]	-	926	H30-1, BB68-1, F68-2, H31-1, G37-3, LL359-2, C34-2, LL360-2, BB70-1	Grouped with *Amelanchier utahensis - Cercocarpus montanus* Shrubland and *Amelanchier utahensis* Shrubland: 37, 40, 99, 100, 103, 121, 152, 159, 199, 240, 242, 252, 294, 295, 296, 297, 298, 299, 300, 301, 378, 401, 403, 404, 406, 409, 411, 416, 418, 421, 423, 424, 428, 433, 434, 436, 442, 443, 444, 446, 449, 450, 451, 452, 453, 454, 455, 457, 492, 502, 503, 507, 512, 588, 589, 594, 596
Prunus virginiana - (*Prunus americana*) Shrubland	-	0740, 0788	A4-1, GG302-2	-
Purshia tridentata / Achnatherum hymenoides - Poa fendleriana Shrubland	-	768	-	510
Quercus gambelii - Amelanchier utahensis Shrubland	-	0707, 0714, 0720, 0723, 0742, 0741, 0782, 0783, 0784, 0794, 0805, 0806, 0809, 0812, 0814, 0827, 0831, 0847, 0848, 0853, 0855, 0860, 0864, 0870, 0872, 0875, 0878, 0881, 0883, 0885, 0899, 0890, 0915, 0925	GG85-3, AA59-1, O48-3, AA253-2, AA246-2, O51-1, O55-3, X231-2, AA241-2, AA240-2, A7-2, A14-2, V212-2, A10-2, A21-2, A20-2, A19-2, A18-2, O47-1, A12-2, A13-2, A8-1, BB266-2, BB66-1, AA64-1, BB67-1, LL346-2, O158-2, BB274-2, BB73-3, BB75-3, BB272-2, BB271-2, JJ89-3, JJ85-3, BB269-2, O155-2, AA66-3, AA64-3, BB263-2, O161-2, AA65-3, JJ332-2, E57-2, AA68-3, JJ321-2, BB264-2	Grouped with *Quercus gambelii - Cercocarpus montanus/ (Carex geyeri)* Shrubland and *Quercus gambelii / Symphoricarpos oreophilus* Shrubland: 59, 233, 248, 249, 250, 251, 268, 269, 270, 313, 369, 371, 372, 373, 387, 389, 390, 488, 493, 495, 496, 498, 508, 511, 531, 532, 535, 536, 565, 567, 575, 585, 586, 603
Quercus gambelii - Cercocarpus montanus / (*Carex geyeri*) Shrubland	-	858	JJ341-2, AA57-1, KK92-1, BB74-3, BB72-3, BB265-2, O166-2, H101-2	Grouped with *Quercus gambelii - Amelanchier utahensis* Shrubland and *Quercus gambelii / Symphoricarpos oreophilus* Shrubland: 59, 233, 248, 249, 250, 251, 268, 269, 270, 313, 369, 371, 372, 373, 387, 389, 390, 488, 493, 495, 496, 498, 508, 511, 531, 532, 535, 536, 565, 567, 575, 585, 586, 603

Table B. Plot numbers documenting plant communities at Mesa Verde National Park, cont.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Shrubland. cont.				
Quercus gambelii / Symphoricarpos oreophilus Shrubland	86-88, 92, 93, 145, 151, 159, 267, 285, 312	0826, 0829, 0846, 0851, 0856, 0927, 0928	V213-2, BB71-1, A2-1, Y234-2, Y236-2, O48-1, AA62-1, BB270-2, A7-1, AA248-2, AA247-2, A6-1, A9-2, A5-1, A4-2, AA63-1, O150-2	Grouped with *Quercus gambelii - Amelanchier utahensis* Shrubland and *Quercus gambelii - Cercocarpus montanus/ (Carex geyeri)* Shrubland: 59, 233, 248, 249, 250, 251, 268, 269, 270, 313, 369, 371, 372, 373, 387, 389, 390, 488, 493, 495, 496, 498, 508, 511, 531, 532, 535, 536, 565, 567, 575, 585, 586, 603
Quercus gambelii Shrubland	-	0795, 0828, 0849, 1000, 1002	O162-2, JJ331-2, V61-3, Y233-2, V210-2, BB79-3, A6-2, A5-2, N144-2, A8-2	5, 6, 7, 8, 9, 10, 11, 13, 14, 18, 20, 25, 27, 30, 31, 32, 33, 34, 35, 44, 45, 46, 47, 48, 49, 51, 52, 55, 57, 58, 63, 64, 65, 66, 67, 70, 71, 72, 74, 75, 77, 79, 80, 82, 84, 85, 88, 89, 94, 95, 98, 102, 104, 105, 106, 109, 110, 111, 114, 115, 116, 117, 119, 124, 130, 131, 132, 136, 146, 148, 156, 163, 171, 186, 204, 215, 216, 217, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 231, 232, 234, 236, 237, 238, 244, 247, 255, 275, 276, 280, 379, 380, 381, 382, 384, 385, 487, 497, 499, 537, 549, 550, 551, 552, 553, 560, 568, 569, 570, 571
Salix exigua / Mesic Forbs Shrubland	-	916	CC283-2, CC282-2	-
Sarcobatus vermiculatus - Artemisia tridentata Shrubland	-	922	H29-1, P56-3, DD81-3, E25-3, P55-3, P58-3	135, 158, 161
Herbaceous				
Bouteloua gracilis Herbaceous Vegetation	-	Identified by park resource management	-	-
Bromus inermis - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation	-	0776, 0778, 0837	HH310-2, GG292-2, JJ330-2, S60-3, U200-2, U199-2, U198-2, DD76-1, P188-2	108, 138, 218, 246, 259, 260, 374
Bromus tectorum Semi-natural Herbaceous Vegetation	-	0721, 0722, 0726, 0747, 0824, 0913, 0936, 0938	II318-2, V228-2, V214-2, JJ322-2	235, 261, 262, 263, 264, 265, 266, 267, 279, 383, 386, 388, 391
Juncus balticus Herbaceous Vegetation	-	0789, 0791	II317-2, P187-2, W228-2, W226-2	12
Leymus cinereus Herbaceous Vegetation	-	917	-	16

Table B. Plot numbers documenting plant communities at Mesa Verde National Park, cont.

Plant community	1993 classification relevés	2004 classification relevés	2006 accuracy assessment observations	Photointerpreter's observation locations
Herbaceous, cont.				
Eurybia glauca Herbaceous Vegetation	-	908	-	-
Elymus trachycaulus ssp. *trachycaulus* Semi-natural Herbaceous Vegetation	-	725	-	22, 73
Ericameria nauseosa / Bromus inermis (*Pascopyrum smithii)* Shrub Herbaceous	-	-	U206-2, U196-2, W230-2, GG87-1, O154-2, P178-2, U197-2, P176-2, GG296-2, GG297-2, U195-2, U205-2, GG295-2, GG293-2, GG300-2, P56-1, GG83-3, I114-2, HH307-2, GG82-3, S59-3, GG90-1	-
Mixed Weedy Herbaceous Vegetation	-	-	GG303-2, GG289-2, W224-2, AA61-1, P175-2, P54-1	54, 284, 285, 286, 287, 288, 289, 290, 292, 293
Mixed Wetland Herbaceous Vegetation	-	-	GG290-2	3, 500, 501, 509
Post-Fire Mixed Herbaceous Vegetation	-	0841, 0730, 0733, 0759, 0766, 0792, 0798, 0830, 0832, 0874, 0882, 0888, 0902, 0910, 0911, 0914, 0918, 0940	BB261-2, HH311-2, D45-2, JJ324-2, LL350-2, O46-1, JJ94-3, JJ93-2, JJ92-3, JJ91-3, V208-2, JJ88-3, V209-2, V211-2, JJ335-2, V218-2, JJ323-2, GG84-1, P190-2, V229-2, G87-2, G88-2, G90-2, V219-2, GG85-1, V227-2, V224-2, V221-2, JJ320-2	2, 24, 76, 83, 120, 170, 172, 173, 174, 175, 189, 194, 195, 196, 197, 200, 205, 206, 207, 208, 209, 210, 211, 212, 213, 291, 322, 392, 393, 394, 395, 396, 397, 398, 459, 464, 465, 466, 468, 469, 470, 471, 472, 489, 490, 491, 529, 587, 595, 598, 599
Stanleya pinnata Shale Herbaceous Vegetation	-	0727, 0808, 0898, 0934	U55-1, LL109-1	-
Sparse				
Eriogonum corymbosum Badlands Sparse Vegetation	-	729	LL354-2, LL357-2, LL364-2, LL99-1, LL356-2, KK93-1, LL105-1, N42-1, KK94-1, LL353-2, N135-2, LL341-2, LL342-2, N37-1, LL347-2, N150-2, LL106-1	26, 38, 39, 42, 43, 56, 86, 87, 91, 93, 126, 127, 133, 137, 483, 484, 577
Sandstone *Pinus edulis - Juniperus osteosperma* Barrens	-	929	E19-3, E18-3, MM93-3, E53-2, C11-3	-

Appendix C
Global and Local Plant Community Descriptions

C.1 Introduction

The plant community descriptions present information on each association, alliance, and park special as it occurs in Mesa Verde NP (local) and as it has been found elsewhere (global) (NatureServe 2007). The plant communities are organized by life form–forest, woodland, shrubland, herbaceous, and finally sparse.

Following is a summary of the information provided by each description, in the order in which it occurs within each description:

- Scientific name for plant community
    - Translated name for plant community assigned by NatureServe
    - NatureServe Code: Community Element Global code (CEGL) assigned by NatureServe
- Summary: Global concept of plant community
- Classification
    - Classification Confidence: The level of confidence in the classification, based on the quality and type of data used in the analysis, as well as the extent to which the entire (or potential) range of the element was considered. Values include: 1 = Strong, 2 = Moderate, and 3 = Weak.
    - Classification Comments: Globally and locally
    - Vegetation Hierarchy
        - Physiognomic Class: NVCS version 1 class
        - Physiognomic Subclass: NVCS version 1 subclass
        - Physiognomic Group: NVSC version 1 group
        - Physiognomic Subgroup: NVCS version 1 subgroup
        - Formation Name: NVCS version 1 formation name
        - Alliance Name: NVCS version 1 alliance name
- Ecological Systems Placement: Nature Serve-assigned ecological system
- NatureServe Conservation Status: NatureServe-assigned conservation status rank (G5 Secure/G4 Apparently secure/G3 Vulnerable/G2 Imperiled/GNR Not yet ranked)
- Distribution: Global and local distribution
- Environmental Setting
    - USFWS Wetland System (Cowardin et al. 1979)
    - Global and local environments of occurrence
- Vegetation
    - Global and local descriptions
    - Most Abundant Species: Global and local
    - Other Noteworthy Species: Global and local
- Element Sources
    - Authors of global and local descriptions
    - References

Note: This project uses the spelling piñon for map class names. NatureServe uses the alternate spelling pinyon. NatureServe spellings are maintained in this appendix when they refer to vegetation names assigned by NatureServe.

C.2 Forest

C.2.1 *Pseudotsuga menziesii / Quercus gambelii* Forest

Translated Name: Douglas-fir / Gambel Oak Forest
NatureServe Code: CEGL000452

C.2.1.1 Summary

This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into Arizona and Utah. Elevation ranges from 1,370–2,870 m (4,500–9,400 feet). Stands are found along drainages, lower and middle slopes, steep upper slopes, and ridgetops. 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 sandy loams to clay. The vegetation has a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa*, *Pinus strobiformis*, *Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *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 over 25%. At higher elevations, the *Quercus gambelii* are more tree-like 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 herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but can be moderately dense and diverse. Many other species are associated, such as *Amelanchier* spp., *Holodiscus dumosus*, *Mahonia repens*, *Paxistima myrsinites*, *Robinia neomexicana*, *Rosa woodsii*, *Carex* spp., *Festuca arizonica*, *Muhlenbergia virescens*, *Poa fendleriana*, *Lathyrus lanszwertii* var. *leucanthus*, *Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

C.2.1.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—Within the Habitat Type literature 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. 1984, Alexander et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). Three similar USNVC *Pseudotsuga menziesii* associations use these phase species as the nominal species. These phases represent "intermediate" vegetation. Review of these associations might clarify relationships between associations.

Mesa Verde National Park—The sampling design limited the number of relevés sampled. This association is common in canyons and on steep canyon walls and would likely benefit from additional sampling. A third relevé, with *Pseudotsuga menziesii* and *Acer negundo*, was classified as *Pseudotsuga menziesii* / *Acer negundo* Woodland (CEGL002754). An alternative interpretation would be to classify this third relevé as *Pseudotsuga menziesii* / *Quercus gambelii* Forest (CEGL000452).

Vegetation Hierarchy		
Physiognomic Class	I	Forest
Physiognomic Subclass	I.A	Evergreen forest
Physiognomic Group	I.A.8	Temperate or subpolar needle-leaved evergreen forest
Physiognomic Subgroup	I.A.8.N	Natural/Semi-natural temperate or subpolar needle-leaved evergreen forest
Formation Name	I.A.8.N.c	Conical-crowned temperate or subpolar needle-leaved evergreen forest
Alliance Name	*Pseudotsuga menziesii* Forest Alliance, Douglas-fir Forest Alliance	

C.2.1.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.823	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland

C.2.1.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (23-Feb-1994).

C.2.1.5 Distribution

Globally—This *Pseudotsuga menziesii* forest association occurs in the southern Rocky Mountains and southwestern U.S. and on foothills, mountains, and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah.

Mesa Verde National Park—This forest association was sampled from two relevés on the lower slopes of canyons within Mesa Verde National Park. The relevés for this association were on the Menefee Formation in isolated small stands in Long Canyon and Spruce Canyon.

C.2.1.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This forest association occurs on mountains and plateaus at elevation ranges from 1,370–2,870 m (4,500–9,400 feet). Stands occur along drainages, gentle to moderate lower and middle slopes, steep upper slopes, and ridgetops. 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 sandy loams to clay. A thin layer of litter generally covers the surface. Parent materials include fractured limestone, sandstone, granite, basalt, andesite, and even slickrock.

Mesa Verde National Park—This association occurs on sandy soils at elevations of 2,040 and 2,180 m (7,020–7,150 feet). The slopes of these relevés are 10% and 17% and have a northeast and eastern aspect. The surface rocks in this association consist of sandstone. Both relevés exhibited signs of intermittent flooding, and one relevé represented a remnant *Pseudotsuga menziesii* stand within the 1989 Long Mesa fire.

C.2.1.7 Vegetation

Globally—This association is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii*, sometimes with scattered large *Pinus ponderosa*, *Pinus strobiformis*, *Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the 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 over 25%. At higher elevations, the *Quercus gambelii* are more tree-like 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. Other common shrub species, depending on geographic location, may include *Acer glabrum*, *Arctostaphylos patula*, *Amelanchier* spp., *Cercocarpus montanus*, *Holodiscus dumosus*, *Mahonia repens*, *Paxistima myrsinites*, *Prunus virginiana*, *Ribes cereum*, *Robinia neomexicana*, and *Rosa woodsii*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs but ranges to moderately dense and diverse. Associated graminoids may include *Bromus* spp., *Carex rossii*, *Festuca arizonica*, *Koeleria macrantha*, *Muhlenbergia montana*, *Muhlenbergia virescens*, and *Poa fendleriana*. Common forbs include *Achillea millefolium*, *Lathyrus lanszwertii* var. *leucanthus*, *Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

Mesa Verde National Park—Two relevés are classified as *Pseudotsuga menziesii* / *Quercus gambelii*

Forest. The tree stratum was characterized with a canopy cover of 25–50% in both relevés. In one relevé the shrub cover is low (5–10%) and in the other high (50–75% cover). In both relevés, the herbaceous stratum is low (1–5%). The species richness is 13 and 16 species for these relevés. The tree stratum is dominated by *Pseudotsuga menziesii*, which was recorded in one relevé with 25–50% cover and in the other with 50–75% cover. The trees were tall (20–30 m). The shrub stratum is dominated by *Quercus gambelii* with 10–25% cover in one relevé and 25–50% cover in the other at heights ranging from 1–2 m. *Symphoricarpos oreophilus* also occurs in both relevés with 1–5% and 5–10% cover. *Rhus trilobata* var. *trilobata* occurs in the shrub stratum of one relevé with a 5–10% cover. The herbaceous stratum is minimal (<5% cover) with the most common species being *Mahonia repens*, *Paxistima myrsinites*, and *Poa fendleriana* ssp. *longiligula*.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Pinus ponderosa, Pinus strobiformis, Pseudotsuga menziesii*
Tall shrub/sapling	*Quercus gambelii*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tall shrub/sapling	*Quercus gambelii, Rhus trilobata* var. *trilobata, Symphoricarpos oreophilus*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.2.1.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Drake
Local Description Authors: M. McTeague, L. Floyd-Hanna, K. A. Thomas, J. Donald
References: Alexander et al. 1984, Alexander et al. 1987, Bader 1932, Blackhawk Coal Company 1981, Bourgeron and Engelking 1994, Bourgeron et al. 1993, Bourgeron et al. 1995, CONHP unpubl. data 2003, Cogan et al. 2004, DeVelice et al. 1986, Diamond 1993, Fitzhugh et al. 1987, Freeman and Dick-Peddie 1970, Hess and Wasser 1982, Johnston 1987, Keammerer 1974, Kittel et al. 1994, Kittel et al. 1999b, Komarkova et al. 1988a, Komarkova et al. 1988b, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b, Tiedemann and Terwilliger 1978, Western Ecology Working Group n.d., Youngblood and Mauk 1985.

C.3 Woodland

C.3.1 *Pinus edulis - (Juniperus monosperma, Juniperus osteosperma) / Hesperostipa comata* Woodland

Translated Name: Two-needle Pinyon - (One-seed Juniper, Utah Juniper) / Needle-and-Thread Woodland
NatureServe Code: CEGL000797

C.3.1.1 Summary

This woodland association occurs in western and south-central Colorado and eastern Utah. Stands occur on a variety of sites, from flat or gentle lower slopes, benches, and mesa tops to steep colluvial slopes to montane alluvial fans. Parent materials are frequently sandstone or shale. Characteristically, this woodland has dominance or codominance of *Pinus edulis* in an open evergreen tree canopy. *Juniperus osteosperma* or *Juniperus monosperma* may codominate some stands, and *Juniperus scopulorum* can be present. The sparse to moderately dense herbaceous layer is dominated by the perennial bunchgrass *Hesperostipa comata* (= *Stipa comata*), with *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Koeleria macrantha*, *Bouteloua gracilis*, *Pleuraphis jamesii* (= *Hilaria jamesii*), and *Pascopyrum smithii* often present to common. Forb cover is generally sparse but may include *Heterotheca villosa*, *Hymenoxys* spp., *Artemisia dracunculus* (= *Artemisia dracunculoides*), *Oxytropis lambertii*, *Castilleja* sp., *Eriogonum jamesii*, and *Sphaeralcea coccinea*. Scattered shrubs and dwarf-shrubs may also be present, such as *Cercocarpus montanus*, *Quercus gambelii*, *Atriplex canescens*, *Artemisia* frigida, *Ephedra viridis*, or *Gutierrezia sarothrae*. *Opuntia polyacantha* and *Yucca glauca* are often present. Diagnostic of this woodland association is the dominance or codominance of *Pinus edulis* in the tree canopy and a *Hesperostipa comata*-dominated herbaceous layer.

C.3.1.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—*Juniperus monosperma*-codominated stands are restricted to south-central Colorado.

Mesa Verde National Park—The identity of this association at Mesa Verde NP is based on observational data provided by a park resource manager. It was mapped on two polygons.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis - (Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.1.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.1.4 NatureServe Conservation Status

Global Rank & Reasons: G2? (14-Nov-1997). This is a rare, regionally endemic association. It is poorly known, with only five documented locations from four counties (Montrose, San Miguel, Mesa, and Saguache) in the western portion of Colorado (CONHP 1997). None of these stands is protected. There is some uncertainty about the accuracy of this rank (the actual rank may be lower) because both

Isaacson (1967) and Colorado Natural Heritage Program field investigators (P. Lyons pers. comm.) suggest it may be more widespread on the western slope of Colorado and may extend into Utah. This association occurs in a relatively common environmental setting on flat or gently inclining slopes or benches of sandstone origin (CONHP 1997). Existing stands have been degraded by overgrazing, non-native species invasion, and possibly fire suppression. As of 2006, this association occurs regularly in national park units in southern and eastern Utah, as well as western Colorado. However, stands tend to be small, isolated, and affected by grazing.

C.3.1.5 Distribution

Globally—This association occurs in four counties (Montrose, San Miguel, Mesa, and Saguache) in western portion of Colorado (Isaacson 1967, P. Lyon pers. comm.). It also occurs in southeastern Utah.

Mesa Verde National Park—This woodland association was identified during the photointerpretation part of the project.

C.3.1.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This woodland association occurs on slopes, benches, and ridges with coarse-sandy, sometimes rocky soils. Elevations range between 1,490 and 2,156 m (4,900–7,070 feet); slopes are level to steep and may be oriented to any aspect. The unvegetated soil surface may be rocky, gravelly, or mostly bare ground, or biological soil crusts can have high cover in areas that protected from grazing. The sandy or silty soils are generally derived from sandstone, less often from shale, alluvial or eolian deposits.
Mesa Verde National Park—This vegetation class occurs on upland slopes adjacent to the Mancos River.

C.3.1.7 Vegetation

Globally—This woodland association occurs on sandy, sometimes rocky soils in the northern Colorado Plateau. Total vegetation cover ranges between 10% to at least 70%. This woodland association has an open to somewhat closed canopy, typically 2–5 m tall, of *Pinus edulis* and *Juniperus osteosperma* trees, and an understory dominated by the bunchgrass *Hesperostipa comata*. Scattered shrubs, such as *Ephedra viridis* and *Chrysothamnus viscidiflorus*, are present but do not form a layer. The herbaceous layer is diverse and provides up to 15% cover. *Achnatherum hymenoides* may be codominant with *Hesperostipa comata*, and *Pleuraphis jamesii* or *Bouteloua gracilis* may be present with low cover. Forbs are more diverse but contribute little cover and may include *Hymenoxys richardsonii*, *Sphaeralcea coccinea*, and *Mirabilis multiflora*. Cryptobiotic crusts are present in some stands.

Mesa Verde National Park—*Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The herbaceous layer dominates the understory and *Hesperostipa comata* is the dominant herbaceous species.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Hesperostipa comata*

Mesa Verde National Park—No relevé or ground observation data collected.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—No relevé or ground observation data collected.

C.3.1.8 Element Sources

Global Description Authors: D. Clark, mod. J. Coles and K. A. Schulz
Local Description Authors: Data are not available.

References: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, Isaacson 1967, Western Ecology Working Group n.d.

C.3.2 *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / Utah Serviceberry Woodland
NatureServe Code: CEGL002329

C.3.2.1 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 (1,406–2,006 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 (2,481–2,510 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*.

C.3.2.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—*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.

Mesa Verde National Park—This vegetation association represents a mid-succession sere in Mesa Verde National Park, where tall perennial shrubs are essentially codominant with the conifers. *Pinus edulis* and *Juniperus osteosperma* are likely recent arrivals in these areas. This vegetation association occurs in a belt across the cuesta, often with perennial shrub-dominated communities to the north and old-growth piñon-juniper communities to the south. Fires have likely not occurred for 100–200 years, allowing conifer establishment but maintaining vigorous perennial shrub growth.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	Pinus edulis - (Juniperus spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.2.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.2.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (11-Jan-2005)

C.3.2.5 Distribution

Globally—This association occurs in the Colorado Plateau in northeastern Arizona and southeastern Utah and extends east into the southern Rocky Mountains of western Colorado.

Mesa Verde National Park—This woodland association was represented by two relevés on the upper slopes of canyons within Mesa Verde National Park. This association is located on the Cliff House Sandstone Formation. Relevés of this vegetation association occurred Soda Canyon and upper Navajo Canyon.

C.3.2.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This association is characteristic of rocky slopes in western Colorado. Stands in northwestern Colorado are at lower elevations (1,528–1,950 m) and tend to occur on northerly aspects. Stands in central and southern Colorado occur at higher elevations (2,481–2,510 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.
Mesa Verde National Park—This association occurs on sandy soils at mid-elevations of 2,094 and 2,409 m (6,870 and 7,903 feet) on the cuesta. The slopes are steep (14 and 26%), facing an easterly aspect. This association is particularly rocky with high cover of sandstone boulders and stones. Both relevés are unburned and do not exhibit *Ips* bark beetle mortality.

C.3.2.7 Vegetation

Globally—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 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*, *Artemisia ludoviciana*, *Collinsia parviflora*, *Erigeron peregrinus*, *Eriogonum ovalifolium*, *Heterotheca villosa*, *Lathyrus lanszwertii*, *Lepidium montanum*, *Phlox austromontana*, and *Streptanthella longirostris*. Disturbed stands may contain *Bromus tectorum*.

Mesa Verde National Park—Two relevés are classified as *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* Woodland. The tree stratum in these relevés covers 10–25% and 25–50%. The shrub stratum covers 5–10% and 25–50%, and the herbaceous stratum is trace and 1–5%, respectively. The two relevés have 13 and 14 total species. The tree stratum is dominated by *Juniperus osteosperma*, which has 5–10% and 25–50% cover and *Pinus edulis*, with 1–5% and 5–10% cover in each relevé. The tree stratum ranges in height between 2 and 10 m. The shrub stratum is dominated by *Amelanchier utahensis*, which covers 5–10% and 25–50% in these relevés and has a height class of 1–2 m.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis*

Other Noteworthy Species: Globally—*Bromus tectorum*
Mesa Verde National Park—Data are not available.

C.3.2.8 Element Sources

Global Description Authors: J. Drake and J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Western Ecology Working Group n.d.

C.3.3 *Pinus edulis - Juniperus osteosperma / Artemisia nova* Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / Black Sagebrush Woodland
NatureServe Code: CEGL002331

C.3.3.1 Summary

This Colorado Plateau association occurs in western and northern Colorado, eastern Utah, and northeastern Arizona on the higher areas of local topographical features, such as canyon rims, mesas, hills, ridgetops, and upper slopes. Sites are nearly level to moderately steep and tend toward northern aspects, although other directions are possible. Elevation ranges from 1,772 to 2,518 m (5,800–8,260 feet). The soils are variable and range from sandy loam to silt clay loam and sandy clay soil textures. Soils are typically shallow and rapidly drained. Parent materials are often sandstone or limestone but can also be eolian deposits or shale. The unvegetated surface is composed of litter, bare soil, bedrock, and large and small rocks. Cryptogams often have moderate to high cover. This woodland association ranges from a moderately dense to a more typically open tree canopy (10–60% cover) dominated by short evergreen trees 2–10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate the tree canopy and may form a sparse subcanopy 2–5 m tall where the upper canopy is taller. In most stands, *Pinus edulis* and *Juniperus osteosperma* each have between 3 and 35% canopy cover, although in some sparsely vegetated stands, they may have less. Scattered *Pseudotsuga menziesii* may be present at higher elevations. Shrubs provide low to moderate cover. The dwarf-shrub *Artemisia nova* is the most abundant shrub, usually with less than 20% cover (rarely up to 50%). Other shrubs include *Amelanchier utahensis*, *Artemisia tridentata*, *Cercocarpus montanus*, *Ephedra viridis*, *Gutierrezia microcephala*, *Purshia stansburiana*, *Purshia tridentata*, and *Opuntia* spp. A number of herbaceous species occur across the range of this association, but any one stand usually has low to moderate diversity and less than 10% cover in aggregate. Common herbaceous species include the graminoids *Achnatherum hymenoides*, *Bouteloua gracilis*, *Carex* spp., *Elymus elymoides*, *Koeleria macrantha*, and *Poa fendleriana* and forbs *Antennaria parvifolia*, *Arabis* spp., *Hymenoxys richardsonii*, *Petradoria pumila*, *Phlox* spp., and many others.

C.3.3.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—No classification relevés or accuracy assessment sites are available to document this association. It was mapped on six polygons is confirmed with three photointerpreter's observation locations.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.3.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.3.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (11-Jan-2005)

C.3.3.5 Distribution

Globally—This association occurs on the Colorado Plateau and western slope of the southern Rocky Mountains in western and northern Colorado, eastern Utah, and northeastern Arizona.

Mesa Verde National Park—This woodland association was identified during the photointerpretation part of the project. It occurs in the uplands in the central to southern regions of the park in areas without a recent fire history.

C.3.3.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This Colorado Plateau association occurs on the higher areas of local topographical features, such as canyon rims, mesas, hills, ridgetops, and upper slopes. Sites are nearly level to moderately steep and tend toward northern aspects, although other directions are possible. Elevation ranges from 1,772 to 2,518 m (5,800–8,260 feet). The soils are variable and include sandy loam, sandy clay loam, silt loam, and silty clay-loam soil textures. They tend to be shallow and rapidly drained. Parent materials are often sandstones but can also be eolian deposits, limestone, or shale. The unvegetated surface is composed of litter, bare soil, bedrock, and large and small rocks. Cryptogams often have moderate to high cover.
Mesa Verde National Park—The map class occurs on talus slopes at lower elevations and on mesas.

C.3.3.7 Vegetation

Globally—This woodland association ranges from a moderately dense to a more typically open tree canopy (10–60% cover) dominated by short evergreen trees 2–10 m tall. *Pinus edulis* and *Juniperus osteosperma* dominate the tree canopy and may form a sparse subcanopy 2–5 m tall where the upper canopy is taller. In most stands, *Pinus edulis* and *Juniperus osteosperma* each have between 3 and 35% canopy cover, although in some sparsely vegetated stands, they may have less. Shrubs are present but provide low to moderate cover. The dwarf-shrub *Artemisia nova* is the most abundant shrub, usually with less than 20% cover, but stands with up to 50% cover have been observed. Other shrubs that are typically found include *Amelanchier utahensis*, *Artemisia tridentata*, *Cercocarpus montanus*, *Ephedra viridis*, *Gutierrezia microcephala*, *Purshia stansburiana*, *Purshia tridentata*, and *Opuntia* spp. Herbaceous species can be relatively diverse between stands, but any one stand usually has low to moderate diversity and less than 10% cover in aggregate. Common species include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Carex* spp., *Elymus elymoides*, *Koeleria macrantha*, and *Poa fendleriana*. Forbs can include *Antennaria parvifolia*, *Arabis* spp., *Hymenoxys richardsonii*, *Petradoria pumila*, *Phlox* spp., and many others.

Mesa Verde National Park—*Pinus edulis* or *Juniperus osteosperma* dominate the canopy. *Artemisia nova* is the dominant species in the understory.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Artemisia nova*

Mesa Verde National Park—No relevé or ground observation data collected.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—No relevé or ground observation data collected.

C.3.3.8 Element Sources

Global Description Authors: J. Drake, mod. J. Coles and K. A. Schulz
Local Description Authors: Data are not available.
References: Western Ecology Working Group n.d.

C.3.4 *Pinus edulis - Juniperus* spp. */ Artemisia tridentata (*ssp. *wyomingensis,* ssp. *vaseyana)* Woodland

Translated Name: Two-needle Pinyon - Juniper species / (Wyoming Big Sagebrush, Mountain Big Sagebrush) Woodland
NatureServe Code: CEGL000776

C.3.4.1 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 1,465 to 2,500 m (4,800–8,200 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.

C.3.4.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—On dry, rocky or slickrock sites on the Colorado Plateau, this piñon-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 piñon and juniper trees but is a variation of the woodland type because of the ecological values of the trees.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.4.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.4.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (1-Feb-1996)

C.3.4.5 Distribution

***Globally*—**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.

***Mesa Verde National Park*—**This woodland association was represented on two relevés, as it is very uncommon in the park. One relevé was located on Chapin Mesa and the other at a high elevation on Morefield Ridge within Mesa Verde National Park. The relevés for this association both occurred on the Cliff House Sandstone Formation.

C.3.4.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This broadly defined woodland association occurs on dry foothills and mesas across much of the Colorado Plateau and adjacent areas. Elevations range from 1,459 to 2,502 m. Stands occur most often on flat to gentle slopes but occurs 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.
***Mesa Verde National Park*—**This association occurs on sandy soils at elevations of 2,078 and 2,296 m (6,818–7,533 feet). Both of the relevés occur on flat areas. Neither relevé has evidence of fire damage. One relevé has severe *Ips* bark beetle mortality surrounding the relevé and a few trees affected within the relevé.

C.3.4.7 Vegetation

***Globally*—**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.

***Mesa Verde National Park*—**Two relevés are classified as *Pinus edulis* - *Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland. The tree cover in both relevés ranges between 25 and 50%. The shrub stratum has 5–10% cover in one relevé and 50–75% cover in the other. In the herbaceous stratum for both relevés, 1–5% cover is recorded. Species richness is 8 and 23 species for these relevés. The tree stratum is dominated by *Pinus edulis*, which has 25–50% cover in both relevés and consists of a main canopy layer (2–10 m tall) and subcanopy layer (1–2 m). *Juniperus osteosperma* also occurs in the canopy with 1–5% cover and 25–50% cover in respective relevés and ranges in height between 2 and 10 m. The shrub stratum is dominated by *Artemisia tridentata* with a height of 0.5–1 m, with 5–10% cover in one relevé and 50–75% cover in the other. The herbaceous stratum is minimal (<5% cover) with the most common species being *Penstemon linarioides* ssp. *coloradoensis*, *Petradoria pumila*, and *Poa fendleriana* ssp. *longiligula*.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia tridentata* ssp. *vaseyana*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia tridentata*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.4.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Drake and J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, Bunting 1987, CONHP unpubl. data 2003, Cogan et al. 2004, 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, NVNHP 2003, Stuever and Hayden 1997a, Tiedemann 1978, USFS 1983, USFS 1985, USFS 1985, Warren et al. 1982, Western Ecology Working Group n.d., Wright et al. 1979.

C.3.5 *Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii* Woodland

Translated Name: Two-needle Pinyon - Utah Juniper / James' Galleta Woodland
NatureServe Code: CEGL002379

C.3.5.1 Summary

This rare woodland association is documented only from Capitol Reef National Park in southeastern Utah; this summary is derived from plots sampled in the park in 1986 and 2005. It occurs on pediment surfaces cut into ridges and hills between 1,950 and 2,020 m (6,400–6,625 feet) elevation. Parent materials include basalt alluvium or colluvium overlying Moenkopi siltstone that is occasionally exposed. Soils are rapidly drained and fine-textured. Total vegetation cover is around 30%. The vegetation is characterized by an open canopy of *Pinus edulis* and *Juniperus osteosperma* trees with between 5 and 15% cover and an understory dominated by *Pleuraphis jamesii* with up to 10% cover. Shrubs do not form a layer (<5% total cover), but scattered individuals of *Gutierrezia sarothrae*, *Atriplex confertifolia*, *Shepherdia rotundifolia*, *Chrysothamnus viscidiflorus*, and *Ephedra torreyana* are commonly present. Associated herbaceous species include *Achnatherum hymenoides*, *Bouteloua gracilis*, *Hesperostipa comata*, and a variety of forbs with sparse cover.

C.3.5.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—This association occurs in Capitol Reef National Park. Until further inventory is completed, there is no global information.

Mesa Verde National Park—This association at Mesa Verde NP is based on observational data provided by a park naturalist. It is identified on 20 polygons.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.5.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.5.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (23-Mar-2005)

C.3.5.5 Distribution

Globally—This association occurs in Capitol Reef National Park in southeastern Utah (near Fruita and at the northern end of the park).

Mesa Verde National Park—This woodland association was identified during the photointerpretation part of the project. This map class is only known from the Mancos River area.

C.3.5.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This association is only described from Capitol Reef National Park. Until further inventory is completed, there is no global information.
***Mesa Verde National Park*—**This vegetation class occurs on upland slopes adjacent to the river.

C.3.5.7 Vegetation

***Globally*—**This association occurs in Capitol Reef National Park. Until further inventory is completed, there is no global information.

Mesa Verde National Park*—Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The herbaceous layer dominates the understory and *Pleuraphis jamesii* is the dominant herbaceous species. Other herbaceous species may occur, including the non-native invasive species *Acroptilon repens*. Occasionally *Juniperus scopulorum* may occur in the canopy. The shrub layer can have a low cover of shrubs, often including *Artemisia nova*, *Ephedra viridis*, and/or *Ericameria nauseosa*.

***Most Abundant Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**No relevé or ground observation data collected.

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**No relevé or ground observation data collected.

C.3.5.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: Data are not available.
References: Western Ecology Working Group n.d.

C.3.6 *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland

Translated Name: Two-needle Pinyon - Juniper species / Mountain-mahogany - Mixed Shrubs Woodland
NatureServe Code: CEGL000780

C.3.6.1 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 occurs on any slope position, though lower slopes are less common. Elevations range from 1,472 to 2,480 m (4,830–8,135 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. Bedrock, large and small rocks, and/or bare soil with little litter characterize the unvegetated surface. 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* vary with geography and elevation and include *J. deppeana, J. monosperma, J. osteosperma*, and *J. 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.

C.3.6.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—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 piñon-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 piñon and juniper trees but is considered to be a variation of the woodland type because of the ecological values of the trees.

Mesa Verde National Park—This association occurs as part of 295 polygons, half of which were outside the park. It was mapped with *Pinus edulis - Juniperus osteosperma / Amelanchier utahensis* as the base map class Colorado Pinyon - Utah Juniper / Mixed Montane Shrub Woodland.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.6.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.766	Colorado Plateau Pinyon-Juniper Shrubland
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.6.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (23-Feb-1994)

C.3.6.5 Distribution

Globally—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.

Mesa Verde National Park—*Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* - Mixed Shrubs Woodland occurred on two relevés from the 1993 sampling effort.

C.3.6.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This broadly defined woodland association is common on the Colorado Plateau, occurring on sheltered colluvial slopes, sandstone hogbacks, dry foothills, and mesas. It occurs on any slope position (upper, middle, or lower), though lower slopes are the least common. Elevations range from 1,472 to 2,480 m (4,830–8,135 feet). Stands occur on gentle to steep (3–35°) slopes on all aspects. The soils are variable but generally shallow, poorly developed and skeletal, ranging from clayey marl to loamy sands. Bedrock, large and small rocks, and/or bare soil characterize the unvegetated surface. Litter has low cover. Parent materials are often sandstone or shale, but others are possible.
Mesa Verde National Park—This woodland association occurs on mesas and in canyons on any aspect and slope, but is more likely on steeper slopes in canyons. It is generally in unburned areas.

C.3.6.7 Vegetation

Globally—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, 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. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, 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 *Cryptantha, Eriogonum, Penstemon, Petradoria*, and *Phlox*. 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.

Mesa Verde National Park—*Pinus edulis* or *Juniperus osteosperma* dominate the canopy. *Cercocarpus montanus* is the dominant shrub in the understory. The tree and the shrub stratum tend to have equal cover.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Cercocarpus montanus*

Mesa Verde National Park—Data are not available.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.6.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Drake and J. Coles
Local Description Authors: K. A. Thomas
References: Baker 1983b, Baker 1984, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Cogan et al. 2004, Driscoll et al. 1984, Erdman 1962, Erdman 1969, 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, Pase and Lindenmuth 1971, Stuever and Hayden 1997a, USFS 1981a, USFS 1981b, USFS 1983, USFS 1985d, USFS 1985, USFS 1985g, Vories 1974, Western Ecology Working Group n.d., Wright et al. 1979.

C.3.7 *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland

Translated Name: Two-needle Pinyon - Juniper species / Muttongrass Woodland
NatureServe Code: CEGL000787

C.3.7.1 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 1,525 to 2,560 m (5,000–8,400 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*.

C.3.7.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—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).

Mesa Verde National Park—This association is similar in composition to *Pinus edulis* / *Purshia tridentata* Woodland (CEGL000789), with the exception of not containing any *Purshia tridentata*. The one park relevé is representative of an old-growth piñon and juniper community (Floyd 2003).

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	Pinus edulis - (Juniperus spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.7.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.7.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (23-Feb-1994).

C.3.7.5 Distribution

Globally—This association occurs at moderate elevations in the Colorado Plateau region of western Colorado, northern Arizona and New Mexico, and eastern Utah.

***Mesa Verde National Park*—**This woodland association occurs on one relevé on the midslope of Wikiup Canyon within Mesa Verde National Park. The association occurs on the Menefee Formation. This relevé is located near the junction between Wikiup and Navajo canyons.

C.3.7.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**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 1,525 to 2,560 m (5,000–8,400 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 one-third of the surface. In some cases, cryptogamic crusts and moss or litter cover up to 25% of the soil surface.
***Mesa Verde National Park*—**This association occurs on sandy soil at an elevation of 1,972 m (6,479 feet). The slope of this relevé is 7%, with a northeastern aspect. This relevé contains a high cover of sandstone boulders and stones.

C.3.7.7 Vegetation

***Globally*—**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*.

***Mesa Verde National Park*—**One relevé is classified as *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland. The tree stratum has a total cover of 50–75%. The shrub stratum cover is low (1–5%), and the herbaceous stratum cover falls between 5 and 10%. The species richness is 16 species. The tree stratum is dominated by *Pinus edulis*, which has 50–75% cover, and *Juniperus osteosperma*, which has 25–50% cover. This relevé has a canopy height of 5–10 m and a smaller subcanopy of 2–5 m. The shrub stratum is minimal (<5% cover). The herbaceous stratum is dominated by *Poa fendleriana* ssp. *longiligula*, which has 5–10% cover.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Poa fendleriana*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Herb (field)	*Poa fendleriana* ssp. *longiligula*

Other Noteworthy Species: Globally—*Arabis fernaldiana* var. *fernaldiana*, *Bromus tectorum*
***Mesa Verde National Park*—**Data are not available.

C.3.7.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Baker 1982, Barnes 1987, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, 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, USFS 1985, Western Ecology Working Group n.d.

C.3.8 *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland

Translated Name: Two-needle Pinyon - Juniper species / Gambel Oak Woodland
NatureServe Code: CEGL000791

C.3.8.1 Summary

This widespread woodland association occurs in 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 1,580–2,665 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 mesa tops, 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*.

C.3.8.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.8.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.8.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (23-Feb-1994)

C.3.8.5 Distribution

***Globally*—**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.

***Mesa Verde National Park*—**This woodland association occurs on eight relevés on several landforms within Mesa Verde National Park, including mesas, canyons, eolian deposits, channels, and escarpments. The association is found on the Cliff House Sandstone, Mancos Shale, Menefee, and Point Lookout Sandstone formations. Relevés for this association occurred in Soda Canyon, Long Canyon, Chapin Mesa, and in the Mancos Valley area between Point Lookout and the park entrance.

C.3.8.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This widespread woodland association occurs in 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 1,580 to 2,665 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 mesa tops, 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 sandstone, shale, limestone, and rhyolite.

***Mesa Verde National Park*—**This association occurs on sand, silt, and sandy loam soils between the elevations of 2,031 and 2,336 m (6,663–7,664 feet) (average 2,198 m [7,211 feet]). The slope ranges from 0 to 39% (average 11%) at a southeast to southwestern aspect. Most of the relevés have few surface rocks, but where present, they mostly consist of sandstone. One of the relevés shows signs of intermittent flooding. One-quarter of the plots exhibit signs of *Ips* bark beetle mortality. All the relevés are unburned, with the exception of one relevé that burned pre-1900.

C.3.8.7 Vegetation

***Globally*—**This widespread association 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 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., *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*, *Packera neomexicana*, *Thalictrum fendleri*, or *Vicia americana*.

***Mesa Verde National Park*—**Seven relevés are classified as *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland. The tree stratum ranges in cover class from 5–10% to 75–100% (average cover

class 29–57%), and, in some cases, *Quercus gambelii* was included as a tree due to its height, instead of in the shrub layer. The shrub layer ranges from low cover to high cover (50–75% cover; average cover class 34–53%), and the herbaceous stratum ranges from a cover class of 1–5% to 25–50% (average cover class 6–13%). The species richness is 5–22 species (average of 13 species). The tree stratum is dominated by *Pinus edulis*, which ranges between cover classes 5–10% and 50–75% cover (average cover class 22–38%), and *Juniperus osteosperma* with no cover to 50–75% cover (average cover class 8–13%). The tree stratum consists of mainly one main canopy at a variable height of 1–20 m. In two of the relevés, an emergent canopy was recorded with heights ranging between 5 and 30 m. The shrub stratum consists of mostly tall shrubs (1–10 m) and is dominated by *Quercus gambelii*, which ranges between cover classes 5–10% and 75–100% cover (average cover class 39–59%). *Fendlera rupicola* occurs in three-quarters of the relevés and ranges between no cover and 50–75% cover (average cover class 13–24%). *Amelanchier utahensis* occurs in more than half of the relevés and ranges between no cover and 25–50% cover (average 5–10%). Other common shrubs are *Amelanchier utahensis*, *Machaeranthera bigelovii* var. *bigelovii* (= *Aster bigelovii*), *Cercocarpus montanus*, *Fendlera rupicola*, *Lathyrus pauciflorus*, *Lupinus ammophilus*, *Opuntia polyacantha*, *Pascopyrum smithii*, *Physaria acutifolia*, *Purshia tridentata*, *Rhus trilobata* var. *trilobata*, and *Symphoricarpos oreophilus*. The herbaceous stratum is variable. One relevé contains a high cover of *Pascopyrum smithii* (25–50% cover), another contains a high cover of *Machaeranthera bigelovii* (25–50% cover), and a third has a significant cover of *Physaria acutifolia* (50–75% cover). *Poa fendleriana* ssp. *longiligula* is present in more than half of the relevés.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii, Cercocarpus montanus*
Short shrub/sapling	*Symphoricarpos oreophilus*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii, Rhus trilobata var. trilobata, Symphoricarpos oreophilus, Cercocarpus montanus, Fendlera rupicola, Purshia tridentata*
Herb (field)	*Opuntia polyacantha, Lathyrus pauciflorus, Lupinus ammophilus, Machaeranthera bigelovii, Physaria acutifolia, Pascopyrum smithii*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.8.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bassett 1987, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, 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. 1973, Muldavin et al. 1994, Muldavin et al. 2000a, Steinhoff 1978, Stuever and Hayden 1997a, Vories 1974, Warren et al. 1982, Western Ecology Working Group n.d., Wright 1972, Wright et al. 1979.

C.3.9 *Pinus edulis / Purshia tridentata* Woodland

Translated Name: Two-needle Pinyon / Bitterbrush Woodland
NatureServe Code: CEGL000789

C.3.9.1 Summary

This association is common at middle elevations of the piñon-juniper woodland zone in western Colorado and northwestern New Mexico. Sites occupy ridges, scarps, and mesas with generally gentle to moderate slopes. Elevations range from 1,800 to 2,330 m (5,900–7,645 feet) and aspect is variable. Soils are often coarse and rocky, may be shallow, and sometimes contain outcrops of the underlying sandstone or limestone. This association is characterized by a mixed canopy of *Pinus edulis* and *Juniperus* spp. with a shrub layer dominated by *Purshia tridentata*. Canopy cover ranges from 10% in the beetle- and fungus-affected woodlands of southwestern Colorado to around 50% in the mountains of northern New Mexico. The canopy sometimes includes arborescent *Quercus gambelii* in the southern part of the range. The shrub layer may consist almost entirely of *Purshia tridentate*, with between 5 and 25% cover or, more often, is mixed with other shrubs that have at least 1% cover, including *Amelanchier utahensis*, *Artemisia tridentata*, *Artemisia nova*, *Cercocarpus montanus*, *Ephedra viridis*, *Opuntia polyacantha*, *Ribes cereum*, and *Yucca baccata*. Graminoids are well-represented to abundant; common species include *Pseudoroegneria spicata*, *Poa fendleriana*, *Koeleria macrantha*, *Carex rossii*, and *Piptatherum micranthum*. The forb component of the understory is often diverse but rarely contributes significantly to the overall vegetation cover. Species noted as occurring in this community include *Astragalus scopulorum*, *Eriogonum jamesii*, *Eriogonum racemosum*, *Penstemon linarioides* ssp. *coloradoensis*, *Petradoria pumila*, *Phlox* spp., and *Stenotus acaulis*.

C.3.9.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—Some stands of this association in northwestern Colorado have a shrub layer that is codominated by *Artemisia nova* and *Purshia tridentata*. The classification of these stands may need to be revisited to determine whether they are a better fit with the concept of this association or with *Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland (CEGL002331).

Mesa Verde National Park—*Poa fendleriana* consistently occurs in all of these relevés and seems to be equally important as *Purshia tridentata* in the community composition. The park relevés represent the "old-growth" piñon and juniper community for which Mesa Verde National Park is known (Floyd 2003).

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus edulis* - (*Juniperus* spp.) Woodland Alliance (A.516), Two-needle Pinyon - (Juniper species) Woodland Alliance	

C.3.9.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.766	Colorado Plateau Pinyon-Juniper Shrubland
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.9.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (1-Feb-1996)

C.3.9.5 Distribution

***Globally*—**This association occurs in the Sandia and Jemez ranges in New Mexico, from Mesa Verde in southwestern Colorado, and from Dinosaur National Monument in northwestern Colorado.

***Mesa Verde National Park*—**This woodland association occurs on 14 relevés on eolian deposits, mesas, canyons, and cliffs within Mesa Verde National Park. The association occurs on Cliff House Sandstone and Menefee formations. Relevés of this vegetation association occur at Navajo Canyon, Long Canyon, Rock Canyon, Wikiup Canyon, Chapin Mesa, and Morefield Ridge.

C.3.9.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This association is common at middle elevations of the piñon-juniper woodland zone in western Colorado and northwestern New Mexico. Sites occur on ridges, scarps, and mesas with gentle to moderate slopes, but a few stands are on slopes approaching 100%. Elevations range from 1,800 to 2,330 m (5,900–7,645 feet) and aspect is variable. Soils are often coarse and rocky, may be shallow, and sometimes have outcrops of the underlying sandstone or limestone.
***Mesa Verde National Park*—**This association occurs on sand and sandy loam soils between the elevations of 1,921 and 2,330 m (6,303–7,644 feet), average 2,146 m (7,041 feet). The slope ranges from 0 to 90% (average 16%) at a south to western aspect. Surface rocks are minimal in this association and, when present, are predominantly sandstone. All of the relevés are unburned, and five show damage from *Ips* bark beetle.

C.3.9.7 Vegetation

***Globally*—**This association is characterized by a mixed canopy of *Pinus edulis* and *Juniperus* spp. with a shrub layer dominated by *Purshia tridentata*. Canopy cover ranges from 10% in the beetle- and fungus-affected woodlands of southwestern Colorado to around 50% in the mountains of northern New Mexico. The canopy occasionally includes arborescent *Quercus gambelii* in the southern part of the range. The shrub layer may consist almost entirely of *Purshia tridentata* with between 5 and 25% cover or, more often, is mixed with other shrubs that have at least 1% cover, including *Amelanchier utahensis*, *Artemisia tridentata*, *Artemisia nova*, *Cercocarpus montanus*, *Ephedra viridis*, *Opuntia polyacantha*, *Ribes cereum*, and *Yucca baccata*. Graminoids are well-represented to abundant; common species include *Pseudoroegneria spicata*, *Poa fendleriana*, *Koeleria macrantha*, *Carex rossii*, and *Piptatherum micranthum*. The forb component of the understory is often diverse but rarely contributes significantly to the overall vegetation cover. Species noted as occurring in this community include *Astragalus scopulorum*, *Eriogonum jamesii*, *Eriogonum racemosum*, *Penstemon linarioides* ssp. *coloradoensis*, *Petradoria pumila*, *Phlox* spp., and *Stenotus acaulis*.

***Mesa Verde National Park*—**Thirteen relevés are classified as *Pinus edulis* / *Purshia tridentata* Woodland. The tree stratum ranges in cover class from 5–10% to 75–100% (average cover class 43–64%). The shrub stratum ranges between 1–5% and 75–100% (average cover class 17–29%), and the herbaceous stratum ranges between 1–5% and 50–75% (average cover class 14–27%). The species richness is 10–25 species (average of 15 species). The tree stratum is dominated by *Juniperus osteosperma* ranging between 1–5% and 50–75% cover (average range 21–40%) and *Pinus edulis* with 1–5% and 75–100% cover (average cover class 18–31%). In most relevés, the tree stratum consists of one main canopy with tree heights ranging between 2–10 m, and in some relevés a subcanopy occurs with tree heights of 0.5–2 m. The shrub stratum is dominated by *Purshia tridentata*, which ranges between 1–5% and 75–100% cover (average cover class 15–26%) and between 0.5–2 m in height. Many of the relevés also contain a low cover of *Cercocarpus montanus* and *Quercus gambelii*. The herbaceous stratum is dominated by *Poa fendleriana* ssp. *longiligula*, which ranges from a trace to 50–75% cover (average cover class 7–15%). Over half of the relevés contain *Petradoria pumila*, and two relevés have

a high 25–50% cover. *Pedicularis centranthera* occurs in 70% of the relevés and is characteristic of the old-growth woodlands at Mesa Verde National Park.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Short shrub/sapling	*Artemisia nova, Purshia tridentata*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Shrub/sapling (tall & short)	*Quercus gambelii, Cercocarpus montanus, Purshia tridentata*
Herb (field)	*Opuntia polyacantha, Eurybia glauca, Pedicularis centranthera, Petradoria pumila, Koeleria macrantha, Poa fendleriana* ssp. *longiligula*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.9.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Driscoll et al. 1984, Erdman 1962, Erdman 1970, Erdman et al. 1969, Floyd 2003, Larson and Moir 1987, Western Ecology Working Group n.d.

C.3.10 *Pinus ponderosa Woodland* Alliance

Translated Name: Ponderosa Pine Woodland
NatureServe Code: A.530

C.3.10.1 Summary

This alliance is one of the most widespread wooded alliances in the western United States; there are currently more than 50 plant associations in this alliance. The alliance occurs throughout the western half of the U.S. and southwestern Canada, as well as the Trans-Pecos of Texas and the western portions of the Great Plains, such as in western Oklahoma and the Dakotas. Sites are dry/dry-mesic to xeric, and soils are generally well-drained and coarse-textured. *Pinus ponderosa* often dominates these woodlands, but codominant species may include *Pseudotsuga menziesii*, other *Pinus* species, and species of *Juniperus*, *Abies*, or *Picea*. The understory ranges from dense shrub or graminoid layers to barren rock. The associated plant species vary with changes in geography and environmental conditions. Associated trees include species of *Pinus*, *Quercus*, *Juniperus*, *Abies*, *Pseudotsuga*, *Populus*, and *Picea*. Shrubs can include species of *Arctostaphylos*, *Artemisia*, *Cercocarpus*, *Ceanothus*, *Symphoricarpos*, *Physocarpus*, *Rosa*, *Purshia*, and others. Important graminoids include species of *Carex*, *Elymus*, *Poa*, *Festuca*, *Muhlenbergia*, *Piptochaetium*, and many others.

C.3.10.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—The *Pinus ponderosa* Woodland Alliance (A.530) is distinguished by the singular dominance of *Pinus ponderosa* in open stands (25–60% cover) occurring in non-wetland habitats and exhibiting an obvious woodland physiognomy. The presence of significant amounts of *Pseudotsuga menziesii* may make it difficult to separate some stands from communities in the II.A.4.N.a *Pinus ponderosa - Pseudotsuga menziesii* Woodland Alliance (A.533). The abundance of graminoids typically found in dry and dry-mesic prairies is one diagnostic feature to separate many elements within this woodland alliance from those within the *Pinus ponderosa* Forest Alliance (A.124). However, some woodland elements are relatively mesic and contain mesophytic shrubs. The classification status and diagnostic characteristics for these elements need better description. Taxonomists (Kartesz 1999) recognize two varieties of *Pinus ponderosa*, a Pacific form, *Pinus ponderosa* var. *ponderosa*, and an interior form, *Pinus ponderosa* var. *scopulorum*. Associations dominated by either variety are included in this alliance. The classification status of all associations currently placed in the *Pinus ponderosa* Forest Alliance (A.124) need review and verification.

Mesa Verde National Park—This alliance has no field documentation from this project. It is known through photointerpretation observations. Identified stands were typically less than 0.5 ha.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.a.	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pinus ponderosa* Woodland Alliance (A.530), Ponderosa Pine Woodland Alliance	

C.3.10.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES303.648	Southern Rocky Mountain Ponderosa Pine Woodland

C.3.10.4 NatureServe Conservation Status

Data are not available.

C.3.10.5 Distribution

***Globally*—**These woodlands occur in every state west of the Great Plains, as well as in British Columbia, Canada. East of the Rocky Mountains, they extend locally into North and South Dakota, Nebraska, Oklahoma, and Texas. The alliance also occurs in northern Mexico.

***Mesa Verde National Park*—**This woodland alliance was identified during the photointerpretation part of the project. The alliance occurs throughout the park cuesta.

C.3.10.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**These woodlands typically occur at the lower treeline/ecotone between grassland or shrubland and more mesic coniferous forest. They occur across 20 degrees of latitude, from Canada well into northwestern Mexico. The quantity and timing of precipitation vary greatly across the range of the alliance, ranging from 25 to 60 cm annually, with at least some seasonal drought. East of the Continental Divide and in the Southwest, summer precipitation predominates, whereas western stands receive most of their precipitation from westerly winter storms. Monsoonal summer rains can contribute a substantial proportion to the annual precipitation totals in the Southwest. Elevations decrease with increasing latitude, from less than 1,000 m in eastern Washington to over 2,750 m in southern Arizona and New Mexico. Stands occur at low elevations (<1,000 m) in the eastern Great Plains and west of the Cascade–Sierra axis. Fire is a key factor in maintaining the open canopies characteristic of these woodlands, but soil drought or infertility may be equally important in some areas. Soils derive from igneous, metamorphic, and sedimentary materials and have good aeration and drainage, coarse textures, circumneutral to slightly acid pH, an abundance of mineral material, and periods of drought during the growing season. Some stands may occur as edaphic climax communities on very skeletal, infertile, and/or excessively drained soils, such as pumice, cinder or lava fields, and scree slopes. All slopes and aspects are represented, but moderately steep to very steep slopes or ridgetops are the most common sites. Adjacent vegetation is highly varied, but most commonly these woodlands grade into semi-arid steppe grasslands or shrublands at the lower elevation margins and closed forests of *Abies grandis*, *Abies concolor*, *Pseudotsuga menziesii*, or *Populus tremuloides* at the upper elevation margins or adjacent more mesic sites. Adjacent drier sites can be dominated by *Juniperus scopulorum* or *Juniperus occidentalis* woodlands.

***Mesa Verde National Park*—**No field data was collected on the environment of the alliance.

C.3.10.7 Vegetation

***Globally*—**This alliance includes woodlands dominated by *Pinus ponderosa*. Structurally, these are open woodlands or savannas with large, open growth-form *Pinus ponderosa* trees (generally) as the only canopy dominant. Average tree canopy cover ranges from 20 to 70%. The understory may include dense stands of shrubs or be dominated by grasses, sedges, or herbaceous species, although many of the associations are named for shrub species. Existing stands usually have younger cohorts of *Pinus ponderosa* present and may be less open than in the past. Associated trees and understory species vary widely across the range of this alliance. In the southern Rocky Mountains and the mountains of southern Arizona and New Mexico, associated trees include *Pseudotsuga menziesii*, *Abies concolor*, *Picea pungens*, *Pinus strobiformis*, *Pinus edulis*, *Pinus discolor*, *Pinus cembroides*, *Pinus flexilis*, *Juniperus scopulorum*, and *Populus tremuloides*. In far southern stands, *Juniperus deppeana* may also be common. In the interior Pacific Northwest as far east as northwestern Montana, associated tree species may include *Pseudotsuga menziesii*, *Abies grandis*, *Cercocarpus ledifolius*, *Pinus contorta*, *Larix occidentalis*, *Juniperus occidentalis*, or *Quercus garryana*. As in the southern Rockies, none of these trees are ever abundant in the canopy, but in some stands one or more may be successfully regenerating, particularly *Abies grandis* or *Pseudotsuga menziesii*.

A shrub layer may be prominent or nearly absent, depending on location and disturbance history. Common species include *Arctostaphylos uva-ursi*, *Arctostaphylos patula*, *Arctostaphylos pungens*, *Arctostaphylos nevadensis*, *Artemisia tridentata*, *A. arbuscula*, *A. nova*, *Amelanchier alnifolia*, *Cercocarpus montanus*, *Cercocarpus ledifolius*, *Ceanothus greggii*, *Ceanothus fendleri*, *Ceanothus velutinus*, *Juniperus communis*, *Purshia mexicana*, *P. tridentata*, and species of *Quercus*, *Ribes*, and *Symphoricarpos*.

The herbaceous layer tends to vary inversely with shrub cover, but is composed primarily of graminoids. Important species include *Bouteloua gracilis*, *Carex geyeri*, *Carex rossii*, *Carex pensylvanica*, *Koeleria macrantha*, *Leucopoa kingii* (= *Festuca kingii*), *Muhlenbergia virescens*, *Muhlenbergia montana*, *Achnatherum hymenoides* (= *Oryzopsis hymenoides*), *Achnatherum occidentale* (= *Stipa occidentalis*), *Pseudoroegneria spicata*, *Poa secunda*, *Elymus elymoides*, *Festuca idahoensis*, *Festuca arizonica*, and *Hesperostipa comata* (= *Stipa comata*). Important or diagnostic forb species include *Aspidotis densa*, *Wyethia mollis*, *Balsamorhiza sagittata*, *Achillea millefolium*, *Sedum stenopetalum*, *Maianthemum racemosum* (= *Smilacina racemosa*), *Vicia americana*, and species of many other genera, such as *Erigeron*, *Lupinus*, *Fragaria*, *Lathyrus*, *Heterotheca*, *Arenaria*, and *Antennaria*. In western Texas and Oklahoma other associated species include *Piptochaetium fimbriatum*, *Piptochaetium pringlei*, *Achnatherum lobatum* (= *Stipa lobata*), *Bothriochloa barbinodis* (= var. *barbinodis*), *Schizachyrium scoparium* var. *scoparium* (= ssp. *neomexicanum*), *Muhlenbergia rigida*, and *Panicum bulbosum*.

Woodlands of the Black Hills and the surrounding region have somewhat unique species assemblages not found elsewhere. Tree associates include *Picea glauca*, *Quercus macrocarpa*, *Populus tremuloides*, *Betula papyrifera*, and *Juniperus scopulorum*. Characteristic shrubs in these eastern stands include *Rhus trilobata*, *Physocarpus monogynus*, *Symphoricarpos albus*, *Symphoricarpos occidentalis*, *Shepherdia canadensis*, *Arctostaphylos uva-ursi*, and *Rosa* spp. Many stands have an herbaceous understory composed of species from the adjacent mixed-grass prairie, including *Carex filifolia*, *Hesperostipa comata*, *Andropogon gerardii*, *Calamovilfa longifolia*, *Danthonia* spp., and *Schizachyrium scoparium*. In southwestern North Dakota, communities within this alliance do not cover large contiguous tracts. They are interrupted by other types of vegetation, usually grasslands (Potter and Green 1964).

In the far west, these woodlands occur in summer dry valleys and foothills from southern Oregon to central California. Typical tree associates include *Calocedrus decurrens*, *Pinus sabiniana*, *Pinus lambertiana*, *Pinus attenuata*, *Pseudotsuga menziesii*, *Quercus* spp., and *Aesculus californica*. The understory typically contains shrub species from adjacent chaparral communities, including *Arctostaphylos patula*, *Arctostaphylos viscida*, *Ceanothus* cuneatus, *Toxicodendron* diversilobum, *Frangula californica* (= *Rhamnus californica*), and *Symphoricarpos* spp. The herbaceous layer is typically sparse due to litter accumulation and is dominated by xerophytic forbs and grasses.

Mesa Verde National Park—*Pinus ponderosa* is the dominant species. The understory varies and can consist of a shrub layer with species, such as *Quercus gambelii* and/or *Ericameria nauseosa*. The herbaceous layer is often present and may consist of a combination of native and non-native species and can include the grass species *Bromus inermis* and *Pascopyrum smithii*.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Pinus ponderosa*

Mesa Verde National Park—No field data was collected on species in the alliance within the park.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—No field data was collected on species in the alliance within the park.

C.3.10.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: Data are not available.

References: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clausnitzer and Zamora 1987, Cooper et al. 1985, Cooper et al. 1987, Costello and Schwan 1946, Currie 1975, Daubenmire 1952, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Ganskopp 1979, Hall 1967, Hall 1973, Hoffman and Alexander 1976, Johnson and Simon 1987, Johnston 1987, Jones 1992, Jones and Ogle 2000, Kagan et al. 2000, Komarkova et al. 1988b, MTNHP 2002, Mauk and Henderson 1984, McLean 1970, Pfister 1977, Pfister et al. 1977, Steele et al. 1981, Terwilliger et al. 1979a, Tisdale and McLean 1957, WNHP unpubl. data, Western Ecology Working Group n.d., Zamora 1983.

C.3.11 *Populus angustifolia - Juniperus scopulorum* Woodland

Translated Name: Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland
NatureServe Code: CEGL002640

C.3.11.1 Summary

This semi-riparian woodland association occurs in north-central Wyoming, western Colorado, and northern New Mexico, on terraces or slopes of gorges, ravines, and moderate-sized intermittent or perennial drainages between 1,740 and 2,400 m (5,725–7,875 feet) elevation. This type usually occurs on high, dry stream terraces with level slopes and a sandy surface soil texture. Stands are infrequently flooded (10–100-year recurrence intervals). The vegetation is characterized by moderately open canopies (25–60% cover) dominated by *Populus angustifolia*, with *Juniperus scopulorum* or occasionally *Juniperus monosperma*, *Betula occidentalis*, or *Pinus edulis* in the subcanopy. An open, grassy understory with abundant *Sporobolus cryptandrus* is characteristic, although other grasses, such as *Carex geyeri*, *Juncus balticus*, *Leymus cinereus*, and *Poa fendleriana*, may also be present. In disturbed stands, the native grasses may have been replaced by exotic species, such as *Bromus inermis*. Although shrubs are uncommon, those present, such as *Brickellia californica*, *Quercus gambelii*, *Artemisia tridentata*, *Mahonia repens*, *Purshia tridentata*, *Rosa woodsii*, and *Symphoricarpos oreophilus*, reflect relatively dry site conditions. The herbaceous understory also reflects open, dry site conditions. Facultative and upland forbs, such as *Thalictrum fendleri*, *Achillea millefolium*, *Maianthemum stellatum*, *Solidago nemoralis*, and *Penstemon barbatus*, are common. In open areas, *Bouteloua curtipendula* is common. Regardless of the drier conditions, a variety of native wetland indicators can occur, including *Juncus effusus*, *Glyceria striata*, *Carex nebrascensis*, *Agrostis exarata*, *Rudbeckia laciniata*, *Equisetum arvense*, *Epilobium ciliatum*, *Mertensia ciliata*, and *Equisetum laevigatum*. Many stands have decadent *Populus angustifolia* trees that are being replaced by *Juniperus scopulorum*. Other stands periodically flood and retain a large amount of woody debris. In all cases, the vegetation and topographic position indicate a community that is becoming isolated from the water table. As the water table drops, the facultative and obligate wetland plants will be replaced by upland species.

C.3.11.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—These mature riparian forests occupy some of the driest sites in the floodplain. Some stands may be directly adjacent to the stream but still situated several meters above it due to downcut streambanks, or they may be dry because the stream only flows intermittently. In these stands, the cottonwoods have limited self-sustaining capabilities except vegetatively by root sprouts. Many of the trees are often decadent or dying, and junipers are commonly growing up under them, colonizing the drying terraces. Further, the presence of juniper in these and other floodplain communities is often considered invasive. Juniper, as a codominant in these communities, is at least viewed as an indicator that flooding occurs infrequently. Only the largest of floods will remove these communities. This type is a refinement of the *Populus angustifolia* / *Juniperus scopulorum* association reported by Muldavin (1991) for northern New Mexico and Kittel et al. (1994, 1996) for Colorado. It is synonymous with *Populus angustifolia* / *Physocarpus monogynus - Padus virginiana* in Bighorn National Forest, Wyoming (Girard et al. 1997), and *Populus angustifolia - Juniperus scopulorum* in New Mexico (Durkin et al. 1995). *Padus virginiana* is an old name for *Prunus virginiana*.

Mesa Verde National Park—The species composition for this association was documented in the field from two accuracy observation sites. It was identified on 36 polygons.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.B.	Deciduous woodland
Physiognomic Group	II.B.2.	Cold-deciduous woodland
Physiognomic Subgroup	II.B.2.N.	Natural/Semi-natural cold-deciduous woodland
Formation Name	II.B.2.N.b.	Temporarily flooded cold-deciduous woodland
Alliance Name	*Populus angustifolia* Temporarily Flooded Woodland Alliance (A.641), Narrowleaf Cottonwood Temporarily Flooded Woodland Alliance	

C.3.11.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.821	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

C.3.11.4 NatureServe Conservation Status

Global Rank & Reasons: G2G3 (7-Apr-1998)

C.3.11.5 Distribution

***Globally*—**This association occurs in north-central Wyoming, western Colorado, and northern New Mexico. It may occur in Utah.

***Mesa Verde National Park*—**This riparian woodland association was identified during the photointerpretation part of the project. This map class is restricted to the Mancos River corridor.

C.3.11.6 Environmental Setting

USFWS Wetland System: Palustrine

***Environmental Summary: Globally*—**The community is found in mountainous regions of north-central Wyoming, western Colorado, and northern New Mexico, on terraces or slopes of gorges, ravines, and moderate-sized intermittent or perennial drainages with elevations ranging from 1,740 to 2,400 m (5,725–7,875 feet). This type usually occurs on higher and drier terraces that have a relatively flat surface topography and are mostly composed of sandy alluvial sediments. As a result, stands are infrequently flooded (10–100-year recurrence intervals). Soils are young, weakly developed Entisols. Thick organic layers (Mollisols) have had time to develop in some stands. Soils tend to be dry, well-drained, and mostly sandy or silty at the surface, although commonly gravelly/cobbly with depth. Some of the lower terraces may be very moist at depths within the rooting zone, particularly during seasonal high water events.

***Mesa Verde National Park*—**This association occurs on flats adjacent to the active river channel.

C.3.11.7 Vegetation

***Globally*—**The species composition and percent cover in this association are variable and depend on aspect, elevation, and streamflow, in addition to the degree of disturbance by recreational use and livestock grazing. This type is characterized by mature, moderately open stands (25–60% cover) dominated by *Populus angustifolia*, with *Juniperus scopulorum* or occasionally *Juniperus monosperma*, *Betula occidentalis*, or *Pinus edulis* in the subcanopy. Total biomass and canopy cover are usually low. An open, grassy understory with abundant *Sporobolus cryptandrus* is characteristic, although other grasses, such as *Carex geyeri*, *Juncus balticus*, *Leymus cinereus*, and *Poa fendleriana*, may also be present. In disturbed stands, the native grasses may have been replaced by exotic species, such as *Bromus inermis*. Cottonwood reproduction occurs vegetatively from root sprouts, and young junipers are common. Although shrubs are uncommon, those present, such as *Brickellia californica*, *Quercus gambelii*, *Artemisia tridentata*, *Mahonia repens*, *Purshia tridentata*, *Rosa woodsii*, and *Symphoricarpos oreophilus*, reflect relatively dry site conditions. The herbaceous understory also reflects the open,

drier site conditions. Facultative and upland forbs, such as *Thalictrum fendleri*, *Achillea millefolium*, *Maianthemum stellatum*, *Solidago nemoralis*, and *Penstemon barbatus*, are common. In open areas, *Bouteloua curtipendula* is common. Regardless of the drier conditions, a variety of native wetland indicators can occur: *Juncus effusus*, *Glyceria striata*, *Muhlenbergia racemosa*, *Carex nebrascensis*, *Agrostis exarata*, *Rudbeckia laciniata*, *Equisetum arvense*, *Epilobium ciliatum*, *Mertensia ciliata*, *Lycopus asper*, *Equisetum laevigatum*, and *Asclepias incarnata*.

Mesa Verde National Park—The tree canopy is dominated or codominated by *Populus angustifolia* or *Populus* X *acuminata*. *Juniperus scopulorum* is always present and often codominates the canopy. Shrubs may occur in the understory, including *Salix exigua*. The herbaceous understory may include the non-native invasive grasses, *Bromus inermis* and *Poa pratensis*, and the non-native forb, *Melilotus officinalis*.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Populus angustifolia*
Tree subcanopy	*Juniperus scopulorum*
Herb (field)	*Sporobolus cryptandrus*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Populus angustifolia, Populus X acuminata*
Tree subcanopy	*Juniperus scopulorum*
Shrub canopy	*Salix exigua*
Herbaceous	*Chaetopappa ericoides, Poa pratensis*

Other Noteworthy Species: Globally—*Bromus inermis*
Mesa Verde National Park—Data are not available.

C.3.11.8 Element Sources

Global Description Authors: Muldavin et al., mod. J. Coles
Local Description Authors: Data are not available.
References: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carsey et al. 2003b, Cooper and Cottrell 1990, Durkin et al. 1994, Durkin et al. 1995, Girard et al. 1997, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1999a, Kittel et al. 1999b, Muldavin 1991, Muldavin et al. 2000b, Western Ecology Working Group n.d.

C.3.12 *Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland

Translated Name: Narrowleaf Cottonwood / Invasive Perennial Grasses Semi-natural Woodland
NatureServe Code: CEGL003749

C.3.12.1 Summary

This riparian association occurs in the foothill and lower montane zones of the Rocky Mountains extending west into the Great Basin and east onto the northern plains. Sites are between 945 and 2,490 m (3,100–8,160 feet) elevation and are found along streams and rivers in broad valleys to narrow canyons. Stands extend onto the floodplain and stream terraces. Generally, soils are well-drained sand, loam, or silt, with river gravels and cobbles mixed within the matrix. This vegetation is characterized by a moderately open to closed (50–90% cover) tree canopy (10–15-m tall), dominated by *Populus angustifolia*, with an understory dominated by introduced perennial grasses without a notable shrub layer. *Acer negundo*, *Fraxinus velutina*, *Populus fremontii* (in the southwestern part of range), or *Salix amygdaloides* are often present, and *Juniperus scopulorum*, *Juniperus monosperma*, or *Juniperus deppeana* may be common in subcanopy. Shrubs are absent or present only as scattered individuals. The moderately dense to dense herbaceous layer is frequently dominated or codominated by *Poa pratensis*, *Bromus inermis*, or other introduced graminoids, such as *Agrostis stolonifera*, *Agrostis gigantea*, *Alopecurus geniculatus*, *Elymus repens*, *Dactylis glomerata*, and *Phleum pratense*. Native graminoids are often present but have low cover and may include *Carex* spp., *Bromus porteri*, *Elymus canadensis*, *Elymus trachycaulus*, *Juncus balticus*, and *Pascopyrum smithii*. Forb diversity is moderately high but variable. The introduced invasives *Cirsium arvense*, *Melilotus officinalis*, and *Taraxacum officinale* are common on disturbed sites. Adjacent, lower alluvial bars may be dominated by *Salix* spp. and *Alnus* spp. and occasionally emergent wetlands. Uplands may be open grasslands and hillslopes that support mixed coniferous spruce-fir forests on north-facing aspects and pine or juniper woodlands on south-facing slopes.

C.3.12.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—This *Populus angustifolia* forest association is the result of combining *Populus angustifolia* / *Poa pratensis* Woodland (CEGL005963) and *Populus angustifolia* / *Bromus inermis* Semi-natural Woodland (CEGL005847). It includes all *Populus angustifolia* forest stands that have an herbaceous layer dominated by introduced graminoids species and lack a shrub layer, although scattered shrubs may be present. It typically occurs because of heavy grazing and browsing use.

Mesa Verde National Park—These two relevés have equal cover of the native trees *Populus angustifolia* and *Populus fremontii*. Although both of these trees seem to be important to the association composition at Mesa Verde National Park, this particular association was defined in other localities as dominated by *Populus angustifolia*. The high cover of the non-native herbaceous species *Bromus inermis* suggests that the sites have been continually disturbed by grazing and, in some cases, agriculture. *Bromus inermis* is widespread in the region, as it was planted in fields, on roadsides in re-vegetation projects, and has spread throughout the area. The Mancos River has historically been heavily impacted and only recently have fencing and rehabilitation been accomplished by Mesa Verde National Park.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.B.	Deciduous woodland
Physiognomic Group	II.B.2.	Cold-deciduous woodland
Physiognomic Subgroup	II.B.2.N.	Natural/Semi-natural cold-deciduous woodland
Formation Name	II.B.2.N.b.	Temporarily flooded cold-deciduous woodland
Alliance Name	*Populus angustifolia* Temporarily Flooded Woodland Alliance (A.641), Narrowleaf Cottonwood Temporarily Flooded Woodland Alliance	

C.3.12.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.821	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

C.3.12.4 NatureServe Conservation Status

Global Rank & Reasons: GNA (ruderal) (26-May-2004)

C.3.12.5 Distribution

Globally—This riparian association is widespread in mountainous regions of the Rio Grande, Pecos, and Gila River watersheds and is widely distributed in foothills and lower montane zones throughout much of the Rocky Mountains and Intermountain West from New Mexico to Montana and Idaho extending west into the Great Basin and east onto the northern plains.

Mesa Verde National Park—This semi-natural woodland association occurs on two relevés on low-elevation and channel bed positions of alluvial flats and fans within Mesa Verde National Park. The relevés of this vegetation association are found near the Mancos River in the southeast corner of the park, the only habitat with perennial water that can support arboreal riparian vegetation.

C.3.12.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This riparian association occurs in the foothill and lower montane zones of the Rocky Mountains, extending west into the Great Basin and east onto the northern plains. Sites are between 945 and 2,490 m (3,100–8,160 feet) elevation and are found along streams and rivers in broad valleys to narrow canyons. Stands extend onto the floodplain and stream terraces. Terraces may border the channel but are elevated several meters above the stream. Consequently, the community is only periodically flooded (10–25-year recurrence intervals). On the older elevated terraces, soils show some development (Inceptisols), with some beginning to develop a rich organic layer from decomposition and leaching of leaves and branches (Mollic Epipedons). On recently aggraded bars, soils lack development (Entisols). These soils are located closer to the active channel and, therefore, can be wet or moist well within rooting depth. Generally, all soils are well-drained sand, loam, or silt, with river gravels and cobbles mixed within the matrix.

Mesa Verde National Park—This association occurs on sandy loam soils at elevations of 1,887 and 1,910 m (6,191 and 6,266 feet). Both of these relevés occur on flat areas with alluvial surfaces. Both relevés show signs of seasonal flooding and recent evidence of cattle grazing. Adjacent to one relevé is a treatment area for the removal of the non-native tree, *Tamarix* sp.

C.3.12.7 Vegetation

Globally—This riparian association is characterized by a moderately open to closed (50–90% cover) tree canopy 10–15-m tall dominated by *Populus angustifolia*, with an understory dominated by introduced perennial grasses without a notable shrub layer. *Acer negundo*, *Fraxinus velutina*, *Populus fremontii* (in the Southwest), or *Salix amygdaloides* are often present in the tree canopy at lower elevations, and *Pinus ponderosa* at higher elevations. *Juniperus scopulorum*, *Juniperus monosperma*, or *Juniperus deppeana* may be common in the subcanopy. Shrubs are absent or present only as scattered individuals. Shrub species are varied, and include *Acer glabrum*, *Crataegus douglasii*, *Chrysothamnus viscidiflorus*, *Cornus sericea* ssp. *sericea*, *Juniperus communis*, *Prunus virginiana*, *Ribes* spp., *Rosa woodsii*, *Rubus deliciosus*, *Salix irrorata*, *Salix exigua*, *Salix lutea*, *Symphoricarpos* spp., and the vine, *Clematis ligusticifolia*. Sapling and seedling/root sprouts of *Populus angustifolia* and *Juniperus* spp. may also be present. The moderately dense to dense herbaceous layer is frequently dominated or codominated by *Poa pratensis*, *Bromus inermis*, or other introduced graminoids, such as *Agrostis stolonifera*, *Agrostis gigantea*, *Alopecurus geniculatus*, *Elymus repens*, *Dactylis glomerata*, and *Phleum pratense*. Native graminoids are often present but have low cover. Other graminoids include *Carex* spp., *Bromus porteri*, *Elymus canadensis*, *Elymus glaucus*, *Elymus trachycaulus*, *Juncus balticus*, and

Pascopyrum smithii. Forb diversity is moderately high but variable. The most abundant forbs are *Achillea millefolium*, *Allium* sp., *Anemone* sp., *Artemisia ludoviciana*, *Chenopodium leptophyllum*, *Equisetum* spp., *Geranium* sp., *Galium boreale*, *Grindelia squarrosa*, *Heracleum maximum*, *Heterotheca villosa*, *Maianthemum stellatum*, *Pedicularis procera*, *Potentilla pulcherrima*, *Solidago canadensis*, *Thalictrum fendleri*, *Thermopsis montana*, and *Vicia americana*. The introduced invasives *Cirsium arvense*, *Melilotus officinalis*, and *Taraxacum officinale* are common on disturbed sites.

Mesa Verde National Park—Two relevés are classified as *Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland. The tree stratum in these relevés covers 25–50% and 50–100%. The shrub stratum covers 5–10% and 25–50%, and the herbaceous stratum covers 25–50% and 50–100%, respectively. The species richness is 14 and 24 species. The tree stratum is dominated by native riparian trees *Populus angustifolia* and *Populus fremontii*, both of which range between 5–10% and 25–50% cover and range in height from 10 m to >30 m. One relevé also contains *Juniperus scopulorum* with significant cover of 5–10%. The shrub stratum has no dominant species, except for *Rosa woodsii*, with cover classes of 1–5% and 5–10%, and *Salix exigua*, a riparian shrub, which occurs in one relevé with 5–10% cover. The shrub stratum height ranges between 1–2 m. The herbaceous stratum is dominated by the non-native invasive grass *Bromus inermis*, which has cover classes of 25–50% and 50–75%. In one relevé the non-native invasive forb *Acroptilon repens* occurs in the understory with 5–10% cover. *Poa pratensis*, a native grass, is present in both relevés and ranges in cover between a trace and 5–10%.

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Populus angustifolia*
Herb (field)	*Agrostis stolonifera, Bromus inermis, Dactylis glomerata, Phleum pratense, Poa pratensis*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus scopulorum, Populus angustifolia, Populus fremontii*
Tall shrub/sapling	*Rosa woodsii*
Herb (field)	*Acroptilon repens, Bromus inermis, Poa pratensis*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.12.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Carsey et al. 2003b, Fitzhugh et al. 1987, Hall and Hansen 1997, Hansen et al. 1995, Jones and Walford 1995, Manning and Padgett 1995, Muldavin 1991, Muldavin et al. 2000b, Padgett et al. 1989, Western Ecology Working Group n.d., Youngblood et al. 1985a, Youngblood et al. 1985b.

C.3.13 *Pseudotsuga menziesii / Acer negundo* Woodland

Translated Name: Douglas-fir / Box-elder Woodland
NatureServe Code: CEGL002754

C.3.13.1 Summary

This mixed-canopy woodland association has been documented from cold, narrow, high-gradient tributary canyons in Dinosaur National Monument and Mesa Verde National Park in western Colorado and northeastern Utah. Elevations range from 1,600 to 2,344 m (5,250–7,740 feet). Sites are rocky and subject to periodic flash flooding. The canopy consists of *Pseudotsuga menziesii* with a subcanopy of *Acer negundo*. Other tree species present include *Populus angustifolia* and *Juniperus scopulorum*. The shrub layer is variable but may include *Amelanchier utahensis*, *Prunus virginiana*, *Rosa woodsii*, *Rhus trilobata*, and *Symphoricarpos oreophilus*. Herbaceous species have low to moderate cover.

C.3.13.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Only one *Pseudotsuga menziesii* association was originally defined in the classification scheme (*Pseudotsuga menziesii* / *Quercus gambelii* Forest (CEGL000452)); however, *Pseudotsuga menziesii* / *Acer negundo* Woodland (CEGL002754) is recorded by NatureServe as occurring in other localities outside of Mesa Verde National Park. The project classification team therefore determined that this association was a distinct community at Mesa Verde National Park and it was separated from its original placement.

Vegetation Hierarchy		
Physiognomic Class	II	Woodland
Physiognomic Subclass	II.A.	Evergreen woodland
Physiognomic Group	II.A.4.	Temperate or subpolar needle-leaved evergreen woodland
Physiognomic Subgroup	II.A.4.N.	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland
Formation Name	II.A.4.N.b.	Conical-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance Name	*Pseudotsuga menziesii* Woodland Alliance (A.552), Douglas-fir Woodland Alliance	

C.3.13.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.825	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

C.3.13.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (12-Apr-2005)

C.3.13.5 Distribution

Globally—This association has been documented from Mesa Verde National Park and Dinosaur National Monument in western Colorado, and in northeastern Utah.

Mesa Verde National Park—This woodland association was sampled from only one location at a low elevation on the valley floor of Mesa Verde National Park. The association was identified from the Point Lookout Sandstone Formation in Prater Canyon.

C.3.13.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This mixed-canopy woodland association has been documented from cold, narrow, high-gradient tributary canyons in Dinosaur National Monument and Mesa Verde National Park in western Colorado, and in northeastern Utah. Elevations range from 1,600 to 2,344 m (5,250–7,740 feet). Sites are rocky and subject to periodic flash flooding. Substrates are coarse-textured soils derived from alluvium.

Mesa Verde National Park—This association occurs on sandy soils at an elevation of 2,344 m (7,690 feet). The slope of this relevé is 23%, with a southerly aspect. One large sandstone boulder was present in the relevé.

C.3.13.7 Vegetation

Globally—This mixed-canopy woodland association consists of *Pseudotsuga menziesii* with a subcanopy of *Acer negundo*. Other tree species present include *Populus angustifolia* and *Juniperus scopulorum*. The mixed shrub layer is variable but may include *Amelanchier utahensis*, *Prunus virginiana*, *Rhus trilobata*, *Ribes aureum*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. Herbaceous species have low to moderate cover. Common species include *Carex occidentalis*, *Thalictrum fendleri*, and other mesic species.

Mesa Verde National Park—One relevé was classified as *Pseudotsuga menziesii* / *Acer negundo* Woodland. The tree stratum in this relevé covers 50–75%, the shrub stratum covers 25–50%, and the herbaceous stratum covers 25–50%. The species richness is 20 species. The tree stratum is dominated by *Acer negundo*, which has 50–75% cover, and *Pseudotsuga menziesii*, which has 25–50% cover. The tree stratum has two main layers: an emergent canopy of *Pseudotsuga menziesii* and *Acer negundo* with a height of 10–20 m and an *Acer negundo* subcanopy below with a height of 5–10 m. The shrub stratum is dominated by *Symphoricarpos oreophilus*, which has 25–50% cover and an average height ranging between 1–2 m. Also present in the shrub stratum are *Prunus virginiana* and *Ribes aureum*, each having 5–10% cover. The herbaceous stratum is dominated by *Carex occidentalis*, which has 25–50% cover. Other notable species in the herbaceous stratum are the forb *Thalictrum fendleri* (5–10% cover) and the non-native grass *Bromus tectorum* (1–5% cover).

Most Abundant Species: Globally—

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tree subcanopy	*Acer negundo*
Short shrub/sapling	*Rosa woodsii, Symphoricarpos oreophilus*
Herb (field)	*Carex occidentalis*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Pseudotsuga menziesii*
Tree subcanopy	*Acer negundo*
Tall shrub/sapling	*Prunus virginiana, Ribes aureum, Symphoricarpos oreophilus*
Herb (field)	*Thalictrum fendleri, Carex occidentalis*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—*Bromus tectorum*

C.3.13.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Western Ecology Working Group n.d.

C.3.14 *Juniperus scopulorum / Bromus inermis (Pascopyrum smithii)* Woodland [Park Special]

Translated Name: Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland [Park Special]
NatureServe Code: Park Special

C.3.14.1 Summary

Data are not available.

C.3.14.2 Classification

Classification Confidence: 3–Weak
*Classification Comments: Globally—*Data are not available.

*Mesa Verde National Park—*The identity of this association at Mesa Verde NP is based on observational data provided by a park naturalist.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.3.14.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.14.4 NatureServe Conservation Status

Data are not available.

C.3.14.5 Distribution

*Globally—*Data are not available.

*Mesa Verde National Park—*This woodland association was identified during the photointerpretation part of the project. Park resource staff has noted *Juniperus scopulorum* associated with *Pinus edulis* and sometimes with *Juniperus osteosperma* on sandy colluvium over shales, Cliffhouse Sandstone, and Point Lookout sandstones in the park. The relative contribution of the two junipers varies (M. Colyer pers. comm.); for example, at the base of the Point Lookout Sandstone, Rocky Mountain juniper is the dominant juniper. These woodland sites occur in scattered locations between 6,500–8,300 feet (1,980–2,530 m) with a relatively high water table. Rocky Mountain juniper is also associated with various grasses, including *Pleuraphis jamesii* on lower canyon slopes in Mancos Canyon, *Bromus inermis* and *Elymus trachycaulus* on Mancos Shales along the North Escarpment, and other native grasses in Morefield Canyon. Stands occur in upper Morefield Canyon on the Switchback Road and in Mancos Canyon on Park Point.

C.3.14.6 Environmental Setting

USFWS Wetland System: Not applicable
*Environmental Summary: Globally—*Data are not available.
*Mesa Verde National Park—*This vegetation class occurs along drainages and the river channel.

C.3.14.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—*Juniperus scopulorum* is the dominant species. The understory consists of a mix of native and non-native species and can include the grass species, *Bromus inermis* and *Pascopyrum smithii*.

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—No relevé or ground observation data collected.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—No relevé or ground observation data collected.

C.3.14.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: Data are not available.
References: Data are not available.

C.3.15 *Pinus edulis - Juniperus* spp. / Shale Sparse Woodland [Park Special]

Translated Name: Two-needle Pinyon - Juniper spp. / Shale Sparse Woodland [Park Special]
NatureServe Code: Park Special

C.3.15.1 Summary

Data are not available.

C.3.15.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—This park special was identified on 223 polygons, 70% of which are less than 0.5 ha. It is documented with 14 accuracy assessment sites, and noted on six photointerpreter's locations.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.3.15.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.767	Colorado Plateau Pinyon-Juniper Woodland

C.3.15.4 NatureServe Conservation Status

Data are not available.

C.3.15.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This park special type was identified during the photointerpretation part of the project. It occurs throughout the lower elevations of the escarpment in the north and upslope of the Mancos River Valley in the east.

C.3.15.6 Environmental Setting

USFWS Wetland System: Not applicable
Environmental Summary: Globally—Data are not available.
Mesa Verde National Park—This park special is restricted to the Mancos Shale. Accuracy assessment observation sites for this plant community were collected between 2,069 and 2,291 meters.

C.3.15.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—*Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory tends to be very sparse (<10% cover). The understory tends to contain species that commonly occur on the Mancos Shale, including the shrub *Eriogonum corymbosum* as well as *Cercocarpus montanus, Amelanchier utahensis,* and *Quercus gambelii.*

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Shrub canopy	*Amelanchier utahensis, Cercocarpus montanus, Ericameria nauseosa, Eriogonum corymbosum*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.3.15.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: Data are not available.
References: Data are not available.

C.4 Shrubland

C.4.1 *Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland

Translated Name: Utah Serviceberry, Saskatoon Serviceberry) – Mountain mahogany Shrubland
NatureServe Code: CEGL001070

C.4.1.1 Summary

The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, and ridges, and in alcoves. Sites may be oriented to any aspect. Elevation ranges between 1,586 and 2,595 m (5,200–8,500 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Soils range from shallow to deep but are generally always rocky with a high cover of surface rock. The vegetation is characterized by a more open shrub layer and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical associated shrub species include *Artemisia bigelovii*, *Artemisia tridentata*, *Chrysothamnus viscidiflorus*, *Ephedra viridis*, *Ericameria nauseosa*, *Eriogonum corymbosum*, *Purshia tridentata*, *Rhus trilobata*, *Fraxinus anomala*, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla*, *Eriogonum microthecum*, *Gutierrezia sarothrae*, *Mahonia repens*, and *Paxistima myrsinites*. Succulents, such as *Opuntia* spp. or *Yucca* spp., may also have minor cover. If *Quercus gambelii* is present, cover is low (<5%). Scattered trees of *Juniperus osteosperma*, *Juniperus scopulorum*, or *Pinus edulis* may be present in some stands. *Achnatherum hymenoides* (= *Oryzopsis hymenoides*) is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana*, *Koeleria macrantha*, *Achnatherum lettermanii*, *Pseudoroegneria spicata*, *Elymus lanceolatus*, *Hesperostipa comata*, and *Leymus salinus*. Forb species may include *Arenaria fendleri*, *Chaenactis douglasii*, *Cryptantha flava*, *Balsamorhiza sagittata*, *Eriogonum umbellatum*, *Galium coloradoense*, *Heterotheca villosa*, *Lepidium montanum*, *Lithospermum ruderale*, *Petradoria pumila*, *Phlox longifolia*, *Physaria acutifolia*, *Senecio integerrimus*, *Sphaeralcea coccinea*, *Stanleya pinnata*, *Stenotus acaulis*, and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

C.4.1.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Amelanchier utahensis* Shrubland Alliance (A.916), Utah Serviceberry Shrubland Alliance	

C.4.1.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES306.822	Rocky Mountain Lower Montane-Foothill Shrubland

C.4.1.4 NatureServe Conservation Status

Global Rank & Reasons: G2? (18-May-2001). This association is well-known only from a small area

in Colorado, and very few occurrences have been documented. It also occurs in Utah and Nevada, but no information is available on its conservation status in those states. Very little is known about the larger scale abiotic factors that contribute to the distribution. The global rank should be at least G3 based on the numbers of sites documented at Dinosaur and Colorado national monuments.

C.4.1.5 Distribution

Globally—This association is documented from stands in western Colorado and eastern Utah. It has been reported from Nevada and is likely to occur in xeric areas of mixed mountain shrubland throughout the plateaus and foothills of Colorado and in higher elevations of the Colorado Plateau, western Rocky Mountains, and Intermountain West.

Mesa Verde National Park—This shrubland association was identified from seven relevés on high slopes, canyons, and hillsides within Mesa Verde National Park. The association is found on the Menefee, Mancos Shale, and Cliff House Sandstone formations. Relevés of this vegetation type were found in the west fork of Long Canyon, Navajo Canyon, Waters Canyon, Chapin Mesa, and in the Mancos Valley area between Point Lookout and the park entrance.

C.4.1.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—The description for this association is based on information from Colorado and Utah; its characteristics in Nevada are unknown and will be described when more information becomes available. This plant association is found on moderate to steeply sloping colluvial slopes, canyons, and ridges, and in alcoves. Sites may be oriented to any aspect. Elevations range between 1,586 and 2,500 m (5,200–8,200 feet). Relative to other mixed mountain shrub types, it is found on the driest sites with the least soil development and relatively low diversity. Exposed ground is moderate to extensive, averaging 40%. Soils range from shallow to deep but are generally always rocky with a high cover of surface rock.

Mesa Verde National Park—This association occurs on sandy soils (with the exception of one relevé that is found on silty clay loam in the Mancos Valley) and is found at elevations between 2,179 and 2,398 m (7,148–7,867 feet), average 2,314 m (7,592 feet). The slope ranges from 4 to 45% (average 20%), mostly at a southwest to northwestern aspect. Most of the relevés have a low cover of sandstone boulders, stones, cobbles, and gravel. All of the relevés have at least 5% cover of vegetation litter.

C.4.1.7 Vegetation

Globally—The vegetation is characterized by a more open shrub layer and a sparse understory relative to other mixed mountain shrub types. Total vegetation cover often does not exceed 50%. *Amelanchier utahensis* and *Cercocarpus montanus* are the dominants of as many as 16 shrub species in this association. Typical shrub species include *Artemisia bigelovii*, *Artemisia tridentata*, *Chrysothamnus viscidiflorus*, *Ephedra viridis*, *Ericameria nauseosa*, *Eriogonum corymbosum*, *Purshia tridentata*, *Rhus trilobata*, *Fraxinus anomala*, and *Tetradymia canescens*. *Symphoricarpos oreophilus* can dominate the lower shrub layer, which may also include *Brickellia microphylla*, *Eriogonum microthecum*, *Gutierrezia sarothrae*, *Mahonia repens*, and *Paxistima myrsinites*. Succulents, such as *Opuntia* spp. or *Yucca* spp., may also have minor cover. *Achnatherum hymenoides* (= *Oryzopsis hymenoides*) is the most common species in the diverse herbaceous layer. Other graminoid species may include *Poa fendleriana*, *Koeleria macrantha*, *Achnatherum lettermanii*, *Pseudoroegneria spicata*, *Elymus lanceolatus*, *Hesperostipa comata*, and *Leymus salinus*. Forb species may include *Arenaria fendleri*, *Chaenactis douglasii*, *Cryptantha flava*, *Balsamorhiza sagittata*, *Eriogonum umbellatum*, *Galium coloradoense*, *Heterotheca villosa*, *Lepidium montanum*, *Lithospermum ruderale*, *Petradoria pumila*, *Phlox longifolia*, *Physaria acutifolia*, *Senecio integerrimus*, *Sphaeralcea coccinea*, *Stanleya pinnata*, *Stenotus acaulis*, and *Streptanthella longirostris*. Disturbed sites may have high cover of *Bromus tectorum*.

Mesa Verde National Park—Eight relevés are classified as *Amelanchier* (*utahensis*, *alnifolia*) - *Cercocarpus montanus* Shrubland. The tree stratum ranges in cover class from no cover to 5–10% (average cover class 2–4%). The shrub stratum ranges between 10–25% and 75–100% (average cover class 40–

64%), and the herbaceous stratum ranges between 1–5% and 25–50% (average cover class 11–23%). The species richness is 9–19 species (average of 14 species). The tree stratum is absent or minimal. *Pinus edulis* occurs in one relevé with 5–10% cover. The shrub stratum is dominated by *Amelanchier utahensis*, which ranges between cover classes 5–10% and 25–50% (average cover class 10–22%), and *Cercocarpus montanus*, which ranges between cover classes of 1–5% and 50–75% (average cover class 17–32%). *Fendlera rupicola* is represented in all but one of the relevés and ranges between no cover and a cover class of 25–50% (average cover class 7–15%). Also commonly present in the shrub stratum are *Purshia tridentata* and *Quercus gambelii*. The shrub stratum consists of mostly tall shrubs with heights ranging between 1 and 5 m. *Poa fendleriana* ssp. *longiligula*, a native grass, occurs in over half of the plots and ranges in cover between a trace to cover class 25–50% (average cover class 4–9%). *Bromus inermis*, a non-native invasive grass, occurs in two relevés; in one relevé, this species has a high cover of 25–50%. *Petradoria pumila*, a native forb, occurs in one relevé, with a cover of 5–10%.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Cercocarpus montanus*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Pinus edulis*
Tall shrub/sapling	*Amelanchier utahensis, Cercocarpus montanus, Fendlera rupicola, Purshia tridentata*
Herb (field)	*Petradoria pumila, Bromus inermis, Poa fendleriana ssp. longiligula*

Other Noteworthy Species: Globally—*Bromus tectorum*
Mesa Verde National Park—Data are not available.

C.4.1.8 Element Sources

Global Description Authors: L. Tasker, mod. J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, CONHP unpubl. data, CONHP unpubl. data 2003, Driscoll et al. 1984, NVNHP 2003, Tiedemann 1978, Vories 1974, Western Ecology Working Group n.d.

C.4.2 *Amelanchier utahensis - Fendlera rupicola* Shrubland

Translated Name: Utah Serviceberry - Fendlerbush Shrubland
NatureServe Code: CEGL003817

C.4.2.1 Summary

This shrubland association occurs only from Mesa Verde National Park in southwestern Colorado in the Colorado Plateau. It occurs in lower canyon slopes, high-slope eolian deposits, and the upper slopes of escarpments from 2,371 to 2,497 m (7,779–8,192 feet) elevation. Stands occur on gentle to moderately steep slopes (4–32%) with a northwest to southeast aspect. Soils are sandy. The vegetation is characterized by a moderately dense shrub canopy codominated by *Amelanchier utahensis* and *Fendlera rupicola*. Other shrub species also have significant cover, including *Artemisia nova* and *Tetradymia canescens*. Scattered *Juniperus osteosperma* and *Quercus gambelii* may also be present with low cover (<5%). The herbaceous layer is variable, but usually sparse. *Phlox hoodii* ssp. *canescens*, *Balsamorhiza sagittata*, and *Eriogonum umbellatum* are common species. High cover exotic annual grass *Bromus tectorum* may per present.

C.4.2.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Amelanchier utahensis* Shrubland Alliance (A.916), Utah Serviceberry Shrubland Alliance	

C.4.2.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.2.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (6-Jun-2006)

C.4.2.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This shrubland association was identified from four relevés. They were identified from a high-slope eolian deposit in the Cliff House Sandstone Formation, a low slope of a canyon in the Menefee Formation, and the upper slope of an escarpment in the Menefee Formation. They are located in the west fork of Navajo Canyon, in Soda Canyon, Long Spur North Rim, and the North Escarpment.

C.4.2.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This association occurs on sandy soils at high elevations ranging from

2,371 to 2,497 m (7,779–8,192 feet), average 2,388 m (7,825 feet). The slope of this relevé ranges from 4 to 32% (average 14%) with a northwest to southeast aspect. A few of the relevés have a low cover of sandstone boulders, stones, cobbles, and gravel. One relevé has evidence of impact from the 1972 fire.

C.4.2.7 Vegetation

***Globally*—**Data are not available.

***Mesa Verde National Park*—**Three relevés were classified as *Amelanchier utahensis - Fendlera rupicola* Shrubland. The total tree cover ranges from no cover to a cover class of 50–75% (average cover class 12–19%). The total shrub cover ranges from a cover class of 25–50% and 75–100% (average cover class 44–69%), and the herbaceous cover ranges from a cover class of 1–5% and 50–75% (average cover class 17–29%). The species richness is 17–26 species (average 20). The shrub stratum is dominated by *Amelanchier utahensis*, with cover ranging between 5–10% and 50–75% (average cover class 21–36%), and *Fendlera rupicola*, with cover ranging between cover classes 5–10% and 50–75% (average cover class 19–34%). Other shrub species also have significant cover, including *Artemisia nova* in one relevé with 50–75% cover and *Tetradymia canescens* with 25–50% cover. The herbaceous stratum does not have a consistent herbaceous layer. Two relevés have a high cover of *Phlox hoodii* ssp. *canescens* (25–50% cover), and one relevé has a very high cover of *Bromus tectorum* (75–100% cover). *Collomia grandiflora* occurs in one relevé with 5–10% cover and can re-sprout after fire (Floyd et al. 2001). *Balsamorhiza sagittata* and *Eriogonum umbellatum* occur in 75% of the relevés with a low cover of 0–5%.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Tree canopy	*Juniperus osteosperma, Quercus gambelii*
Shrub/sapling (tall & short)	*Amelanchier utahensis, Symphoricarpos oreophilus, Tetradymia canescens, Artemisia nova, Fendlera rupicola*
Short shrub/sapling	*Ephedra torreyana*
Herb (field)	*Collomia grandiflora, Crepis acuminata, Lomatium dissectum, Petradoria pumila, Phlox hoodii* ssp. *Canescens, Bromus tectorum, Koeleria macrantha, Poa fendleriana* ssp. *longiligula*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park*—Bromus tectorum*

C.4.2.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Floyd et al. 2001, Western Ecology Working Group n.d.

C.4.3 *Amelanchier utahensis* Shrubland

Translated Name: Utah Serviceberry Shrubland
NatureServe Code: CEGL001067

C.4.3.1 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 and also on northern aspects, and in cold-air drainages at lower elevations and latitudes that are more southern. 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.

C.4.3.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This association is not well known. More survey work and classification work are needed to define further this type.

Mesa Verde National Park—*Amelanchier utahensis* Shrubland (CEGL001067) is ecologically similar to *Amelanchier* (*utahensis*, *alnifolia*) - *Cercocarpus montanus* Shrubland (CEGL001070), with the exception that *Amelanchier utahensis* Shrubland relevés all occur within recent fires and lack *Cercocarpus montanus*.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Amelanchier utahensis* Shrubland Alliance (A.916), Utah Serviceberry Shrubland Alliance	

C.4.3.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.3.4 NatureServe Conservation Status

Global Rank & Reasons: G4 (19-Sep-2000)

C.4.3.5 Distribution

Globally—This shrubland association occurs in the foothills and mountain areas in north-central Utah, Colorado Plateau, and Great Basin of the western U.S.

Mesa Verde National Park—This shrubland association was identified from six relevés on the upper and high slopes of mesas and the high-elevation eolian deposits within Mesa Verde National Park. The association occurs solely in the Cliff House Sandstone Formation. The relevés that were identified

from this association occur in recent fires on Park Mesa (1996 fire), Whites Canyon (2000 fire), and the east fork of Long Canyon (1989 fire).

C.4.3.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This montane shrubland association occurs on foothills, canyons, mountains, and mesas at elevations from 1,480 to 2,440 m (4,855–8,000 feet). Stands occur on moderate to steep slopes (9–37°) with a high proportion of talus or rockfall. It is found on relatively warm southern aspects in the Wasatch Mountains (Yake and Brotherson 1979) and on northern aspects, in cold-air drainages at lower elevations, and at latitudes that are more southern. Substrates are moderately deep, rocky loams and clays and are rapidly drained.

Mesa Verde National Park—This association occurs on sandy soils between the elevations of 2,352 and 2,420 m (7,717–7,940 feet), average 2,385 m (7,940 feet). The slope ranges from 3 to 35% (average 10%) mostly at a south to western aspect. Most of the relevés in this association have a low cover of sandstone surface rocks. Two relevés were in the 1989 fire area, three from the 1996 fire, and one from the 2000 fire.

C.4.3.7 Vegetation

Globally—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.

Mesa Verde National Park—Four relevés are classified as *Amelanchier utahensis* Shrubland. The total shrub cover ranges between cover classes 25–50% and 50–75% (average cover class 29–54%), and the total herbaceous cover ranges between cover classes 5–10% and 75–100% (average cover class 30–52%). The tree stratum is absent and is not likely to colonize for at least 50–75 years post-fire. The species richness is 9–28 species (average of 19 species). The shrub stratum is dominated by *Amelanchier utahensis*, with all six of the relevés recorded as occurring in cover class 25–50%. The average height of the *Amelanchier utahensis* shrub layer is between 1 and 2 m. The shrub layer is otherwise sparse. *Artemisia tridentata* occurs in one relevé with a high cover of 10–25% cover. *Symphoricarpos oreophilus* also occurs in one relevé with a cover of 5–10%. The herbaceous stratum is not consistent and varies among relevés. Three relevés have a high cover of *Elymus elymoides*, which ranges between no cover to 25–50% cover (average cover class 6–12%), and *Hesperostipa comata*, which ranges between no cover to 75–100% (average cover class 21–33%). *Eurybia glauca* and *Eriogonum racemosum* occur in more than 50% of the relevés, all with a low cover of less than 5%.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis*
Short shrub/sapling	*Symphoricarpos oreophilus*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Symphoricarpos oreophilus, Artemisia tridentata*
Herb (field)	*Astragalus scopulorum, Petradoria pumila, Sphaeralcea coccinea* ssp. *coccinea, Bromus tectorum, Elymus elymoides, Hesperostipa comata, Koeleria macrantha, Poa fendleriana* ssp. *longiligula*

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**Data are not available.

C.4.3.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Drake
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, Carmichael et al. 1978, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, NVNHP 2003, Western Ecology Working Group n.d., Yake and Brotherson 1979.

C.4.4 *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland

Translated Name: Basin Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland
NatureServe Code: CEGL002699

C.4.4.1 Summary

This association is common throughout the Colorado Plateau, occurring in small to moderate-sized patches on alluvial terraces, floodplains, and point bars. *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*.

C.4.4.2 Classification

Classification Confidence: 1–Strong
*Classification Comments: Globally—*This semi-natural association is likely much more widespread across the western U.S. but is not often sampled.

*Mesa Verde National Park—*This association at Mesa Verde National Park occurs in an area with high disturbance from intermediate flooding. This association has a native shrub component with a high cover of non-native invasive herbaceous species. These non-native species likely thrive in this disturbance regime, which until recently has been characterized by heavy grazing. This vegetation association should be monitored along the Mancos River corridor.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.A.	Evergreen shrubland
Physiognomic Group	III.A.4.	Microphyllous evergreen shrubland
Physiognomic Subgroup	III.A.4.N.	Natural/Semi-natural microphyllous evergreen shrubland
Formation Name	III.A.4.N.a.	Lowland microphyllous evergreen shrubland
Alliance Name	*Artemisia tridentata* Shrubland Alliance (A.829), Basin Big Sagebrush Shrubland Alliance	

C.4.4.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.777	Inter-Mountain Basins Big Sagebrush Shrubland

C.4.4.4 NatureServe Conservation Status

Global Rank & Reasons: GNA (ruderal) (14-Aug-2001)

C.4.4.5 Distribution

*Globally—*This association is widespread in southern Utah and western Colorado.

*Mesa Verde National Park—*This semi-natural shrubland association occurs on one relevé on the low level of an alluvial fan within Mesa Verde National Park. This relevé was located in the Mancos River.

C.4.4.6 Environmental Setting

USFWS Wetland System: Not applicable

*Environmental Summary: Globally—*This association occurs on alluvial terraces, flats, and fans or valley floors throughout the Colorado Plateau. Most stands occur below 2,000 m (6,560 feet) on level to gently sloping sites. Soils are variable and include sandy loams, silt loams, and clay loams, depending

on the size of the stream and the geology of the watershed. Cryptobiotic soil crusts are often extensive.

***Mesa Verde National Park*—**The relevé occurs in a flat area with loamy sand at an elevation of 1,884 m (6,181 feet). A small cover of alluvium gravel occurs in this relevé. An intermittent flooding regime occurs in this location.

C.4.4.7 Vegetation

***Globally*—**This association is widespread on floodplains and terraces within the Colorado Plateau that have been subject to grazing. *Artemisia tridentata* ssp. *tridentata* is always present with cover ranging between 10 and 70% and up to 2 m in height. *Ericameria nauseosa* is not always present, but is likely to be present in the vicinity. Other shrubs that occur in this community consistently include *Atriplex canescens*, *Chrysothamnus viscidiflorus*, and *Sarcobatus vermiculatus*. In some stands there may be scattered individuals of *Pinus edulis* or *Juniperus osteosperma*. The herbaceous layer has a long history of disturbance. It is dominated by exotic annual species, especially *Bromus tectorum*. Other common herbaceous species include *Erodium cicutarium*, *Lappula occidentalis*, 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* and *Oenothera caespitosa*.

***Mesa Verde National Park*—**One relevé is classified as *Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland. The total tree cover is 5–10%, the total shrub cover is 25–50%, and the total herbaceous cover is 25–50%. The species richness is 17 species. The tree stratum is sparse with *Juniperus scopulorum* and *Populus angustifolia*, both with less than 5% cover and occurring as small trees (<1 m tall). The shrub stratum is dominated by *Artemisia tridentata* and *Ericameria nauseosa*, both with 5–10% cover. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the invasive non-native species, *Acroptilon repens*, *Bromus tectorum*, and *Cardaria draba* (all species with 25–50% cover). Additional invasive non-native species *Bromus inermis*, *Carduus nutans* ssp. *macrolepis*, and *Sisymbrium altissimum* all occur in the relevé with 1–5% cover.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Bromus tectorum*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Ericameria nauseosa, Artemisia tridentata*
Herb (field)	*Acroptilon repens, Cardaria draba, Bromus tectorum*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park*—Bromus inermis*, *Carduus nutans* ssp. *macrolepis*, *Sisymbrium altissimum*

C.4.4.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Cogan et al. 2004, Western Ecology Working Group n.d.

C.4.5 *Artemisia tridentata* ssp. *tridentata / Pascopyrum smithii - (Elymus lanceolatus)* Shrubland

Translated Name: Basin Big Sagebrush / Western Wheatgrass - (Streamside Wild Rye) Shrubland
NatureServe Code: CEGL001017

C.4.5.1 Summary

This widespread sagebrush shrubland occurs on valley bottoms, stream terraces, and other relatively mesic sites west of the Great Plains throughout much of the intermountain western U.S. Stands occur over an elevational range of 1,800–2,410 m (5,900–7,900 feet). Most stands grow on alluvial terraces in stream alluvium, although a few occur on upland swales. Soils generally are loamy or sandy. Water tables may be within 2 m of the soil surface. The stream channel often is dry and may be incised. Soils are moderately well-drained sandy loam to sandy clay loam derived from alluvium. This association is characterized by a sparse to moderately dense short-shrub layer (up to about 40% canopy cover and to 1.5 m tall) that is dominated by *Artemisia tridentata* ssp. *tridentata*, with an herbaceous layer that is usually dominated by *Pascopyrum smithii* or *Elymus lanceolatus*. Other shrubs may be present in small amounts, especially *Artemisia tridentata* ssp. *wyomingensis*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Ericameria parryi*, *Krascheninnikovia lanata*, or *Quercus gambelii*. The sparse to dense herbaceous layer is dominated by graminoids and is poor in species richness relative to other sagebrush types. Other species that may be present in substantial amounts are *Achnatherum hymenoides*, *Achnatherum pinetorum*, *Bromus inermis*, *Elymus elymoides*, *Leymus cinereus*, *Muhlenbergia richardsonis*, *Poa fendleriana*, *Poa secunda* (= *Poa nevadensis*), and introduced species *Bromus inermis* and *Poa pratensis*. Forbs contribute much less cover than do grasses. Species that often occur are *Achillea millefolium*, *Astragalus* spp., *Erigeron compositus*, *Packera cana* (= *Senecio canus*), *Penstemon* spp., *Symphyotrichum ascendens* (= *Aster ascendens*), and introduced species *Taraxacum officinale* and *Melilotus officinalis*.

C.4.5.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—The identity of this association at Mesa Verde NP is based on observational data provided by a park naturalist.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.A.	Evergreen shrubland
Physiognomic Group	III.A.4.	Microphyllous evergreen shrubland
Physiognomic Subgroup	III.A.4.N.	Natural/Semi-natural microphyllous evergreen shrubland
Formation Name	III.A.4.N.a.	Lowland microphyllous evergreen shrubland
Alliance Name	*Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrubland Alliance (A.830), (Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance	

C.4.5.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.777	Inter-Mountain Basins Big Sagebrush Shrubland

C.4.5.4 NatureServe Conservation Status

Global Rank & Reasons: G3? (1-Feb-1996)

C.4.5.5 Distribution

Globally—This association occurs across the interior western U.S. from southwestern Montana, southwestern Wyoming, and north-central Colorado to southwestern Utah and northeastern Nevada. It may also occur in Washington, Oregon, and Idaho, given the broad geographic ranges of *Artemisia*

tridentata ssp. *tridentata* and *Pascopyrum smithii*.

***Mesa Verde National Park*—**This shrubland association was identified during the photointerpretation part of the project. The association is restricted to the Mancos River area.

C.4.5.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This widespread sagebrush shrubland occurs on valley bottoms, stream terraces, and other relatively mesic sites west of the Great Plains. Stands occur over an elevational range of 1,800–2,410 m (5,900–7,900 feet). Most stands grow on alluvial terraces in stream alluvium, although a few occur on upland swales. Soils generally are loamy or sandy. Water tables may be within 2 m of the soil surface. The stream channel often is dry and may be incised. Soils are moderately well-drained sandy loam to sandy clay loam derived from alluvium.

***Mesa Verde National Park*—**The association is found on broad flats of land in the Mancos River valley that have been cleared for agriculture.

C.4.5.7 Vegetation

***Globally*—**This association is characterized by a sparse to moderately dense short-shrub layer (up to about 40% canopy cover and 1.5 m tall) that is dominated by *Artemisia tridentata* ssp. *tridentata*, with an herbaceous layer that is usually dominated by *Pascopyrum smithii* or *Elymus lanceolatus*. Other shrubs may be present in small amounts, especially *Artemisia tridentata* ssp. *wyomingensis*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Ericameria parryi*, *Krascheninnikovia lanata*, or *Quercus gambelii*. The sparse to dense herbaceous layer is dominated by graminoids and is poor in species richness relative to other sagebrush types. Other species that may be present in substantial amounts are *Achnatherum hymenoides*, *Achnatherum pinetorum*, *Bromus inermis*, *Elymus elymoides*, and *Poa fendleriana* in Colorado (Tiedemann et al. 1987), *Poa secunda* (= *Poa nevadensis*), and *Muhlenbergia richardsonis* in Nevada (Blackburn et al. 1971), and *Leymus cinereus* and *Poa pratensis* in Montana (Cooper et al. 1995). Forbs contribute much less cover than do grasses. Species that often occur are *Symphyotrichum ascendens* (= *Aster ascendens*) and *Collinsia parviflora* in Nevada (Blackburn et al. 1971), *Achillea millefolium*, *Astragalus convallarius*, *Astragalus drummondii*, *Astragalus tenellus*, *Penstemon strictus*, and *Penstemon caespitosus* in north-central Colorado (Tiedemann et al. 1987), *Achillea millefolium*, *Erigeron compositus*, *Packera cana* (= *Senecio canus*), and *Taraxacum officinale* in southwestern Montana (Cooper et al. 1995), and *Cordylanthus ramosus* in southwestern Wyoming (Jones and Fertig 1996). Mosses and lichens may be important ground cover.

Mesa Verde National Park*—Artemisia tridentata* is the main shrub and dominates the shrub layer. The herbaceous layer is dominated by *Pascopyrum smithii*. *Elymus lanceolatus* can occur in this association in other locations outside of Mesa Verde National Park. It has not been observed to codominate this association at Mesa Verde National Park.

***Most Abundant Species: Globally*—**

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*
Herb (field)	*Elymus lanceolatus, Pascopyrum smithii*

***Mesa Verde National Park*—**No relevé or ground observation data collected.

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**No relevé or ground observation data collected.

C.4.5.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: Data are not available.
References: Beetle and Johnson 1982, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bunting

1987, CONHP Ecology Team 2001, Cogan et al. 2004, Cooper et al. 1995, Driscoll et al. 1984, Everett 1987, Francis 1983, Johnston 1987, Jones and Fertig 1996, Keammerer 1977, MTNHP 2002, NVNHP 2003, Strong 1980, Tiedemann et al. 1987, Western Ecology Working Group n.d., Wright et al. 1979.

C.4.6 Artemisia tridentata ssp. *tridentata / Pleuraphis jamesii Shrubland*

Translated Name: Basin Big Sagebrush / James' Galleta Shrubland
NatureServe Code: CEGL001015

C.4.6.1 Summary

This association has been described from the Colorado Plateau in southeastern Utah and may occur in parts of Colorado, New Mexico, and Arizona. Most stands occur on valley floors, alluvial flats, and on the terraces of intermittent drainages. A few stands have been reported from mesas. Sites are located between 1,866 and 2,200 m (6,122–7,220 feet) elevation on level to gentle slopes (<5%). Up to 80% of the unvegetated surface is covered by bare ground. Soils are generally deep, calcareous, and alkaline sandy loams or clay loams derived from alluvium. This association occupies dry sites on valley floors in the Colorado Plateau. Total vegetation cover is variable; some disturbed stands may appear to be sparsely vegetated with total vegetation cover less than 10%. Stands are characterized by an open shrub canopy (5 to 35% cover) dominated by *Artemisia tridentata* ssp. *tridentata*. Associated shrubs may include *Chrysothamnus viscidiflorus*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Atriplex* spp., and *Krascheninnikovia lanata*. Total woody canopy ranges from 5–35% cover. The sparse herbaceous layer (5–15% cover) is dominated by graminoids, such as *Pleuraphis jamesii* (= *Hilaria jamesii*), *Achnatherum hymenoides*, *Aristida purpurea*, *Bouteloua gracilis*, *Elymus elymoides*, and *Sporobolus cryptandrus*. Forbs are sparse and variable; species recorded from plots include *Castilleja linariifolia* and *Psoralidium lanceolatum*.

C.4.6.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—The identity of the association at Mesa Verde NP is based on observational data provided by a park naturalist. It was identified on four polygons.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.A.	Evergreen shrubland
Physiognomic Group	III.A.4.	Microphyllous evergreen shrubland
Physiognomic Subgroup	III.A.4.N.	Natural/Semi-natural microphyllous evergreen shrubland
Formation Name	III.A.4.N.a.	Lowland microphyllous evergreen shrubland
Alliance Name	*Artemisia tridentata* (ssp. *tridentata*, ssp. *xericensis*) Shrubland Alliance (A.830), (Basin Big Sagebrush, Foothill Big Sagebrush) Shrubland Alliance	

C.4.6.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.777	Inter-Mountain Basins Big Sagebrush Shrubland

C.4.6.4 NatureServe Conservation Status

Global Rank & Reasons: G2G4 (9-Nov-2005). This association occurs in southeastern Utah on the Colorado Plateau and likely occurs in adjacent Colorado, New Mexico, and Arizona. Stands are relatively small and grow in deep, non-saline soils on bottomland, alluvial flats, and possibly mesa tops. The lowland sites are easily accessible, and most have been grazed for decades and, in some cases, centuries by livestock. Overgrazing reduces the graminoid layer and damages the *Artemisia tridentata* ssp. *tridentata* shrubs. A number of stands are located in Capitol Reef National Park, although they have been subject to grazing. This association may have a relatively large range, but stands in good condition will be small and difficult to find. Until more information is available from field surveys, the rank should stay G2G4.

C.4.6.5 Distribution

***Globally*—**This association is found on the Colorado Plateau in southeastern Utah, and likely occurs in adjacent Colorado, New Mexico, and Arizona.

***Mesa Verde National Park*—**This shrubland association was identified during the photointerpretation part of the project. The association was restricted to the Mancos River area.

C.4.6.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This association has been described from the Colorado Plateau in southeastern Utah and may occur in parts of Colorado, New Mexico, and Arizona. Most stands occur on valley floors, alluvial flats, and on the terraces of intermittent drainages. A few stands have been reported from mesas. Sites are located between 1,866 and 2,200 m (6,122–7,220 feet) elevation on level to gentle slopes (<5%). Up to 80% of the unvegetated surface is covered by bare ground. Soils are generally deep, calcareous, and alkaline sandy loams or clay loams derived from alluvium.

***Mesa Verde National Park*—**The association occurs in the Mancos River area on fallow agricultural fields.

C.4.6.7 Vegetation

***Globally*—**This association occupies dry sites on valley floors in the Colorado Plateau. Total vegetation cover is variable; some disturbed stands may appear to be sparsely vegetated, with total vegetation cover less than 10%. Stands are characterized by an open shrub canopy (5–35% cover) dominated by *Artemisia tridentata* ssp. *tridentata*. Associated shrubs may include *Chrysothamnus viscidiflorus*, *Ephedra viridis*, *Ericameria nauseosa*, *Gutierrezia sarothrae*, *Opuntia polyacantha*, *Atriplex* spp., and *Krascheninnikovia lanata*. Total woody canopy ranges from 5 to 35% cover. The sparse herbaceous layer (5–15% cover) is dominated by graminoids, such as *Pleuraphis jamesii* (= *Hilaria jamesii*), *Achnatherum hymenoides*, *Aristida purpurea*, *Bouteloua gracilis*, *Elymus elymoides*, and *Sporobolus cryptandrus*. Forbs are sparse and variable; species recorded from plots include *Castilleja linariifolia* and *Psoralidium lanceolatum*.

Mesa Verde National Park*—Artemisia tridentata* is the main shrub and dominates the shrub layer. The herbaceous layer is dominated by *Pleuraphis jamesii*.

***Most Abundant Species: Globally*—**

Stratum	Species
Short shrub/sapling	*Artemisia tridentata ssp. tridentata*
Herb (field)	*Pleuraphis jamesii*

***Mesa Verde National Park*—**No relevé or ground observation data collected.

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**No relevé or ground observation data collected.

C.4.6.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: Data are not available.
References: Baker 1984, Barrows et al. 1977, Bourgeron and Engelking 1994, Branson et al. 1976, Donart et al. 1978, Driscoll et al. 1984, Francis 1986, Francis and Aldon 1983, Northcutt 1978, Western Ecology Working Group n.d.

C.4.7 *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland

Translated Name: Wyoming Big Sagebrush / Needle-and-Thread Colorado Plateau Shrubland
NatureServe Code: CEGL002761

C.4.7.1 Summary

This shrubland association occurs on deep soils on the slopes and summits of plateaus, ridges, hills, and mesas throughout the Colorado Plateau in eastern Utah and western Colorado. The type is likely to occur in southwestern Wyoming, as well. Elevations range from 1,450 to 2,419 m (4,750–7,940 feet). Slopes are level to moderately steep (0–50%). Substrates include eolian sands, loess, and landslide deposits; most often soils are not residual but develop from these secondary sources. Total vegetation cover ranges from 25 to 75%, dominated by *Artemisia tridentata* ssp. *wyomingensis*. Other shrubs provide little additional cover but may include *Chrysothamnus viscidiflorus*, *Gutierrezia sarothrae*, *Leptodactylon pungens*, *Opuntia polyacantha*, and *Yucca harrimaniae*. *Hesperostipa comata* dominates the sparse to moderately dense herbaceous layer. Other grass species present depend on the soil texture, with *Achnatherum hymenoides*, *Elymus elymoides*, and *Koeleria macrantha* more common on sandy soils, whereas *Pleuraphis jamesii*, *Bouteloua gracilis*, and *Poa fendleriana* are more common on silty soils. Forbs provide little total cover but may include *Arenaria fendleri*, *Calochortus gunnisonii*, *Lepidium montanum*, *Linum lewisii*, *Phlox hoodii*, *Penstemon teucrioides*, and *Sphaeralcea coccinea*. *Bromus tectorum* may be codominant in heavily disturbed sites. Scattered young *Juniperus osteosperma* and *Pinus edulis* trees are often present. Cryptobiotic soil crusts are common in this type, but development is uneven and tends to be sparse in sites that have been grazed by domestic livestock.

C.4.7.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—A similar association, *Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Shrubland (CEGL001051), describes a shrubland type of the Columbia River Basin of Oregon and Washington, and the Snake River Plain of Idaho, that is restricted to dry calcareous hardpan sites. However, little is known of the specifics of this association and its possible relationship to the Colorado Plateau shrubland. Baker's (1984a) concept of *Artemisia tridentata* ssp. *wyomingensis* / *Stipa comata* association includes both the Colorado and Columbia Basin/Snake River Plain communities. As more data become available, and especially as the range of the Colorado Plateau shrubland type is better known, these two associations should be revisited and compared to justify their separation.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.A.	Evergreen shrubland
Physiognomic Group	III.A.4.	Microphyllous evergreen shrubland
Physiognomic Subgroup	III.A.4.N.	Natural/Semi-natural microphyllous evergreen shrubland
Formation Name	III.A.4.N.a.	Lowland microphyllous evergreen shrubland
Alliance Name	*Artemisia tridentata* ssp. *wyomingensis* Shrubland Alliance (A.832), Wyoming Big Sagebrush Shrubland Alliance	

C.4.7.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.777	Inter-Mountain Basins Big Sagebrush Shrubland

C.4.7.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (12-Apr-2005)

C.4.7.5 Distribution

***Globally*—**This shrubland association occurs on deep soils on the slopes and summits of plateaus, ridges, hills, and mesas throughout the Colorado Plateau in eastern Utah and western Colorado, and may extend into Wyoming.

***Mesa Verde National Park*—**This shrubland association occurs on one relevé in the Mancos River corridor in Mesa Verde National Park. This vegetation association is also known to occur on the north end of the Long Mesa fire (1989) and in the Chapin 5 fire (1996) areas.

C.4.7.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This widespread shrubland association occurs on deep soils on the slopes and summits of plateaus, ridges, hills, and mesas throughout the Colorado Plateau in eastern Utah and western Colorado. The type is likely to occur in southwestern Wyoming, as well. Elevations range from 1,450 to 2,419 m (4,750–7,940 feet). Slopes are level to moderately steep (0–50%). Substrates include eolian sands, loess, and landslide deposits; most often soils are not residual but develop from these secondary sources. In sparsely vegetated stands, there is usually an abundance of exposed soil on the ground surface, whereas in denser stands litter covers most of the ground.

***Mesa Verde National Park*—**The relevé occurs in a flat area with clay loam and shale soils at an elevation of 1928 m (6325 feet). This relevé was identified from the Mancos River area, and the flooding regime was listed as unknown. This relevé has evidence of grazing and disturbance from *Ips* bark beetle.

C.4.7.7 Vegetation

***Globally*—**This sagebrush association is widespread throughout the northern Colorado Plateau, and is abundant in northwestern Colorado. Total vegetation cover ranges from 25 to 75%, dominated by *Artemisia tridentata* ssp. *wyomingensis* with between 5 and 65% cover. Other shrubs provide little additional cover but may include *Chrysothamnus viscidiflorus*, *Gutierrezia sarothrae*, *Leptodactylon pungens*, *Opuntia polyacantha*, and *Yucca harrimaniae*. *Hesperostipa comata* dominates the sparse to moderately dense herbaceous layer. Other grass species present depend on the soil texture, with *Achnatherum hymenoides*, *Elymus elymoides*, and *Koeleria macrantha* more common on sandy soils, whereas *Pleuraphis jamesii*, *Bouteloua gracilis*, and *Poa fendleriana* are more common on silty soils. Forbs provide little total cover but may include *Arenaria fendleri*, *Calochortus gunnisonii*, *Lepidium montanum*, *Linum lewisii*, *Phlox hoodii*, *Penstemon teucrioides*, and *Sphaeralcea coccinea*. *Bromus tectorum* may be codominant in heavily disturbed sites. Scattered young *Juniperus osteosperma* and *Pinus edulis* trees are often present. Cryptobiotic soil crusts are common in this type, but development is uneven and tends to be sparse in sites that have been grazed by domestic livestock.

***Mesa Verde National Park*—**One relevé is classified as *Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Shrubland. The total tree cover is 5–10%, the total shrub cover is 5–10%, and the total herbaceous cover is 50–75%. The species richness is 29 species. *Pinus edulis* occurs in the tree stratum with less than 5 to 10% cover and a height ranging from 5–10 m. The shrub stratum is dominated by *Artemisia tridentata* ssp. *Wyomingensis*, with 5–10% cover. *Artemisia tridentata* ssp. *wyomingensis* likely occurs in high cover in this area due to drying of the site by historical grazing and agriculture. The average height for the shrub stratum is 0.5–1 m. The herbaceous stratum is dominated by the native species, *Hesperostipa comata*, with 5–10% cover. *Bromus tectorum*, a non-native invasive grass, covers less than 5% of the relevé.

Most Abundant Species: Globally—

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *wyomingensis*
Herb (field)	*Hesperostipa comata*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Pinus edulis*
Short shrub/sapling	*Artemisia tridentata*
Herb (field)	*Erigeron speciosus, Sphaeralcea coccinea* ssp. *coccinea, Hesperostipa comata*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—*Bromus tectorum*

C.4.7.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Baker 1984, Western Ecology Working Group n.d.

C.4.8 *Artemisia nova / Hesperostipa comata* Shrubland

Translated Name: Black Sagebrush / Needle-and-Thread Shrubland
NatureServe Code: CEGL001425

C.4.8.1 Summary

This association is found in the foothills, plateaus, and mountains of Nevada, Idaho, northwestern Colorado, and Utah. Stands occur on flat mesa tops, benches, and plains, or on steep-pediment slopes, knolls and ridges, and elevations range from 1,890 to 2,530 m. Aspects are often southern. Substrates are typically shallow, stony soils, often derived from calcareous parent materials, such as limestone. Soil textures are variable and range from sandy, loamy, fine-textured, or skeletal; argillic subsoil horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. Combined ground cover of bare ground, rock, and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies. The vegetation is characterized by an open dwarf-shrub canopy (10–30% cover) that is dominated by *Artemisia nova* and a sparse herbaceous layer dominated by the perennial graminoid *Hesperostipa comata* with scattered forbs. Scattered *Chrysothamnus viscidiflorus*, *Ericameria parryi*, *Grayia spinosa*, *Krascheninnikovia lanata*, and *Tetradymia canescens* are common shrub associates that may be present in smaller amounts. *Achnatherum hymenoides*, *Elymus elymoides*, *Koeleria macrantha*, *Pleuraphis jamesii*, *Poa fendleriana*, or *Poa secunda* may be present in the herbaceous layer but have sparse cover. Forbs include species of *Astragalus*, *Erigeron*, *Eriogonum*, *Packera*, *Phlox*, and *Penstemon*. Introduced annual graminoids, such as *Bromus rubens* and *Bromus tectorum*, are common in disturbed stands.

C.4.8.2 Classification

Classification Confidence: 1–Strong
***Classification Comments: Globally*—**Data are not available.

***Mesa Verde National Park*—**Although *Artemisia ludoviciana* is present in all three relevés and is often dominant or codominant with *Artemisia nova*, *Artemisia nova* is an indicator for this association and was already described in other locations outside of Mesa Verde National Park with similar species composition. *Artemisia ludoviciana* was therefore not included in the nomenclature for *Artemisia nova* / *Hesperostipa comata* Shrubland (CEGL001425).

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.A.	Evergreen shrubland
Physiognomic Group	III.A.4.	Microphyllous evergreen shrubland
Physiognomic Subgroup	III.A.4.N.	Natural/Semi-natural microphyllous evergreen shrubland
Formation Name	III.A.4.N.a.	Lowland microphyllous evergreen shrubland
Alliance Name	*Artemisia nova* Shrubland Alliance (A.1105), Black Sagebrush Shrubland Alliance	

C.4.8.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.762	Colorado Plateau Mixed Low Sagebrush Shrubland

C.4.8.4 NatureServe Conservation Status

Global Rank & Reasons: G3? (26-Feb-2004). This dwarf-shrubland association is present in the southern part of the Intermountain Region above 1,890 m (6,200 feet). This includes northern Utah and Nevada and southeastern Idaho, where small stands occur on southern aspects of flat mesa tops, benches, and plains, or on steep-pediment slopes, knolls, and ridges. The number, condition, and size of stands have been declining due to intensive range management, introduction of exotic species, alteration of fire regime, and road development from off-road vehicles. Remote stands are mostly being threatened through range management of livestock, which exposes them to exotic weed invasion;

subsequently, perennial grasses and soil crust are lost. Fire frequency is increased by the invasion of introduced annual grasses, such as *Bromus tectorum* or *Bromus rubens*, which provide fine fuels that allow fires to spread.

C.4.8.5 Distribution

***Globally*—**This dwarf-shrubland association is present in the southern part of the Intermountain Region above 1,890 m (6,200 feet). This includes northern Utah and Nevada, northwestern Colorado (Jackson and Moffit counties), and southeastern Idaho.

***Mesa Verde National Park*—**This shrubland association was identified from three relevés on high-elevation eolian deposits and on alluvial fans within Mesa Verde National Park. The association occurs on the Cliff House Sandstone Formation and on alluvium. The relevés that were identified from this association occur in the west fork of Navajo Canyon and in Morefield Canyon.

C.4.8.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This association is found in the foothills, plateaus, and mountains of Nevada, Idaho, northwestern Colorado, and Utah. Elevation ranges from 1,890 to 2,530 m (6,200–8,300 feet). In Nevada, stands possibly could be found as low as 1,676 m (5,500 feet) elevation. Stands occur on flat mesa tops, benches, and plains, or on steep-pediment slopes and ridges. Aspects are often southern. Soils are typically shallow, stony, and often derived from calcareous parent materials, such as limestone. Soil textures are variable and range from sandy, loamy, fine-textured, or skeletal; argillic subsoil horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. *Artemisia nova* plants often grow in adjacent *Artemisia tridentata* shrublands that are found on deeper soils in basins. Combined ground cover of bare ground, rock, and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies.

***Mesa Verde National Park*—**This association occurs on sandy soils between the elevations of 2,357 and 2,460 m (7,733–8,070 feet), average 2,422 m (7,946 feet). The slope is low and ranges from 0–4% (average 2%), mostly at a southern aspect. Most of the relevés in this association have a low cover of sandstone gravel and stones. One of the relevés burned in the 2000 fire.

C.4.8.7 Vegetation

***Globally*—**This association is characterized by an open dwarf-shrub canopy (10–30% cover) that is dominated by *Artemisia nova* and a sparse herbaceous layer dominated by the perennial graminoid, *Hesperostipa comata*, with scattered forbs. Scattered *Chrysothamnus viscidiflorus*, *Ericameria parryi*, *Grayia spinosa*, *Krascheninnikovia lanata*, and *Tetradymia canescens* are common shrub associates that may be present in smaller amounts. *Achnatherum hymenoides*, *Elymus elymoides*, *Koeleria macrantha*, *Pleuraphis jamesii*, *Poa fendleriana*, or *Poa secunda* may be present in the herbaceous layer but have sparse cover. Other herbaceous species include *Astragalus* spp., *Erigeron* spp., *Eriogonum racemosum*, *Leptodactylon pungens*, *Packera multilobata*, *Phlox longifolia*, and *Penstemon* spp. Introduced annual graminoids, such as *Bromus rubens* and *Bromus tectorum*, are common in disturbed stands.

***Mesa Verde National Park*—**Three relevés are classified as *Artemisia nova* / *Hesperostipa comata* Shrubland. The tree stratum is absent from all relevés. The total shrub cover ranges from cover class 1–5% and 50–75% (average cover class 25–43%), and the total herbaceous cover ranges from cover class 1–5% and 50–75% (average cover class 42–67%). The species richness is 15–28 species (average of 22 species). The shrub stratum is dominated by *Artemisia nova*, which ranges in cover between cover classes 1–5% and 50–75% (average cover class 19–30%), and *Artemisia ludoviciana*, which ranges between cover classes 5–10% and 50–75% cover (average cover class 27–45%). *Ericameria nauseosa* and *Tetradymia canescens* both occur in one relevé each, with 25–50% cover. *Amelanchier utahensis* occurs in two relevés, both with 5–10% cover, and *Fendlera rupicola* and *Opuntia polyacantha* occur in one relevé, with 5–10% cover each. The average height of the shrub stratum is between 0.5 and 5 m. The herbaceous stratum is variable in species composition and cover. *Hesperostipa comata*

is the dominant species in the herbaceous strata, with cover ranging between cover class 5–10% and 25–50% (average cover class 12–23%). *Petradoria pumila*, an herbaceous forb, occurs in one relevé with high cover of 25–50%. *Poa fendleriana* ssp. *longiligula* occurs in all three relevés and ranges in cover between cover class 1–5% and 10–25% (average cover class 7–18%).

Most Abundant Species: Globally—

Stratum	Species
Short shrub/sapling	*Artemisia nova*
Herb (field)	*Hesperostipa comata*

Mesa Verde National Park—

Stratum	Species
Shrub/sapling (tall & short)	*Amelanchier utahensis, Artemisia ludoviciana, Ericameria nauseosa, Tetradymia canescens, Artemisia nova, Fendlera rupicola*
Herb (field)	*Opuntia polyacantha, Eriogonum umbellatum, Arenaria congesta, Crepis acuminata, Erigeron utahensis, Lomatium dissectum, Lupinus caudatus, Petradoria pumila, Phlox longifolia, Sphaeralcea coccinea* ssp. *coccinea, Bromus tectorum, Hesperostipa comata, Pascopyrum smithii, Poa fendleriana* ssp. *longiligula, Poa pratensis*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.4.8.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Baker and Kennedy 1985, Blackburn et al. 1968, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Cogan et al. 2004, Driscoll et al. 1984, Hironaka et al. 1983, NVNHP 2003, Roberts et al. 1992, Tisdale and Hironaka 1981, Western Ecology Working Group n.d., Wright et al. 1979, Zamora and Tueller 1973.

C.4.9 *Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional]

Translated Name: Mountain mahogany - Fendlerbush Shrubland
NatureServe Code: CEGL003820

C.4.9.1 Summary

This shrubland association occurs in one location at Mesa Verde National Park. It occurs on an upper canyon slope at 2,538 m (7,989 feet) elevation. A moderately dense shrub canopy codominated by *Cercocarpus montanus* and *Fendlera rupicola* characterizes the vegetation. Other shrub species may be present, including *Artemisia nova* and *Opuntia polyacantha*. Scattered *Juniperus osteosperma* may also be present. The herbaceous stratum is dominated by the native forb, *Paxistima myrsinites*, with 5–10% cover.

C.4.9.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—This association is newly described at Mesa Verde National Park. Because only one relevé was identified as this association, insufficient information requires it to be listed as a park special association. Once additional information is collected on this specific association, it will be included as a new association in the NatureServe classification.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Cercocarpus montanus* Shrubland Alliance (A.896), Mountain mahogany Shrubland Alliance	

C.4.9.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.822	Rocky Mountain Lower Montane-Foothill Shrubland

C.4.9.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (6-Jun-2006)

C.4.9.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This shrubland association occurs on one relevé on the upper slope of a canyon. The relevé was identified on the Cliff House Sandstone Formation in Navajo Canyon.

C.4.9.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—The relevé occurs on a moderate slope (7%) with sandy soils and low cover of sandstone boulders and stones.

C.4.9.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—One relevé is classified as *Cercocarpus montanus - Fendlera rupicola* Shrubland. The total tree cover is 5–10%, total shrub cover is 50–75%, and total herbaceous cover is 10–25%. The species richness is 16 species. *Juniperus osteosperma* is the only species in the tree stratum, and occurs with 5–10% cover and a height ranging from 5 to 10 m. The shrub stratum is dominated by *Cercocarpus montanus* and *Fendlera rupicola*, both with 25–50% cover. *Artemisia nova* and *Opuntia polyacantha* both occur with 1–5% cover. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the native forb, *Paxistima myrsinites*, with 5–10% cover.

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—

Stratum	Species
Shrub/sapling (tall & short)	*Cercocarpus montanus, Fendlera rupicola, Paxistima myrsinites*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.4.9.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Western Ecology Working Group n.d.

C.4.10 *Prunus virginiana - (Prunus americana)* Shrubland

Translated Name: Choke Cherry - (American Plum) Shrubland
NatureServe Code: CEGL001108

C.4.10.1 Summary

This widespread, small-patch shrubland occurs in the Columbia Plateau of eastern Washington and eastern Oregon, eastern Nevada, southeastern Idaho, Wyoming, Montana, Colorado, and western South Dakota. It occurs in the foothills and lower slopes of mountain ranges along creeks and in draws and ravines of high plateaus and plains. The elevational range is 680 to 2,652 m (2,234–8,700 feet). This association grows at the interface between larger riparian areas and the adjacent upland and occurs as small, dense thickets, narrow bands, or irregular patches. It often occupies draws, ephemeral creeks in steep, narrow-bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs and on high slopes where snow collects. Shrub cover ranges from dense to open stands, 100–30%. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on upper slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant as well. Stands can be dominated by one species but are often a mix of 3–6 other shrub species, which can be as abundant as and even more abundant than the *Prunus*. Other shrubs include *Rhus trilobata*, *Ribes aureum*, *Ribes lacustre*, *Ribes inerme*, *Salix exigua*, *Sambucus* spp., *Amelanchier* spp., *Amorpha canescens*, *Symphoricarpos oreophilus*, *Symphoricarpos occidentalis*, *Juniperus scopulorum*, *Rosa woodsii*, and *Toxicodendron rydbergii*. In drainage bottoms, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%. Herbaceous species include *Bromus inermis*, *Heracleum maximum* (= *Heracleum* lanatum), *Juncus arcticus*, *Maianthemum stellatum* (= *Smilacina stellata*), *Poa pratensis*, *Cirsium arvense*, *Muhlenbergia montana*, *Leymus cinereus*, and *Bromus tectorum*.

C.4.10.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This is a widespread and highly variable, yet distinct, type. Kovalchik (1987) briefly describes a similar type called Mixed Shrub Canyon Bottom Association from four plots. It occurs in low-elevation canyons below U.S. Forest Service ownership in eastern Oregon. Tall shrubs include *Prunus virginiana*, *Amelanchier alnifolia*, *Rosa woodsii*, *Cornus sericea*, *Salix* spp., *Prunus subcordata*, and/or *Alnus incana*. This may be the same concept.

Mesa Verde National Park—*Prunus americana* is known from other locations to codominate the association and the naming convention reflects this; however, this codominance does not occur at Mesa Verde National Park.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Prunus virginiana* Shrubland Alliance (A.919),Choke Cherry Shrubland Alliance	

C.4.10.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.822	Rocky Mountain Lower Montane-Foothill Shrubland

C.4.10.4 NatureServe Conservation Status

Global Rank & Reasons: G4Q (1-Feb-1996). This type is widespread, but it represents a broadly defined dominance type, with little information on the associated species or habitats that might help define the type more precisely. If, for example, a Great Plains type was separated out from the other

types, such a type could be relatively rare.

C.4.10.5 Distribution

***Globally*—**This is a widespread, if small-patch, shrubland that occurs in the Columbia Plateau of eastern Washington, eastern Oregon, eastern Nevada, southeastern Idaho, throughout Wyoming, Montana, Colorado, and western South Dakota.

***Mesa Verde National Park*—**This shrubland association occurs in two relevés. One relevé was located in the canyon bottom of Soda Canyon. The other relevé was located on the midslope of an escarpment on the east rim of Waters Canyon. Both of the relevés occurred on the Mancos Shale Formation.

C.4.10.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This is a widespread, small-patch shrubland that occurs in the Columbia Plateau of eastern Washington, eastern Oregon, eastern Nevada, southeastern Idaho, Wyoming, Montana, Colorado, and western South Dakota. It occurs in the foothills and lower slopes of mountains along creeks and in draws and ravines in plateaus and plains. The elevational range is 716–2,652 m (2,234–8,700 feet). This association grows at the interface between larger riparian areas and the adjacent upland, as well as on high ridges where snow collects, and occurs as small, dense thickets, narrow bands, or irregular patches. It often occupies draws, ephemeral creeks in steep, narrow-bottomed canyons, and shallow ravines. It can occur on slopes below seeps and springs. Stands can also occur as small pockets on higher terraces or as narrow bands along the high-water mark of steep banks and incised channels. It also grows at the base of cliffs adjacent to rivers. Slope varies from flat to very steep, with variable aspects, and can be associated with rock outcrops and talus. Stands are typically on very well-drained, rocky soils but occasionally have finer soils. Soil texture ranges from sandy loam to clay loam.

***Mesa Verde National Park*—**One relevé occurs on a moderate slope (9%) with a northwestern aspect and the other relevé is flat. The relevés occur in loam and loamy sand soils. The elevations are 2,355 and 2,452 m (7,726 and 8,045 feet). One of the relevés has a low cover of sandstone stones and gravel.

C.4.10.7 Vegetation

***Globally*—**Shrub cover ranges from 100% to 30%, with the higher values tending to occur in sites located in drainage bottoms and on lowermost slopes, and the lower values on higher slopes. *Prunus virginiana* is usually the dominant shrub species, but *Prunus americana* may be solely present to codominant. Stands can be dominated by one species but are often a mix of 3–6 other shrub species, which can be as abundant and sometimes more abundant than the *Prunus*. Other shrubs include *Rhus trilobata*, *Ribes aureum*, *Ribes lacustre*, *Ribes inerme*, *Salix exigua*, *Sambucus* spp., *Amelanchier* spp., *Amorpha canescens*, *Artemisia tridentata*, *Symphoricarpos oreophilus*, *Symphoricarpos occidentalis*, *Juniperus scopulorum*, *Rosa woodsii*, *Mahonia repens*, and *Toxicodendron* spp. In drainage bottom situations, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in a matrix of other shrubland or grassland types, and graminoid cover can be greater than 75%. Herbaceous species include *Bromus carinatus*, *Maianthemum stellatum* (= *Smilacina stellata*), *Poa pratensis*, *Poa fendleriana*, *Muhlenbergia montana*, *Leymus cinereus*, *Agastache urticifolia*, *Balsamorhiza sagittata*, and *Eriogonum umbellatum*. Exotic herbaceous species may be present, including *Cirsium arvense*, *Bromus inermis*, and *Bromus tectorum*.

***Mesa Verde National Park*—**Two relevés are classified as *Prunus virginiana* - (*Prunus americana*) Shrubland. The total shrub cover was recorded at 5–10% cover in one relevé and 75–100% cover in the other. The herbaceous cover was recorded at 25–50% in one relevé and 50–75% cover in the other. The tree stratum is absent in both relevés. The species richness for each relevé is 16 and 27 species. The shrub stratum is dominated by *Prunus virginiana*, with 5–10% cover in one relevé and 50–75% cover in the other. *Quercus gambelii* occurs in one relevé, with 5–10% cover. *Rosa woodsii* occurs in both relevés, with less than 5% cover. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the non-native invasive species, *Carduus nutans* ssp. *macrolepis* (10–25%

cover in one relevé), and *Taraxacum officinale* (25–50% cover in one relevé). The native grass *Poa fendleriana* ssp. *longiligula* occurs in one relevé with 5–10% cover. *Elymus trachycaulus* ssp. *trachycaulus* and *Pascopyrum smithii* native grasses, occur in both relevés, with less than 5% cover.

Most Abundant Species: Globally—

Stratum	Species
Short shrub/sapling	*Prunus americana, Prunus virginiana*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Prunus virginiana, Quercus gambelii*
Herb (field)	*Carduus nutans* ssp. *macrolepis, Taraxacum officinale, Poa fendleriana* ssp. *longiligula*

Other Noteworthy Species: Globally—*Bromus inermis*, *Bromus tectorum*, *Pascopyrum smithii*, *Poa pratensis*, *Prunus americana*, *Symphoricarpos occidentalis*

Mesa Verde National Park—Data are not available.

C.4.10.8 Element Sources

Global Description Authors: D. Faber-Langendoen, mod. G. Kittel, J. Coles, K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, CONHP pers. comm., CONHP unpubl. data 2003, Caicco and Wellner 1983, Carsey et al. 2003b, Copeland 1980, Driscoll et al. 1984, Evans 1989a, Evans 1989b, Hall and Hansen 1997, Hansen et al. 1991, Hansen et al. 1995, IDCDC 2005, Johnston 1987, Jones 1992, Jones and Walford 1995, Kagan et al. 2000, Kittel et al. 1996, Kittel et al. 1999b, Kovalchik 1987, Kudray et al. 2004, MTNHP 2002, Manning and Padgett 1995, Marriott pers. comm., NVNHP 2003, Von Loh et al. 1999, Western Ecology Working Group n.d.

C.4.11 *Purshia tridentata / Achnatherum hymenoides - Poa fendleriana* Shrubland [Park Special]

Translated Name: Bitterbrush / Indian Ricegrass - Muttongrass Shrubland [Park Special]
NatureServe Code: Park Special

C.4.11.1 Summary

Stands occur in the southern Colorado Plateau on low to moderately steep slopes at elevations from 1,485–2,131 m (4,869–6,991 feet). Landforms are variable and range from hills, mesas, sideslopes, and bajadas to stands along drainage channels and in sand deposits. Substrates are typically sandy soils, but textures range from sandy loam to clay loam. There may be low cover of gravel. The vegetation is characterized by a lush perennial herbaceous layer dominated by *Achnatherum hymenoides* with an open shrub layer. The total shrub cover ranges from 5 to 20%. The total herbaceous cover ranges from 50 to 75%. The shrub stratum is typically composed of a mixture of shrub species, although one may dominate. Common shrubs include scattered *Atriplex canescens*, *Ephedra torreyana*, *Ericameria nauseosa*, *Eriogonum leptophyllum*, *Gutierrezia sarothrae*, *Parryella filifolia*, *Purshia tridentata*, *Tetradymia canescens*, or *Yucca angustissima*. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the native grass *Achnatherum hymenoides*; other herbaceous species present may include *Pleuraphis jamesii*, *Poa fendleriana*, or *Sporobolus airoides*. The non-native invasive species *Bromus tectorum* and *Carduus nutans* ssp. *macrolepis* both occur with significant cover.

C.4.11.2 Classification

Classification Confidence: Data are not available.
Classification Comments: Globally—This broadly defined, semi-arid steppe association was considered a placeholder association and is now considered provisional. Some shrub-steppes are characterized by shrub species and others by graminoids, so it is sometimes confusing as to which is characteristic of an association. Indian ricegrass is a widespread species, and so it is likely this association occurs more widely. Continued survey and classification work are needed to fully characterize this association.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.4.11.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.822	Rocky Mountain Lower Montane-Foothill Shrubland

C.4.11.4 NatureServe Conservation Status

Data are not available.

C.4.11.5 Distribution

Globally—This shrub-steppe association occurs in the southern Colorado Plateau of southwestern Colorado and northeastern Arizona.

Mesa Verde National Park—This shrubland association occurs on one relevé on Moccasin Mesa. The relevé was identified on the Cliff House Sandstone Formation.

C.4.11.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**Stands occur in the southern Colorado Plateau, on low to moderately steep slopes at elevations from 1,485 to 2,131 m (4,869–6,991 feet). Landforms are variable and range from hills, mesas, sideslopes, and bajadas to stands along drainage channels and in sand deposits. Substrates are typically sandy soils, but textures range from sandy loam to clay loam. There may be low cover of gravel.

***Mesa Verde National Park*—**This relevé occurs with low slope (1%) on sandy soils at an elevation of 2,131 m (6,991 feet). Low cover of sandstone gravel occurs in this relevé. This relevé was impacted by the 2000 fire and was part of a reseeding effort.

C.4.11.7 Vegetation

***Globally*—**The association is characterized by a lush perennial herbaceous layer dominated by *Achnatherum hymenoides* with an open shrub layer. The total shrub cover ranges from 5 to 20%. The total herbaceous cover ranges from 50 to 75%. The shrub stratum is typically composed of a mixture of shrub species, although one may dominate. Common shrubs include scattered *Atriplex canescens*, *Ephedra torreyana*, *Ericameria nauseosa*, *Eriogonum leptophyllum*, *Gutierrezia sarothrae*, *Parryella filifolia*, *Purshia tridentata*, *Tetradymia canescens*, or *Yucca angustissima*. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the native grass *Achnatherum hymenoides*; other herbaceous species present may include *Pleuraphis jamesii*, *Poa fendleriana*, or *Sporobolus airoides*. The non-native invasive species *Bromus tectorum* and *Carduus nutans* ssp. *macrolepis* both occur with significant cover.

***Mesa Verde National Park*—**One relevé is classified as *Purshia tridentata* / *Achnatherum hymenoides - Poa fendleriana* Shrubland [Park Special]. The total shrub cover is 5–10%; the total herbaceous cover is 50–75%. The tree stratum is absent from this relevé due to recent fire. The species richness is 14 species. The shrub stratum is dominated by *Purshia tridentata*, with 5–10% cover. *Ericameria nauseosa* and *Tetradymia canescens* both occur with 1–5% cover. The average height for the shrub stratum is 1–2 m. The herbaceous stratum is dominated by the native grass, *Achnatherum hymenoides* with 25–50% cover. The non-native invasive species, *Bromus tectorum* and *Carduus nutans* ssp. *Macrolepis*, both occur with 1–5% cover.

Most Abundant Species: Globally—

Stratum	Species
Herb (field)	*Achnatherum hymenoides*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Purshia tridentata*
Herb (field)	*Achnatherum hymenoides, Poa fendleriana* ssp. *longiligula*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park—*Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*

C.4.11.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Thomas et al. 2003b, Western Ecology Working Group n.d.

C.4.12 *Quercus gambelii / Amelanchier utahensis* Shrubland

Translated Name: Gambel Oak / Utah Serviceberry Shrubland
NatureServe Code: CEGL001110

C.4.12.1 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 1,525 to 2,700 m (5,000–8,860 feet). Slopes are gentle to steep (1–100%) and may be oriented to any aspect. Soils 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*, *Eurybia glauca*, *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*.

C.4.12.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This plant association is similar to other montane Gambel oak shrublands, except for the codominance of *Amelanchier utahensis* with only minor amounts (<10% or 5% cover, respectively) of *Artemisia tridentata* or *Cercocarpus montanus*.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Quercus gambelii* Shrubland Alliance (A.920), Gambel Oak Shrubland Alliance	

C.4.12.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.12.4 NatureServe Conservation Status

Global Rank & Reasons: G3G5 (23-Feb-1994)

C.4.12.5 Distribution

Globally—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.

Mesa Verde National Park—This shrubland association was the most frequently sampled association at Mesa Verde National Park; it was sampled from 34 relevés. It was identified on midslopes, upper

slopes, and high elevations of eolian deposits and from low elevations and on canyon floors. It occurs on the high elevations and the upper slopes of mesas and escarpments. The association occurs on Cliff House Sandstone, Mancos Shale, Point Lookout Sandstone, and the Menefee formations. Relevés are located throughout the park and include occurrences in East Fork Rock Canyon, Little Soda Canyon, Long Canyon, Morefield Canyon, Navajo Canyon, Prater Canyon, Rock Canyon, Soda Canyon, Waters Canyon, and West Fork Navajo Canyon.

C.4.12.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This mountain shrubland occurs in southern Utah and western Colorado. Elevation ranges from 1,525 to 2,700 m (5,000–8,860 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. Soils are generally deep, well-developed, and are derived from a variety of sources, including sandstones, shales, and metamorphic rocks.

Mesa Verde National Park—This association occurs on sand, sandy loam, and sandy silt soils between the elevations of 2,137 and 2,510 m (7,011–8,235 feet), average 2,351 m (7,713 feet). The slope ranges from 2 to 47% (average 14%) and is highly variable among the relevés. Most of the relevés in this association have a low cover of gravel, cobbles, stones, and boulders. A few of the relevés have a low cover of bedrock. Where the surface rocks are present, they are derived from sandstone. Eight-five percent of the relevés (29 of 34) represented recently burned areas. Four relevés were in the 1934 fire area, one in the 1972 fire, nine in the 1989 fire, two in the 1996 fire, and 13 in the 2000 fire. Only two of the relevés were reseeded after the fire.

C.4.12.7 Vegetation

Globally—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*, *Eurybia 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*.

Mesa Verde National Park—Thirty relevés are classified as *Quercus gambelii* / *Amelanchier utahensis* Shrubland. The total tree cover ranges from being absent to cover class 25–50% (average cover class 1–2%). The shrub cover ranges from cover class 5–10% to 75–100% (average cover class 47–70%), and the herbaceous cover ranges from absent to 50–75% cover (average cover class 10–19%). The species richness is 6–29 species (average of 15 species). The tree stratum is low to absent in most relevés. *Pinus edulis* occurs in two relevés with cover classes of 5–10% and 10–25%, and *Juniperus osteosperma* occurs in two relevés with cover classes 1–5% and 5–10%. The shrub stratum is dominated by *Quercus gambelii*, a vigorous re-sprouter after fire, which ranges between cover classes 5–10% and 75–100% cover (average cover class 36–57%). *Amelanchier utahensis* is also dominant in the canopy and ranges in cover between cover classes 1–5% and 75–100% (average cover class 12–22%). The average height of the *Quercus gambelii* and *Amelanchier utahensis* shrub layer is between 1–5 m. *Fendlera rupicola* occurs in 15 of the 24 relevés with cover ranging up to cover class 5–10% (average cover class 2–4%). *Symphoricarpos oreophilus* occurs in over 80% of the relevés, with cover ranging up to 25–50% (average cover class 3–8%). *Opuntia polyacantha* occurs in five relevés, with cover ranging up to 5–10%. *Prunus virginiana* occurs in two relevés, and *Purshia tridentata* occurs in three relevés, with at least 5% cover in each relevé. The herbaceous stratum is diverse. *Poa fendleriana* ssp. *longiligula*, a native grass, is the most consistent species in the herbaceous stratum and occurs in 70% of the relevés, with

cover up to 5–10% cover. *Artemisia ludoviciana* occurs in 40% of the relevés and ranges up to 5–10% cover, and *Penstemon linarioides* ssp. *coloradoensis* occurs in 47% of the relevés, with cover up to 5–10%. *Bromus tectorum*, a non-native invasive grass, occurs in 38% of the relevés with no cover to 25–50% cover. In approximately 30% of the relevés, *Balsamorhiza sagittata*, *Elymus elymoides*, and *Lupinus ammophilus* range up to 5–10% cover. Several different forbs occur in a few of the relevés, including *Chenopodium fremontii* in eight relevés ranging up to 5–10% cover, *Eriogonum racemosum* in seven relevés ranging up to 5–10% cover, *Koeleria macrantha* in four relevés ranging up to 5–10% cover, *Artemisia dracunculus* in five relevés ranging up to 10–25% cover, *Pascopyrum smithii* in five relevés ranging up to 5–10% cover, *Paxistima myrsinites* in four relevés ranging up to 10–25% cover, *Pseudostellaria jamesiana* in three relevés ranging up to 5–10% cover, and *Wyethia arizonica* in seven relevés ranging up to 25–50% cover. Three species occur in only one relevé with at least 5% cover: *Brickellia grandiflora* (10–25% cover), *Lathyrus pauciflorus* (5–10% cover), and *Lomatium dissectum* (5–10% cover). One species, *Heliomeris multiflora*, occurs in over 50% of the relevés, and all with a low cover of less than 5%.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*
Shrub/sapling (tall & short)	*Amelanchier utahensis, Prunus virginiana, Quercus gambelii, Symphoricarpos oreophilus* Shrub/sapling (tall & short): *Fendlera rupicola, Paxistima myrsinites, Purshia tridentata*
Herb (field)	*Opuntia polyacantha, Artemisia dracunculus, Brickellia grandiflora, Eriogonum racemosum, Artemisia ludoviciana, Balsamorhiza sagittata, Chenopodium fremontii, Elymus elymoides, Lathyrus pauciflorus, Lomatium dissectum, Lupinus ammophilus, Penstemon linarioides* ssp. *coloradoensis, Pseudostellaria jamesiana, Wyethia arizonica, Bromus tectorum, Koeleria macrantha, Pascopyrum smithii, Poa fendleriana* ssp. *longiligula*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.4.12.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Carmichael et al. 1978, Cedar Creek Associates, Inc. 1987, Clary 1992, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Muldavin et al. 1998, Western Ecology Working Group n.d.

C.4.13 *Quercus gambelii - Cercocarpus montanus / (Carex geyeri)* Shrubland

Translated Name: Gambel Oak - Mountain-mahogany / (Geyer's Sedge) Shrubland
NatureServe Code: CEGL001113

C.4.13.1 Summary

This mixed montane shrubland association is reported from foothills, mountains, and mesa tops in western Colorado and Utah. Stands occur on moderate to steep slopes. Aspect varies with elevation, with low-elevation stands restricted to more mesic northern and eastern aspects, and higher-elevation stands occurring on southern and western aspects. Substrates are typically shallow and rocky, derived from sandstone and shale parent materials, and range from sandy to clayey-textured soil. The vegetation is characterized by a moderately dense to dense thicket of tall (2–5 m) deciduous shrubs (on unstable, eroding, or talus slopes, the shrub canopy may be open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula*, *Arctostaphylos pungens*, *Artemisia tridentata*, *Fendlera rupicola*, *Fraxinus anomala*, *Peraphyllum ramosissimum*, *Physocarpus monogynus*, *Purshia tridentata*, *Prunus virginiana*, *Rhus trilobata*, *Rosa woodsii*, *Quercus turbinella*, *Symphoricarpos oreophilus*, and *Yucca* spp. may be present, depending on geography. Occasional *Juniperus osteosperma* and *Pinus edulis* trees may also be present. The herbaceous layer is generally sparse because of the dense overstory, but *Carex geyeri* may provide low to moderate cover.

C.4.13.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This plant association is similar to other montane Gambel oak shrublands, except for the codominance of *Cercocarpus montanus* (10% cover or more). Other shrubs species may be present to codominant.

Mesa Verde National Park—This relevé was originally classified as a continuum within *Quercus gambelii* / *Amelanchier utahensis* Shrubland (CEGL001110) due to its codominance of *Amelanchier utahensis* in the shrub canopy. However, due to its high cover of *Cercocarpus montanus*, this relevé was considered unique and placed within a currently described NatureServe vegetation association. This association has been described in other locations with a similar species composition and structure.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Quercus gambelii* Shrubland Alliance (A.920), Gambel Oak Shrubland Alliance	

C.4.13.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.13.4 NatureServe Conservation Status

Global Rank & Reasons: G3 (23-Feb-1994)

C.4.13.5 Distribution

Globally—This montane shrubland association occurs in the foothills, mountains, and mesa tops of Utah and western Colorado.

Mesa Verde National Park—This shrubland association occurs on one relevé on the upper slope of

an escarpment of Long Spur on the north rim within Mesa Verde National Park. The association was identified from the Point Lookout Sandstone Formation.

C.4.13.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This mixed montane shrubland association is reported from foothills, mountains, and mesa tops in western Colorado and Utah. Elevation ranges from 1,700 to 2,500 m (5,600–8,200 feet). Stands occur on moderate to steep slopes. Aspect varies with elevation, with low-elevation stands restricted to more mesic northern and eastern aspects, and higher-elevation stands occurring on southern and western aspects. Substrates are typically shallow and rocky, derived from sandstone and shale parent materials, and range from sandy to clayey-textured soil.

Mesa Verde National Park—This association occurs on sandy soil at an elevation of 2,349 m (7,707 feet). The slope of this relevé is 31%, with a western aspect. Sandstone boulders and bedrock occur in this relevé, with 5–10% cover each.

C.4.13.7 Vegetation

Globally—This association is characterized by a moderately dense to dense thicket of tall, deciduous shrubs 2–5 m tall (on unstable, eroding, or talus slopes, the shrub canopy may be open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula*, *Arctostaphylos pungens*, *Artemisia tridentata*, *Fendlera rupicola*, *Fraxinus anomala*, *Peraphyllum ramosissimum*, *Physocarpus monogynus*, *Purshia tridentata*, *Rhus trilobata*, *Rosa woodsii*, *Quercus turbinella*, *Symphoricarpos oreophilus*, and *Yucca* spp. may be present, depending on geography. Occasional *Juniperus osteosperma* and *Pinus edulis* trees may also be present. The herbaceous layer is generally sparse because of dense overstory. It is typically composed of scattered graminoids, such as *Carex geyeri*, *Poa fendleriana*, and *Achnatherum hymenoides*, and forbs like *Vicia Americana*, *Lupinus* spp., and *Lathyrus* spp.

Mesa Verde National Park—One relevé is classified as *Quercus gambelii - Cercocarpus montanus* / (*Carex geyeri*) Shrubland. The total tree cover is sparse (1–5%), shrub cover is 75–100%, and the herbaceous cover is sparse (1–5%). The species richness is 13 species. The tree cover is low and consists of *Juniperus osteosperma* with less than 5% cover and an average canopy height of 5–10 m. The shrub stratum is dominated by *Cercocarpus montanus*, which has 50–75% cover, followed by *Amelanchier utahensis* and *Quercus gambelii*, which each cover 25–50% of the relevé. The average height of the shrub stratum is 1–2 m. The herbaceous stratum covers only 1–5%, with the most abundant species being *Poa fendleriana* ssp. *longiligula*.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii, Cercocarpus montanus*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Amelanchier utahensis, Quercus gambelii, Cercocarpus montanus*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.4.13.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Baker 1982, Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Clary 1992, Cogan et al. 2004, Dillinger 1970, Driscoll et al. 1984, Ellis and Hackney 1981, Erd-

man 1962, Ferchau 1973, Hanson and Ball 1928, Keammerer and Peterson 1981, Muldavin et al. 1998, Pase and Lindenmuth 1971, Schmoll 1935, Vories 1974, Western Ecology Working Group n.d.

C.4.14 *Quercus gambelii / Symphoricarpos oreophilus* Shrubland

Translated Name: Gambel Oak / Mountain Snowberry Shrubland
NatureServe Code: CEGL001117

C.4.14.1 Summary

This plant association is found in foothills, plateaus, and mountains from western Texas to southern and western Colorado and throughout Utah, and likely occurs in northern Arizona. It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities, such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained, sandy loam to clay loam derived from alluvium or colluvium. The vegetation is characterized by an open to closed, typically tall-shrub layer (2–5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species, such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present, including *Amelanchier* spp., *Prunus virginiana*, *Robinia neomexicana*, and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands, the oak is mostly less than 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum*, *Bromus*, *Elymus*, *Poa*, and *Koeleria*. Common forbs include *Vicia americana*, *Thalictrum fendleri*, and *Achillea millefolium*. Occasionally, tree species are present in the overstory.

C.4.14.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This plant association is similar to other montane Gambel oak shrublands, except for the codominance of *Symphoricarpos oreophilus* with only minor amounts (<10% cover) of *Amelanchier utahensis*, *Artemisia tridentata*, or *Cercocarpus montanus*.

Mesa Verde National Park—This association is unique from the other three *Quercus gambelii* shrublands (*Quercus gambelii - Cercocarpus montanus* / (*Carex geyeri*) Shrubland (CEGL001113), *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland (CEGL001117), and *Quercus gambelii* Shrubland (CEGL002477)) due to a low cover of *Cercocarpus montanus*, low cover of *Amelanchier utahensis*, and a presence of *Symphoricarpos oreophilus* in all of the relevés.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Quercus gambelii* Shrubland Alliance (A.920), Gambel Oak Shrubland Alliance	

C.4.14.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.14.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (23-Feb-1994)

C.4.14.5 Distribution

Globally—This shrubland association is reported from foothills, plateaus, and mountains of western

Texas to southern and western Colorado and Utah, and likely occurs in Arizona.

***Mesa Verde National Park*—**This shrubland association occurs on seven relevés on canyon upper slopes, midslopes, and canyon floors within Mesa Verde National Park. The association occurs on the Mancos Shale, Menefee, and Point Lookout Sandstone formations. Relevés of this association were identified from Long Canyon, Morefield Canyon, Prater Canyon, and Waters Canyon.

C.4.14.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This plant association is found in foothills, plateaus, and mountains from western Texas to southern and western Colorado and throughout Utah, and likely occurs in northern Arizona. Elevation ranges from 1,750 to 2,745 m (6,000–8,600 feet). It is a mesic upland and non-obligate riparian community. Some stands appear to be transitional between riparian areas and drier upland communities, such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained, sandy loam to clay loam derived from alluvium or colluvium.

***Mesa Verde National Park*—**This association occurs on sand, sandy loam, and sandy clay soils between the elevations of 2,152 and 2,484 m (7,060–8,150 feet) (average 2,289 m [7510 feet]) where canyon bottoms provide sufficient moisture to support *Symphoricarpos oreophilus*. The slope ranges from 0 to 17% (average 9%) at a southeastern to southwestern aspect. Most of the relevés have a low to moderate cover of sandstone gravel, cobbles, stones, and boulders. All of the relevés have evidence of fire within the last 35 years. Five of the relevés burned in the 2000 fire and two in the 1972 fire. One relevé that occurs in the bottom of Long Canyon shows signs of intermittent flooding.

C.4.14.7 Vegetation

***Globally*—**The vegetation is characterized by an open to closed, tall-shrub layer (2–5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species, such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present, including *Amelanchier* spp., *Artemisia tridentata*, *Prunus virginiana*, *Purshia tridentata*, *Robinia neomexicana*, *Ericameria nauseosa*, and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands, the oak is mostly less than 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids, such as species of *Achnatherum*, *Bromus*, *Elymus*, *Poa*, and *Koeleria macrantha*. Common forbs include *Vicia americana*, *Balsamorhiza sagittata*, *Thalictrum fendleri*, *Clematis ligusticifolia*, and *Achillea millefolium*. Occasionally, tree species are present in the overstory, including *Pinus ponderosa*, *Juniperus scopulorum*, and *Pseudotsuga menziesii*. Introduced graminoids, such as *Bromus inermis* and *Poa pratensis* are often common in stands that have been disturbed by heavy livestock grazing.

***Mesa Verde National Park*—**Five relevés are classified as *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland. The tree stratum is only present in one relevé, with a cover of 1–5%. The total shrub cover ranges from cover class 25–50% to 75–100% (average cover class 51–75%), and the herbaceous stratum ranges from cover class 1–5% to 25–50% (average cover class 10–20%). The species richness is 5–24 species (average of 15 species). The tree stratum is absent from all but one relevé, with 1–5% cover of *Pinus edulis*. The shrub stratum is dominated by *Quercus gambelii*, which ranges between cover classes 5–10% and 75–100% (average cover class 51–73%), and *Symphoricarpos oreophilus*, which ranges between only a trace to cover class 10–25% (average cover class 3–8%). The shrub layer height mostly ranges from 1 to 5 m. The herbaceous stratum has a variable species composition. One relevé contains 25–50% cover of *Maianthemum racemosum* ssp. *racemosum*, and a second contains 10–25% cover of *Machaeranthera bigelovii*. *Lepidium montanum*, *Heliomeris multiflora*, and *Symphyotrichum falcatum* var. *falcatum* each cover 5–10% but occur in only one relevé. All of the herba-

ceous species that are common to at least half of the relevés have minimal cover (<5%), they include *Artemisia ludoviciana*, *Lactuca serriola*, *Lupinus ammophilus*, *Penstemon barbatus*, *Penstemon linarioides* ssp. *coloradoensis*, *Poa fendleriana* ssp. *longiligula*, and *Yucca baccata*.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Quercus gambelii, Symphoricarpos oreophilus*

Mesa Verde National Park—

Stratum	Species
Shrub/sapling (tall & short)	*Quercus gambelii, Symphoricarpos oreophilus*
Herb (field)	*Heliomeris multiflora, Lepidium montanum, Machaeranthera bigelovii, Maianthemum racemosum* ssp. *racemosum, Symphyotrichum falcatum* var. *falcatum*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—*Lactuca serriola*

C.4.14.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Baker 1982, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Clary 1992, Cogan et al. 2004, Crane 1982, Driscoll et al. 1984, Erdman 1962, Hess and Wasser 1982, Hoffman and Alexander 1980, Hoffman and Alexander 1983, Johnston 1987, Kittel et al. 1994, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova et al. 1988a, Muldavin 1994, Muldavin and Mehlhop 1992, Muldavin et al. 1994, Muldavin et al. 1998, Muldavin et al. 2000a, Soil Conservation Service 1978, Western Ecology Working Group n.d., Wright et al. 1979.

C.4.15 *Quercus gambelii* Shrubland

Translated Name: Gambel Oak Shrubland
NatureServe Code: CEGL002477

C.4.15.1 Summary

This tall shrubland occurs in northeastern Arizona and southwestern Colorado, in the Colorado Plateau. Stands occur on southeastern to western aspects at 1,884–2,379 m (6,181–7,805 feet) elevation on gentle to moderately steep slopes (0–30%). Sites include canyons, mesas, and a toeslope at the base of a cliff. The sandy soils have low cover of rock and moderate cover of litter 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 are 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%).

C.4.15.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—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.

Mesa Verde National Park—This association is unique from the other three *Quercus gambelii* shrublands (*Quercus gambelii* / *Amelanchier utahensis* Shrubland (CEGL001110), *Quercus gambelii* - *Cercocarpus montanus* / (*Carex geyeri*) Shrubland (CEGL001113), and *Quercus gambelii* / *Symphoricarpos oreophilus* Shrubland (CEGL001117)) with less than 1% cover of *Amelanchier utahensis*, *Cercocarpus montanus*, or *Symphoricarpos oreophilus* in the shrub stratum.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.a.	Temperate cold-deciduous shrubland
Alliance Name	*Quercus gambelii* Shrubland Alliance (A.920), Gambel Oak Shrubland Alliance	

C.4.15.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.4.15.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (29-Mar-2005)

C.4.15.5 Distribution

Globally—This association has been reported from Mesa Verde National Park in southwestern Colorado and Canyon de Chelly National Monument in northeastern Arizona, on the Colorado Plateau. It likely occurs elsewhere in the region, especially in areas relatively recently disturbed.

Mesa Verde National Park—This shrubland association was identified from five relevés on ridges,

mesas, and canyon lower slopes and bottoms within Mesa Verde National Park. The association occurs on the Menefee Shale, Cliff House Sandstone, and Point Lookout Sandstone formations. Relevés of this association are found at Morefield Canyon, Rock Canyon, Soda Canyon, and the west fork of Long Canyon.

C.4.15.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This tall shrubland occurs in northeastern Arizona and southwestern Colorado, in the Colorado Plateau. Stands occur on southeastern to western aspects at 1,884–2,379 m (6,181–7,805 feet) elevation on gentle to moderately steep slopes (0–30%). Sites include canyons, mesas, and a toeslope at the base of a cliff. The sandy soils have low cover of rock and moderate cover of litter on the ground surface. There is frequently evidence of past fires.

Mesa Verde National Park—This association occurs on sandy soils between the elevations of 2,030 and 2,379 m (6,660–7,805 feet), average 2,223 m (7,293 feet). The slope ranges from 0 and 30% (average 11%) at a southeastern to western aspect. A low cover of sandstone surface rocks was identified from this association. Three of the five relevés have been impacted by the 1934, 1972, and 2000 fires.

C.4.15.7 Vegetation

Globally—This tall shrubland 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 are 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%). Other herbaceous species include *Achillea millefolium* var. *occidentalis*, *Achnatherum hymenoides*, *Artemisia ludoviciana*, *Balsamorhiza sagittata*, *Eriogonum racemosum*, *Elymus trachycaulus* ssp. *trachycaulus*, and *Poa fendleriana* ssp. *longiligula*.

Mesa Verde National Park—Four relevés are classified as *Quercus gambelii* Shrubland. The total tree cover ranges from being absent to 5–10% (average cover class 2–4%), the total shrub cover ranges between cover class 25–50% and 75–100% (average cover class 32–55%), and the herbaceous cover ranges between cover class 1–5% and 50–75% (average cover class 18–33%). The species richness is 8–21 species (average of 14 species). The tree stratum is present in only two relevés, with 5–10% cover of *Pinus edulis* in each relevé, and a canopy height of 2–10 m. The shrub stratum is dominated by *Quercus gambelii*, which ranges between cover class 10–25% and 75–100% (average cover class 34–55%), with an average height of 1–2 m. *Purshia tridentata* is found in two of the relevés, where it covers 10–25%. Also present in the shrub stratum is *Ericameria nauseosa*, which covers 5–10% in one relevé and <1% in a second. The herbaceous stratum is variable, with *Artemisia ludoviciana*, *Bromus tectorum*, and *Elymus elymoides* each covering 25–50% in one relevé.

Most Abundant Species: Globally—

Stratum	**Species**
Shrub/sapling (tall & short)	*Quercus gambelii*

Mesa Verde National Park—

Stratum	**Species**
Tree canopy	*Pinus edulis*
Shrub/sapling (tall & short)	*Ericameria nauseosa, Quercus gambelii*
Short shrub/sapling	*Mahonia repens*
Herb (field)	*Achillea millefolium* var. *occidentalis, Artemisia ludoviciana, Balsamorhiza sagittata, Achnatherum hymenoides, Bromus tectorum, Elymus elymoides, Elymus trachycaulus* ssp. *trachycaulus, Poa fendleriana* ssp. *longiligula*

Other Noteworthy Species: Globally—*Bromus tectorum*, *Erodium cicutarium*
Mesa Verde National Park—*Carduus nutans* ssp. *macrolepis*

C.4.15.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Western Ecology Working Group n.d.

C.4.16 *Salix exigua* / Mesic Forbs Shrubland

Translated Name: Coyote Willow / Mesic Forbs Shrubland
NatureServe Code: CEGL001202

C.4.16.1 Summary

This association typically occurs between 1,464 and 2,562 m (4,800–8,400 feet) elevation in Utah, western Colorado, central Nevada, and eastern Idaho, where it occupies streambanks, terraces, and meadows along a wide variety of low- to moderate-gradient stream types. In contrast, a low-elevation phase of this plant association is found below 1,128 m (3,700 feet) in south-central and southwestern Idaho, on annually flooded banks, islands, and terraces of reservoirs and large rivers (e.g., the Snake River and Boise River). This type usually occurs on well-developed sandy to silty alluvial loam soils, on the wettest (often flooded) but stable sites supporting *Salix exigua* associations. Both phases are dominated by a tall-shrub overstory of open to dense *Salix exigua*, although *Salix lutea*, *Ribes* spp., and *Rosa woodsii* are sometimes also present in lesser amounts. In the typical phase, the herbaceous understory is clearly dominated by a lush understory of mixed tall forbs, each with moderate cover, with *Aconitum columbianum*, *Equisetum arvense*, *Heracleum maximum*, *Maianthemum stellatum*, *Mertensia ciliata*, *Rudbeckia* spp., *Solidago canadensis*, and *Urtica dioica* being most common. No single forb has consistently high constancy and cover across the association's range. In the low-elevation phase, flood-disturbed stands in riverine habitats contain abundant native colonizing forbs (e.g., *Apocynum cannabinum*, *Euthamia occidentalis*, *Glycyrrhiza lepidota*, and *Polygonum* spp.), often mixed with dense exotic forbs (e.g., *Dipsacus fullonum*, *Lythrum salicaria*, *Melilotus officinalis*, and *Xanthium strumarium*). Total mesic graminoid cover is low in both phases of this association (with each species having only low cover) and composed of native species (e.g., *Carex* spp., *Elymus glaucus*) and/or exotics (e.g., *Phalaris arundinacea*, *Poa pratensis*).

C.4.16.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—This association is quantitatively described from 22 plots: 4 plots in Utah and southeastern Idaho (Padgett et al. 1989), and 4 plots in central Nevada (Manning and Padgett 1995). The low-elevation phase is described from at least 14 plots of *Salix exigua* / Mixed Riparian Forb plant association sampled along the middle Snake River by Cole (1996), as well as *Salix exigua* communities with understories dominated by colonizing forbs, such as *Apocynum cannabinum* and *Melilotus officinalis* (Cole 1995, Holmstead 2001). *Euthamia occidentalis* has high constancy and sometimes high cover in many of these low-elevation stands. The higher-elevation phase is usually a stable, mid- to late-seral association (unless disturbed by excessive grazing), while the low-elevation phase is an early-seral association. The compositional heterogeneity inherent in early-seral, flood-disturbed *Salix exigua* stands has led some researchers to lump stands into a *Salix exigua* dominance type (e.g., Hansen et al. (1995) in Montana; Crowe and Clausnitzer (1997) in eastern Oregon; Crawford (2001) in eastern Washington; Hansen and Hall (2002) in southeastern Idaho). Examination of composition data for the *Salix exigua* dominance type reveals that most stands have greater graminoid cover than forb cover and have no mesic forb species with moderate to high cover and constancy. Some of these stands would better fit with the *Salix exigua* / *Equisetum arvense* association described by Youngblood et al. (1985a) but do not (except for rare cases) include stands of *Salix exigua* / mesic forbs. The *Salix exigua* / Mesic Forbs Shrubland association is probably successionally related to the *Salix exigua* / Bench Community type described by Manning and Padgett (1995) from eight locations in Nevada. *Salix exigua* ssp. *melanopsis* is now synonymous with *Salix melanopsis*. Although recent classifications (i.e., Crowe et al. 2002) have separated *Salix exigua* and *Salix melanopsis* associations, most *Salix melanopsis* stands are considered synonymous with *Salix exigua* associations by other researchers.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.2.	Cold-deciduous shrubland
Physiognomic Subgroup	III.B.2.N.	Natural/Semi-natural cold-deciduous shrubland
Formation Name	III.B.2.N.d.	Temporarily flooded cold-deciduous shrubland
Alliance Name	*Salix* (*exigua, interior*) Temporarily Flooded Shrubland Alliance (A.947), (Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance	

C.4.16.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES306.821	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

C.4.16.4 NatureServe Conservation Status

Global Rank & Reasons: G2 (22-Oct-2002). This association is moderately wide-ranging but infrequently sampled throughout the core of its range at mid elevations in central Nevada, western Colorado, Utah, and north through eastern Idaho. In this range, the association occurs along a wide variety of streams and river types on various fluvial landforms. However, it is mid- to late-seral and mostly limited to wet but stable sites with well-developed, loamy soil. A dense understory layer of heterogeneous tall mesic forbs and low cover of mesic graminoid species characterizes the typical phase of this association. Stands are threatened by livestock overgrazing leading to invasion by exotic graminoid species. A low-elevation, disturbance-induced phase of this association occurs on about 15 stands on the lower Snake River and its larger tributaries of southwestern Idaho. This phase is often in poor to fair ecological condition and may be better classified as *Salix exigua* / *Euthamia occidentalis* or another type. There are only about 15–20 known occurrences of the higher-elevation, less-disturbed phase of the association, despite the abundance of other *Salix exigua* associations in this region. Only the higher-elevation typical stands were considered in changing the rank from G2? to G2.

C.4.16.5 Distribution

Globally—This association has been documented to occur at mid elevations in central Nevada, Utah, western Colorado, and north through eastern Idaho. It is expected to occur in similar habitats in Wyoming.

Mesa Verde National Park—This shrubland association occurs in one relevé in a canyon bottom of the Mancos River corridor within Mesa Verde National Park. The association was identified in the Mancos Shale Formation.

C.4.16.6 Environmental Setting

USFWS Wetland System: Palustrine

Environmental Summary: Globally—This association typically occurs between 1,464 and 2,562 m (4,800–8,400 feet) elevation in Utah, western Colorado, central Nevada, and eastern Idaho, where it occupies streambanks, terraces, and meadows along a wide variety of low- to moderate-gradient stream types. In contrast, a low-elevation phase of this plant association is found below 1,128 m (3,700 feet) in south-central and southwestern Idaho, on annually flooded banks, islands, and terraces of reservoirs and large rivers (e.g., the Snake River and Boise River). This type usually occurs on well-developed sandy to silty alluvial loam soils, on the wettest (often flooded) but stable sites supporting *Salix exigua* associations.

Mesa Verde National Park—This association occurs on silty clay soil at an elevation of 1,919 m (6,296 feet). The relevé is flat and floods seasonally. A low cover of gravel, cobbles, and boulders also occurs in the relevé.

C.4.16.7 Vegetation

Globally—Both phases are dominated by a tall-shrub overstory of open to dense *Salix exigua*, although *Salix lutea*, *Ribes* spp., and *Rosa woodsii* are sometimes also present in lesser amounts. Sapling *Populus angustifolia* or *Tamarix ramosissima* may also be present. In the typical phase, the herbaceous understory is clearly dominated by a lush understory of mixed tall forbs, each with moderate cover, with *Aconitum columbianum*, *Asclepias speciosa*, *Equisetum arvense*, *Heracleum maximum*, *Maianthemum stellatum*, *Mertensia ciliata*, *Rudbeckia* spp., *Solidago canadensis*, and *Urtica dioica* being most common. No single forb has consistently high constancy and cover across the association's range. In the low-elevation phase, flood-disturbed stands in riverine habitats contain abundant native colonizing forbs (e.g., *Apocynum cannabinum*, *Euthamia occidentalis*, *Glycyrrhiza lepidota*, *Veronica anagallis-aquatica*, and *Polygonum* spp.) often mixed with dense exotic forbs (e.g., *Ambrosia trifida*, *Dipsacus fullonum*, *Lythrum salicaria*, *Melilotus officinalis*, *Tripleurospermum perforata* (= *Matricaria perforata*), and *Xanthium strumarium*). Total mesic graminoid cover is low in both phases of this association (with each species having only low cover) and composed of native species (e.g., *Carex* spp., *Elymus glaucus*) and/or exotics (e.g., *Phalaris arundinacea*, *Poa pratensis*).

Mesa Verde National Park—One relevé is classified as *Salix exigua* / Mesic Forbs Shrubland. The total shrub cover is 75–100%, and the herbaceous cover is 5–10% cover. There was no tree stratum recorded from this relevé. The species richness is high, with 21 species. The shrub stratum is dominated by *Salix exigua*, which has 75–100% cover, and *Rosa woodsii* with 5–10% cover. The average shrub height ranges from 2–5 m. The herbaceous stratum is minimal, with the exception of a few species, such as *Glycyrrhiza lepidota*, *Juncus balticus* var. *montanus*, *Pascopyrum smithii*, and *Rosa woodsii*.

Most Abundant Species: Globally—

Stratum	Species
Tall shrub/sapling	*Salix exigua*
Herb (field)	*Aconitum columbianum, Asclepias speciosa, Heracleum maximum, Maianthemum stellatum, Mertensia ciliata, Solidago canadensis, Urtica dioica, Equisetum arvense*

Mesa Verde National Park—

Stratum	Species
Tall shrub/sapling	*Rosa woodsii, Salix exigua*
Herb (field)	*Glycyrrhiza lepidota, Juncus balticus var. montanus, Pascopyrum smithii*

Other Noteworthy Species: Globally—*Alopecurus aequalis*, *Ambrosia trifida*, *Cirsium arvense*, *Linaria vulgaris*, *Lythrum salicaria*, *Melilotus officinalis*, *Phalaris arundinacea*, *Plantago major*, *Poa pratensis*, *Spiranthes diluvialis*, *Trifolium repens*, *Tripleurospermum perforata*, *Xanthium strumarium*
Mesa Verde National Park—Data are not available.

C.4.16.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, Cole 1995, Cole 1996, Crawford 2001, Crowe and Clausnitzer 1997, Crowe et al. 2002, Driscoll et al. 1984, Hansen and Hall 2002, Hansen et al. 1995, Holmstead 2001, IDCDC 2005, IDCDC unpubl. data 2002, Jankovsky-Jones et al. 2001, Jones 1992, Manning and Padgett 1995, NVNHP 2003, Padgett et al. 1988, Padgett et al. 1989, Western Ecology Working Group n.d.

C.4.17 *Sarcobatus vermiculatus / Artemisia tridentata* Shrubland

Translated Name: Black Greasewood / Basin Big Sagebrush Shrubland
NatureServe Code: CEGL001359

C.4.17.1 Summary

This mixed bottomland shrubland is characteristic of stream terraces and floodplains of the Intermountain West. The presence of other shrubs in the canopy indicates less saline conditions than found in *Sarcobatus vermiculatus* Disturbed Shrubland (CEGL001357). Soils are deep and generally sandy, but a few sites are on well-drained silt loams. The sagebrush element may be either *Artemisia tridentata* ssp. *tridentata* or *Artemisia tridentata* ssp. *wyomingensis*, and either the sagebrush or *the Sarcobatus vermiculatus* may have the greater cover. *Atriplex canescens*, *Ericameria nauseosa*, and *Chrysothamnus viscidiflorus* are other common minor elements of the shrub canopy. Total shrub cover is between 5 and 30%. The understory is variable; cover by herbaceous species may be sparse to dense, or exotic species may dominate the field layer.

C.4.17.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Although only one relevé was identified as this association in the sampling effort at Mesa Verde National Park, this association was previously described in other locations outside Mesa Verde National Park, and is recognized as a unique vegetation association. This association is very limited at Mesa Verde National Park.

Vegetation Hierarchy		
Physiognomic Class	III	Shrubland
Physiognomic Subclass	III.B.	Deciduous shrubland
Physiognomic Group	III.B.3.	Extremely xeromorphic deciduous shrubland
Physiognomic Subgroup	III.B.3.N.	Natural/Semi-natural extremely xeromorphic deciduous shrubland
Formation Name	III.B.3.N.b.	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland
Alliance Name	*Sarcobatus vermiculatus* Intermittently Flooded Shrubland Alliance (A.1046), Black Greasewood Intermittently Flooded Shrubland Alliance	

C.4.17.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.780	Inter-Mountain Basins Greasewood Flat

C.4.17.4 NatureServe Conservation Status

Global Rank & Reasons: G4 (1-Feb-1996)

C.4.17.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This shrubland association occurred in one relevé, in a canyon bottom at the confluence of Spruce Canyon and Navajo Canyon within Mesa Verde National Park. The association was identified from the Mancos Shale Formation and has a very limited distribution in Mesa Verde National Park.

C.4.17.6 Environmental Setting

USFWS Wetland System: Palustrine

Environmental Summary: Globally—This minor shrub association occurs on stream terraces, alluvial fans, floodplains, toeslopes, and valley floors. Elevations ranges from 1,300 to 1,950 m. Slopes are generally gentle, and the upper soil layers are somewhat saline. Soils are deep and generally sandy, but a few sites are on well-drained silt loams. Bare soil and litter cover most of the ground surface. Biological soil crusts are commonly present and can provide up to 60% cover.

Mesa Verde National Park—This association occurs on sandy soil at an elevation of 1,900 m (6,234 feet). The relevé is flat and has no indication of fire.

C.4.17.7 Vegetation

Globally—This mixed bottomland shrubland is characteristic of stream terraces and floodplains of the Intermountain West. The sagebrush element may be either *Artemisia tridentata* ssp. *tridentata* or *Artemisia tridentata* ssp. *wyomingensis*, and either the sagebrush or the *Sarcobatus vermiculatus* may have the greater cover. *Atriplex canescens*, *Ericameria nauseosa*, and *Chrysothamnus viscidiflorus* are other common minor elements of the shrub canopy. Total shrub cover is between 5 and 50%. The understory is variable; cover by herbaceous species may be sparse to dense, or exotic species may dominate the field layer. Common graminoids include the exotic annual grass, *Bromus tectorum*. Common forbs include *Chaenactis stevioides*, *Cryptantha crassisepala*, *Descurainia pinnata*, and *Salsola tragus*. Scattered *Juniperus osteosperma* may be present in some stands.

Mesa Verde National Park—One relevé is classified as *Sarcobatus vermiculatus - Artemisia tridentata* Shrubland. The total shrub cover is 25–50%, and the herbaceous cover is 75–100%. There is no tree stratum in this relevé. The species richness is 7 species. The shrub stratum is dominated by *Sarcobatus vermiculatus*, which has 25–50% cover, and *Artemisia tridentata*, with 5–10% cover. This relevé has two distinct shrub layers, a tall-shrub layer of 2–5 m and a short-shrub layer of 1–2 m. The herbaceous stratum is dominated by the invasive grass, *Bromus tectorum*, which covers 75–100% of the relevé.

Most Abundant Species: Globally—

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus, Artemisia tridentata* ssp. *tridentata, Artemisia tridentata* ssp. *wyomingensis*

Mesa Verde National Park—

Stratum	Species
Shrub/sapling (tall & short)	*Sarcobatus vermiculatus, Artemisia tridentata*
Herb (field)	*Bromus tectorum*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.4.17.8 Element Sources

Global Description Authors: J. Coles, mod. K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Lesica and DeVelice 1992, MTNHP 2002, Western Ecology Working Group n.d.

C.5 Herbaceous

C.5.1 *Bouteloua gracilis* Herbaceous Vegetation

Translated Name: Blue Grama Herbaceous Vegetation
NatureServe Code: CEGL001760

C.5.1.1 Summary

This minor plant association is reported from Arizona, Colorado, New Mexico, Utah, and Wyoming. Sites are flat to gently sloping and include plains, plateaus, and montane meadows. Substrates are variable and range from coarse-textured soils derived from sand, gravel, granite, or cinder to silty-clay loam prairie soils. The vegetation is characterized by a moderate to dense (25–80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass, *Bouteloua gracilis*. Associated grasses are *Bouteloua curtipendula*, *Elymus elymoides*, *Muhlenbergia* spp., *Pascopyrum smithii*, *Pleuraphis jamesii* (= *Hilaria jamesii*), *Sporobolus cryptandrus*, and the introduced annual grass, *Bromus tectorum*. Forb cover is sparse. Scattered *Ericameria nauseosa* shrubs and an occasional *Pinus edulis*, *Juniperus* spp., or *Pinus ponderosa* tree (in montane stands) may be present.

C.5.1.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—This is a low-confidence association. There are many other associations in the *Bouteloua gracilis* Herbaceous Alliance (A.1282). This association often represents degraded montane grasslands and *Bouteloua gracilis*-dominated grasslands that lack other diagnostic species. *Bouteloua gracilis* is often able to persist after other species are eliminated because it is an extremely drought- and grazing-tolerant species.

Mesa Verde National Park—The identity of this association at Mesa Verde NP is based on observational data provided by a park naturalist. It is identified on one polygon.

Vegetation Hierarchy		
Physiognomic Class	V	Herbaceous Vegetation
Physiognomic Subclass	V.A.	Perennial graminoid vegetation
Physiognomic Group	V.A.5.	Temperate or subpolar grassland
Physiognomic Subgroup	V.A.5.N.	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.e.	Short sod temperate or subpolar grassland
Alliance Name	*Bouteloua gracilis* Herbaceous Alliance (A.1282), Blue Grama Herbaceous Alliance	

C.5.1.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.787	Inter-Mountain Basins Semi-Desert Grassland

C.5.1.4 NatureServe Conservation Status

Global Rank & Reasons: G4Q (23-Feb-1994)

C.5.1.5 Distribution

Globally—This minor plant association occurs in Arizona, Colorado, New Mexico, Utah, and Wyoming.

Mesa Verde National Park—This grassland association was identified during the photointerpretation part of the project. The association is restricted to areas near the Mancos River corridor.

C.5.1.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This minor plant association is reported from Arizona, Colorado, New Mexico, Utah, and Wyoming. Elevation ranges from 1,660 to 2,705 m (5,420–8,875 feet). Sites are flat to moderately sloping and include plains, plateaus, and montane meadows and parks. Substrates are variable and range from coarse-textured soils derived from sand, gravel, granite, or cinder to silty-clay loam prairie soils. Montane *Bouteloua gracilis*-dominated grasslands included in this association are typically the result of heavy grazing by wildlife and/or livestock that select out less grazing-tolerant mid grasses.

Mesa Verde National Park—The association occurs in the Mancos River corridor in upslope areas away from the main watercourse.

C.5.1.7 Vegetation

Globally—This association is characterized by a moderate to dense (10–80% cover) herbaceous layer that is strongly dominated by the warm-season, perennial shortgrass, *Bouteloua gracilis*. Associated grasses are *Achnatherum hymenoides*, *Bouteloua curtipendula*, *Elymus elymoides*, *Koeleria macrantha*, *Muhlenbergia montana*, *Muhlenbergia richardsonis*, *Muhlenbergia torreyi*, *Pascopyrum smithii*, *Pleuraphis jamesii* (= *Hilaria jamesii*), *Sporobolus cryptandrus*, and the introduced annual grass, *Bromus tectorum*. Forb cover is sparse. Associated forbs include *Artemisia carruthii*, *Artemisia dracunculus*, *Eriogonum* spp., and *Sphaeralcea coccinea*. Scattered *Ericameria nauseosa* shrubs and an occasional *Juniperus* spp., *Pinus edulis*, or *Pinus ponderosa* tree (in montane stands) may be present.

Mesa Verde National Park—*Bouteloua gracilis* is the dominant herbaceous species. Other herbaceous species can occur, including *Hesperostipa comata*.

Most Abundant Species: Globally—

Stratum	Species
Herb (field)	*Bouteloua gracilis*

Mesa Verde National Park—No relevé or ground observation data collected.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—No relevé or ground observation data collected.

C.5.1.8 Element Sources

Global Description Authors: K. A. Schulz, mod. J. Coles
Local Description Authors: Data are not available.
References: Bourgeron and Engelking 1994, Bradley et al. 1992, CONHP unpubl. data 2003, Driscoll et al. 1984, Dwyer and Pieper 1967, Fisser 1970, Fisser et al. 1965, Hansen et al. 2004a, Hansen et al. 2004b, Muldavin et al. 2000a, Pieper 1968, Western Ecology Working Group n.d., Williams 1961, Zimmerman 1967.

C.5.2 *Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation

Translated Name: Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation
NatureServe Code: CEGL005264

C.5.2.1 Summary

This smooth brome grassland type occurs widely throughout the northern Great Plains, in disturbed montane meadows in the Rocky Mountains, on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture, and hay fields, and has escaped into a variety of habitats, including prairie, riparian grasslands, and mesic mountain meadows. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia that forms moderately dense to dense stands that often develop into monocultures. Other weedy species, such as *Cirsium arvense* and *Poa pratensis*, may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata* (= *Stipa comata*), and sparse, scattered mesic shrubs, such as *Symphoricarpos* spp., as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site, or the stand would be typed as such.

C.5.2.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. *Bromus inermis* occurs widely throughout the midwestern and western U.S., and perhaps this association should be broadened to include almost any stand dominated almost exclusively by *Bromus inermis*.

Mesa Verde National Park—This association has been described in other locations with *Pascopyrum smithii* often occurring as a codominant grass in the association. At Mesa Verde National Park, however, this codominance was not found; *Bromus inermis* occurred in almost homogenous stands.

Vegetation Hierarchy		
Physiognomic Class	V	Herbaceous Vegetation
Physiognomic Subclass	V.A.	Perennial graminoid vegetation
Physiognomic Group	V.A.5.	Temperate or subpolar grassland
Physiognomic Subgroup	V.A.5.N.	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.d.	Medium-tall bunch temperate or subpolar grassland
Alliance Name	*Bromus inermis* Semi-Natural Herbaceous Alliance (A.3561), Smooth Brome Semi-natural Herbaceous Alliance	

C.5.2.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.787	Inter-Mountain Basins Semi-Desert Grassland

C.5.2.4 NatureServe Conservation Status

Global Rank & Reasons: GNA (invasive) (17-Jun-1999). This is a naturalized type from Europe and Asia, widely planted for cover, pasture, and hay. It has escaped into a variety of habitats.

C.5.2.5 Distribution

Globally—This type occurs widely throughout the northern Great Plains, disturbed montane meadows in the Rocky Mountains, in relatively mesic sites in Utah and Wyoming, and perhaps more widely in the midwestern and western U.S. and Canada, as well, where *Bromus inermis* has escaped from revegetation and forage plantings.

***Mesa Verde National Park*—**This semi-natural herbaceous association occurs on three relevés on low-elevation valley floors and alluvial flats within Mesa Verde National Park. The association occurs in the Mancos Shale Formation. Relevés of this association were identified from the Mancos Valley between Point Lookout and the park entrance.

C.5.2.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**This smooth brome grassland type occurs widely throughout the northern Great Plains, on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture, and hay fields, and has escaped into a variety of habitats, including prairie, riparian grasslands, and mesic mountain meadows. In Montana, this community is found at elevational ranges from 1,100 to 2,050 m (3,590–6,700 feet), with best examples occurring on mesic alluvial terraces (Hansen et al. 1995). *Bromus inermis* grows best on moist, well-drained, finer-textured loam and clay loams, not heavy clays or sand, and does not tolerate prolonged flooding (Hansen et al. 1995). In the southern Rocky Mountains, this grassland type is reported from montane elevations (2,610 m [8,560 feet]), on well-drained sandy loam derived from granitic parent material. It also occurs in foothills and plains at lower elevations on relatively mesic sites. On the Colorado Plateau, stands occur at about 2,040 m elevation on poorly drained sites to rapidly drained sites with fine-textured alluvial soils derived from shale.

***Mesa Verde National Park*—**This association occurs on silty and silt loam soils between the elevations of 2,105 and 2,147 m (6,906–7,044 feet), average 2,124 m (6,969 feet). The slope is minimal and ranges from 0 to 2% (average 1%). Only one relevé has a small cover of gravel and cobbles. None of the relevés has a fire history.

C.5.2.7 Vegetation

***Globally*—**This association is dominated by medium-tall (0.5–1 m) graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia that forms moderately dense to dense stands that often develop into monocultures. Other weedy species, such as *Cirsium arvense*, *Poa pratensis*, and other introduced forage species, may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Juncus balticus*, *Pascopyrum smithii*, *Deschampsia caespitosa*, and *Hesperostipa comata* (= *Stipa comata*); sparse, scattered mesic shrubs, such as *Artemisia tridentata* ssp. *wyomingensis*, *Ericameria nauseosa*, and *Symphoricarpos* spp.; and ruderal forbs, such as *Heterotheca villosa*, as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site, or the stand would be typed as such.

***Mesa Verde National Park*—**Three relevés are classified as *Bromus inermis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation. The total herbaceous cover ranges from cover class 5–10% to 75–100% (average cover class 52–70%). The shrub and tree strata are represented only in trace amounts. The species richness ranges from 6 to 15 species (average of 9 species). The tree and shrub strata (when present) are represented by *Pinus edulis*, *Artemisia nova*, *Artemisia tridentata*, *Atriplex canescens*, and *Ericameria nauseosa*. The herbaceous stratum is dominated by *Bromus inermis*, a non-native invasive grass, which has 5–100% cover (average range 52–70%). *Bromus inermis* was used on federal highways projects until the 1970s, and has spread away from roadways in the park. All other herbaceous species have minimal presence (<5% cover). *Sphaeralcea coccinea* ssp. *coccinea* is present in all three relevés. *Helianthus annuus* and *Melilotus officinalis*, a non-native invasive forb, are present in two relevés.

Most Abundant Species: Globally—

Stratum	Species
Herb (field)	*Bromus inermis, Pascopyrum smithii*

Mesa Verde National Park—

Stratum	Species
Herb (field)	*Bromus inermis*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—*Melilotus officinalis*

C.5.2.8 Element Sources

Global Description Authors: D. Faber-Langendoen, mod. K. A. Schulz and J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Butler et al. 2002, Cogan et al. 2004, Cooper 2003, Cronquist et al. 1977, Hansen et al. 1995, MTNHP 2002, Midwestern Ecology Working Group n.d., NDNHI n.d., Trammel and Butler 1995, Von Loh et al. 2000.

C.5.3 *Bromus tectorum* Semi-natural Herbaceous Vegetation

Translated Name: Cheatgrass Semi-natural Herbaceous Vegetation
NatureServe Code: CEGL003019

C.5.3.1 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 *B. hordeaceus*, *B.madritensis*, *B.japonicus*, *B.rigidus*, or *B.rubens*. It is distinct from the annual *Bromus* communities found along the Pacific Coast, typical of the Mediterranean or maritime climates.

C.5.3.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—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).

Mesa Verde National Park—*Bromus tectorum* commonly occurs in the relevés sampled at Mesa Verde National Park. This species is an annual invasive non-native species that is prolific throughout the park. All of the relevés in this association have been impacted by fire, and three have been reseeded. In all of the relevés, *Bromus tectorum* is the dominant species with a minimal shrub and tree layer. Although the NVC classifies this vegetation association as "semi-natural," many ecologists would consider this community unnatural. The NVC maintains the semi-natural modifier to indicate that these communities were previously natural and many of the sites have some native species in their composition.

Vegetation Hierarchy		
Physiognomic Class	V	Herbaceous Vegetation
Physiognomic Subclass	V.D.	Annual graminoid or forb vegetation
Physiognomic Group	V.D.2.	Temperate or subpolar annual grasslands or forb vegetation
Physiognomic Subgroup	V.D.2.N.	Natural/Semi-natural temperate or subpolar annual grasslands or forb
Formation Name	V.D.2.N.d.	Short temperate annual grassland
Alliance Name	*Bromus tectorum* Semi-Natural Herbaceous Alliance (A.1814), Cheatgrass Semi-natural Herbaceous Alliance	

C.5.3.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.787	Inter-Mountain Basins Semi-Desert Grassland

C.5.3.4 NatureServe Conservation Status

Global Rank & Reasons: GNA (invasive) (1-Dec-1997)

C.5.3.5 Distribution

Globally—This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to the intermountain and southwestern U.S.

***Mesa Verde National Park*—**This semi-natural herbaceous association was identified from eight relevés on mesas and eolian deposits within Mesa Verde National Park. The association occurs on the Cliff House and Point Lookout Sandstone formations. Relevés of this association were found on Park Mesa, Moccasin Mesa, and Wetherill Mesa, and in Long Canyon, Soda Canyon, and Rock Canyon near Jug House. This association has expanded in the region in the past five years into all types of disturbed habitats.

C.5.3.6 Environmental Setting

USFWS Wetland System: Not applicable

***Environmental Summary: Globally*—**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).

***Mesa Verde National Park*—**This association occurs on sandy and sandy clay soils between the elevations of 2,186 and 2,293 m (7,172–7,523 feet), average 2,247 m (7,302 feet). The slope ranges from 0 to 13% (average 5%), with variable aspect. Three of the relevés have a low cover of sandstone gravel, cobbles, stones, boulders, and bedrock. All of the relevés have a fire history dating from 1934, 1989, 1996, and/or 2000, and the openings created have allowed *Bromus tectorum* to invade. Three of the relevés received post-fire reseeding treatment, yet the cover was not sufficient to prevent *Bromus tectorum* invasion.

C.5.3.7 Vegetation

***Globally*—**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* that may alternatively dominate or codominate are *B. carinatus*, *B. hordeaceus*, *B. madritensis*, *B. japonicus*, *B. rigidus*, or *B. 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. 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 *B. inermis*, *B. japonicus*, and *B. tectorum*. Cover is variable (H. Marriott pers. comm. 1999), and in drought years, *Bromus tectorum* may be sparse or absent.

***Mesa Verde National Park*—**Seven relevés are classified as *Bromus tectorum* Semi-natural Herbaceous Vegetation. The total tree cover is 0–5% (trees are only present in three relevés). The shrub stratum cover ranges between none to 25–50% (average cover class 5–11%), and the herbaceous stratum cover ranges between cover class 25–50% and 75–100% (average cover class 59–84%). The species richness is 16 species (average of 13 species). The tree stratum (when present) consists of *Pinus edulis* and *Juniperus osteosperma*, with a canopy height of 1–5 m. The shrub stratum is variable, with no single species occurring in more than three relevés. The shrub canopy height varies from 0.5 to 2 m. The herbaceous stratum is dominated by *Bromus tectorum*, a non-native invasive grass, which ranges in cover between 25–100% (average range 53–78%). The other species in the herbaceous stratum vary in cover. *Carduus nutans* ssp. *macrolepis* has a cover of 25–50% in two relevés and is present in six of the eight relevés. *Achnatherum hymenoides*, *Heterotheca villosa*, *Penstemon linarioides* ssp. *coloradoensis*, and *Poa fendleriana* ssp. *longiligula* occur in more than half of the relevés and cover more than 5% in at least one relevé. One relevé contains a significant amount of *Pascopyrum smithii*, with 50–75% cover.

Most Abundant Species: Globally—

Stratum	Species
Herb (field)	*Bromus hordeaceus, Bromus japonicus, Bromus madritensis, Bromus rigidus, Bromus rubens, Bromus tectorum*

Mesa Verde National Park—

Stratum	Species
Shrub/sapling (tall & short)	*Amelanchier utahensis, Purshia tridentata,*
Short shrub/sapling	*Ericameria nauseosa, Artemisia nova*
Herb (field)	*Artemisia dracunculus, Eriogonum racemosum, Yucca baccata, Alyssum alyssoides, Carduus nutans* ssp. *macrolepis, Heterotheca villosa, Lupinus ammophilus, Penstemon linarioides* ssp. *coloradoensis, Penstemon strictus, Achnatherum hymenoides, Bromus inermis, Bromus tectorum, Carex geyeri, Elymus trachycaulus* ssp. *trachycaulus, Hesperostipa comata, Koeleria macrantha, Pascopyrum smithii, Poa fendleriana* ssp. *longiligula*

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**Data are not available.

C.5.3.8 Element Sources

Global Description Authors: D. Faber-Langendoen, mod. K. Schulz and J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Beatley 1976, Cogan et al. 2004, Daubenmire 1975, Englund 2004, Evans et al. 2001, FEIS 2001, Karl et al. 1999, Marriott pers. comm., Naumann pers. comm., Redente et al. 1992, Sawyer and Keeler-Wolf 1995, Western Ecology Working Group n.d., Young and Evans 1973, Young and Evans 1978.

C.5.4 *Juncus balticus* Herbaceous Vegetation

Translated Name: Baltic Rush Herbaceous Vegetation
NatureServe Code: CEGL001838

C.5.4.1 Summary

This Baltic rush wet meadow community is found widely throughout the western United States and into western Canada. This wet meadow vegetation occurs as small, open to typically dense patches on flat stream benches, along overflow channels, and near springs. 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 a dense sward of *Juncus balticus* and often minor cover of *Carex* species, including *Carex aquatilis*, *Carex praegracilis*, *Carex nebrascensis*, or *Carex utriculata*. 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 a grazing-induced community because it increases with disturbance.

C.5.4.2 Classification

Classification Confidence: 1–Strong
Classification Comments: Globally—This association is often considered a grazing-induced community because 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.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	V	Herbaceous Vegetation
Physiognomic Subclass	V.A.	Perennial graminoid vegetation
Physiognomic Group	V.A.5.	Temperate or subpolar grassland
Physiognomic Subgroup	V.A.5.N.	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.k.	Seasonally flooded temperate or subpolar grassland
Alliance Name	*Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374), Baltic Rush Seasonally Flooded Herbaceous Alliance	

C.5.4.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES300.729	North American Arid West Emergent Marsh
CES306.812	Rocky Mountain Alpine-Montane Wet Meadow

C.5.4.4 NatureServe Conservation Status

Global Rank & Reasons: G5 (1-Feb-1996)

C.5.4.5 Distribution

Globally—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 possibly California, and east to New Mexico. It also occurs in western Canada.

Mesa Verde National Park—This herbaceous association was identified from two relevés in low-elevation positions in the bottom of Prater Canyon within Mesa Verde National Park. This association occurs in the Menefee Shale Formation.

C.5.4.6 Environmental Setting

USFWS Wetland System: Palustrine

Environmental Summary: Globally—This widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 1,420 to 3,500 m (4,655–11,475 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 deeply entrenched to very sinuous (Kittel et al. 1999b). In boreal areas, this community occurs more commonly on gradual sandy shorelines. Soils are also variable and range from sandy and well-drained to poorly drained silty clay loam or silty clay alluvium to organic; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes 1984, Padgett et al. 1989, Kittel et al. 1999b). 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).

Mesa Verde National Park—This association occurs on silty loam soils at elevations of 2,289 and 2,293 m (7,510 and 7,523 feet) with no slope. Both relevés have been impacted by the 2000 fire. One of the relevés shows signs of intermittent flooding.

C.5.4.7 Vegetation

Globally—This association is characterized by a low (<50 cm), open to typically dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. 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 jubatum*, *Muhlenbergia asperifolia*, *Pascopyrum smithii*, *Poa nemoralis* ssp. *interior*, *Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low but may include *Caltha leptosepala*, *Glaux maritima*, *Maianthemum stellatum*, *Rumex aquaticus*, *Cirsium scariosum* (= *Cirsium tioganum*), *Achillea millefolium*, *Artemisia ludoviciana*, *Potentilla plattensis*, *Polygonum bistortoides*, *Dodecatheon pulchellum*, and *Iris missouriensis*. Shrubs and dwarf-shrubs are not common; however, *Artemisia frigida* cover may be significant in some stands, and occasional *Artemisia tridentata* ssp. *tridentata*, *Ericameria nauseosa*, *Dasiphora fruticosa* ssp. *floribunda*, *Populus* spp., *Salix* spp., or *Sarcobatus vermiculatus* shrubs may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera*. Other introduced species, such as *Cirsium arvense*, *Erodium cicutarium*, *Iva axillaris*, *Lactuca serriola*, *Phleum pratense*, *Taraxacum officinale*, *Thinopyrum intermedium*, *Trifolium* spp., *Tragopogon dubius*, and *Xanthium strumarium*, may occur in disturbed stands.

Mesa Verde National Park—One relevé is classified as *Juncus balticus* Herbaceous Vegetation. The shrub cover in one relevé is absent and the other falls between 25–50% cover. The herbaceous stratum cover class is 25–50% in one relevé and 75–100% in the other relevé. The tree stratum is absent in both layers. In one relevé a pure monoculture of *Juncus balticus* occurs; the other relevé has 12 species. The shrub stratum is present in only one relevé and consists of *Chrysothamnus linifolius*, which covers 25–50%. The herbaceous stratum is dominated by *Juncus balticus* var. *montanus* with 75–100% cover in one relevé and 10–25% cover in the second relevé. In the second relevé, the herbaceous stratum also contains *Eurybia glauca* with 25–50% cover and *Achillea millefolium* var. *occidentalis* (= *Achillea* lanulosa) with 5–10% cover.

Most Abundant Species: Globally—

Stratum	Species
Herb (field)	*Juncus balticus*

Mesa Verde National Park—

Stratum	Species
Short shrub/sapling	*Chrysothamnus linifolius*
Herb (field)	*Achillea millefolium* var. *occidentalis, Eurybia glauca, Juncus balticus* var. *montanus*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.5.4.8 Element Sources

Global Description Authors: J. Drake, mod. D. Faber-Langendoen, K. A. Schulz, L. Allen
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: ANHIC 2005, Baker 1984, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, Butler et al. 2002, CONHP unpubl. data 2003, Carsey et al. 2003b, Carsey et al. 2003a, Christy 2004, Cogan et al. 2004, 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, Hall and Hansen 1997, Hansen et al. 1995, Henderson and McAllister 1983, Hess 1981, IDCDC 2005, Jankovsky-Jones et al. 1999, Jankovsky-Jones et al. 2001, Johnston 1987, Jones 1992, Jones and Walford 1995, Kagan et al. 2000, Kartesz 1994, Kierstead and Pogson 1976, Kittel and Lederer 1993, Kittel et al. 1997, Kittel et al. 1999a, Kittel et al. 1999b, Komarkova 1986, Kovalchik 1987, Kunze 1994, MTNHP 2002, Manning 1988, Manning and Padgett 1991, Manning and Padgett 1992, Muldavin et al. 2000b, Murray 2000, Mutel 1973, Mutz and Graham 1982, NVNHP 2003, Olson and Gerhart 1982, Padgett 1981, Padgett 1982, Padgett et al. 1989, Rector 1979, Richard et al. 1996, Shupe et al. 1986, Stewart 1940, Taylor 1980, Taylor and Teare 1979, Thompson and Hansen 2002, Titus and Christy 1996a, Tuhy and Jensen 1982, Volland 1976, WNHP unpubl. data, Wasser and Hess 1982, Western Ecology Working Group n.d., Youngblood et al. 1985a.

C.5.5 *Leymus cinereus* Herbaceous Vegetation

Translated Name: Great Basin Lyme Grass Herbaceous Vegetation
NatureServe Code: CEGL001479

C.5.5.1 Summary

This association is found along lower-elevation riparian corridors and some moderately alkaline valley bottomlands. Elevations range between 305 and 780 m (1,000–2,550 feet) in northeastern and central Oregon, between 915 and 1,525 m (3,000–5,000 feet) in the Great Basin, and from 1,830 to 2,451 m (6,000–8,036 feet) in western Colorado. Generally, stands of this type are described as growing on mesic sites with more soil moisture than is available to the surrounding vegetation: mesic swells and seeps, foothill ravines, moist bottomlands, and along streams. In Oregon, sites are usually situated on gentle slopes in canyon bottoms. Soils are deep, sandy loams, generally from alluvium, with a shallow water table. Parent materials are alluvium or colluvium derived from a variety of parent materials. Soils are rapidly drained silt loams, sandy clay loams, and loamy sands. The vegetation is characterized by a tall (over 1.5 m), moderately dense to more typically dense grassland dominated by high cover (30–95%) of *Leymus cinereus* (= *Elymus cinereus*). Other plants are found mainly between the clumps of *Leymus cinereus* or on the edges of the dense stands. Scattered shrubs may be present, including *Artemisia tridentata*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Rhus trilobata*, *Ribes* spp., *Rosa* spp., and *Symphoricarpos oreophilus*. Associated species occurring at lower cover values include graminoids, such as *Achnatherum hymenoides*, *Achnatherum lettermanii*, *Carex douglasii*, *Elymus glaucus*, *Hesperostipa comata*, *Juncus balticus*, and *Pascopyrum smithii*, the introduced species *Bromus tectorum* and *Poa pratensis*, and forbs, such as *Achillea millefolium*, *Agastache urticifolia*, *Castilleja* spp., *Iris missouriensis*, *Potentilla gracilis* var. *flabelliformis* (= *Potentilla flabelliformis*), *Rumex crispus*, *Sidalcea oregana*, *Stephanomeria minor*, and *Vicia americana*. *Claytonia perfoliata* (= *Montia perfoliata*) is always associated in northwestern Oregon, while more alkaline forbs (*Suaeda* spp.) are more important in the northern Great Basin valleys.

C.5.5.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Stands of *Leymus cinereus* are widely distributed in the Intermountain Region and the Great Basin, but little quantitative information is available on the composition of stands in different areas. The type has been very poorly sampled, since there are only a few examples that have not been much altered from grazing and altered stream function. Therefore, this broadly defined association could be split. This *Leymus cinereus* Herbaceous Vegetation association includes stands growing on relatively non-saline soils in a variety of landscape positions. It is based on the limited information in the literature. It is also very likely that the types found along alluvial terraces in the somewhat alkaline, mid- to high-elevation valleys in the Blue Mountains and the Basin and Range are very different from the non-alkaline, low-elevation stream drainages from the Columbia Basin. Until additional reference sites are found, the type will have to be treated as a single community.

Mesa Verde National Park—Although only one relevé was sampled of this vegetation association, it is a recognized NVC vegetation association, and we did not need to designate it as a park special.

Vegetation Hierarchy		
Physiognomic Class	V	Herbaceous Vegetation
Physiognomic Subclass	V.A.	Perennial graminoid vegetation
Physiognomic Group	V.A.5.	Temperate or subpolar grassland
Physiognomic Subgroup	V.A.5.N.	Natural/Semi-natural temperate or subpolar grassland
Formation Name	V.A.5.N.b.	Tall bunch temperate grassland
Alliance Name	*Leymus cinereus* Herbaceous Alliance (A.1204), Great Basin Lyme Grass Herbaceous Alliance	

C.5.5.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.780	Inter-Mountain Basins Greasewood Flat
CES306.824	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland

C.5.5.4 NatureServe Conservation Status

Global Rank & Reasons: G2G3Q (29-Mar-1999). This is a very widespread community, found in many western states, but is badly degraded everywhere. It has declined markedly throughout its range, and probably represents two or more separate community types. This type was formerly very abundant in interior valleys. Early settlers described the very tall grasslands (up to their horses' backs) in many areas. Most of these sites have been converted to agriculture. Even as described here—as a broad association floristically and geographically—the size and quality of most occurrences should make it a G2. More knowledge of its distribution is needed, but it should remain a priority for conservation. Most sites are threatened by livestock grazing, agriculture, altered stream hydrology, and altered fire regime.

C.5.5.5 Distribution

Globally—This type is found mainly in the Great Basin and the Intermountain Region, and just reaches the western part of the northern Great Plains. Although it occupies a small amount of area in Oregon or in any western state, it has a large range. Unfortunately, few high-quality remnants remain.

Mesa Verde National Park—This herbaceous association occurs on one relevé in a canyon bottom of the Mancos River within Mesa Verde National Park. The association was identified in the Mancos Shale Formation.

C.5.5.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This association is found along lower-elevation riparian corridors and some moderately alkaline valley bottomlands. Elevations range between 305 and 780 m (1,000–2,550 feet) in northeastern and central Oregon, between 915 and 1,525 m (3,000–5,000 feet) in the Great Basin, and from 1,830 to 2,451 m (6,000–8,036 feet) in western Colorado. Generally, stands of this type are described as growing on mesic sites with more soil moisture than is available to the surrounding vegetation: mesic swells and seeps (Thilenius et al. 1995), foothill ravines (Knight et al. 1976), moist bottomlands (Stoddart 1941), and along streams (Mueggler and Stewart 1980). In Oregon, sites are usually situated on gentle slopes in canyon bottoms. Soils are deep, sandy loams, generally from alluvium, with a shallow water table. Parent materials are alluvium or colluvium derived from a variety of parent materials. Soils are rapidly drained silt loams, sandy clay loams, and loamy sands.

Mesa Verde National Park—This association is found on clay soil at an elevation of 1,920 m (6,299 feet) with no slope.

C.5.5.7 Vegetation

Globally—The association is a characteristically tall (over 1.5 m), moderately dense to more typically dense grassland dominated by high cover (30–95%) of *Leymus cinereus* (= *Elymus cinereus*). Other plants are found mainly between the clumps of *Leymus cinereus* or on the edges of the dense stands. Scattered shrubs may be present, including *Artemisia tridentata*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa* (= *Chrysothamnus nauseosus*), *Rhus trilobata*, *Ribes* spp., *Rosa* spp., and *Symphoricarpos oreophilus*. Associated species occurring at lower cover values include graminoids, such as *Achnatherum hymenoides*, *Achnatherum lettermanii*, *Carex douglasii*, *Elymus glaucus*, *Hesperostipa comata*, *Juncus balticus*, and *Pascopyrum smithii*, the introduced species *Bromus tectorum* and *Poa pratensis*, and forbs, such as *Achillea millefolium*, *Agastache urticifolia*, *Castilleja* spp., *Iris missouriensis*, *Potentilla gracilis* var. *flabelliformis* (= *Potentilla flabelliformis*), *Rumex crispus*, *Sidalcea oregana*, *Stephanomeria minor*, and *Vicia americana*. *Claytonia perfoliata* (= *Montia perfoliata*) is always

associated in northwestern Oregon, while more alkaline forbs (*Suaeda* spp.) are more important in the northern Great Basin valleys.

***Mesa Verde National Park*—**One relevé is classified as *Leymus cinereus* Herbaceous Vegetation. The total shrub cover is 1–5% and the total herbaceous cover is 50–75%. There is no tree stratum recorded for this relevé. The species richness is 13 species. The shrub stratum is minimal (<5%) and consists of *Artemisia tridentata*, *Ericameria nauseosa*, *Rhus trilobata* var. *trilobata*, and *Rosa woodsii*. The average height of the shrub stratum is 1–2 m. The herbaceous stratum is dominated by *Leymus cinereus*, which has 50–75% cover. All other herbaceous species are present in trace amounts.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Herb (field)	*Leymus cinereus*

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**Data are not available.

C.5.5.8 Element Sources

Global Description Authors: G. P. Jones and M.P. Murray, mod. K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Aldous and Shantz 1924, Baker 1982, Baker 1984, Bourgeron and Engelking 1994, CONHP unpubl. data 2003, Daubenmire 1970, Daubenmire 1988, DeVelice 1992, Dean 1960, Driscoll et al. 1984, Ferchau 1973, IDCDC 2005, Johnson and Simon 1985, Johnson and Simon 1987, Jones and Ogle 2000, Keammerer 1977, Knight et al. 1976, MTNHP 1988, MTNHP 2002, Mueggler and Stewart 1980, Stoddart 1941, Thilenius et al. 1995, Thorne Ecological Institute 1973, USFS 1937, Vories 1974, WNHP unpubl. data, Walker and Brotherson 1982, Western Ecology Working Group n.d.

C.5.6 *Eurybia glauca* Herbaceous Vegetation [Park Special]

Translated Name: Gray Wood-aster Herbaceous Vegetation [Park Special]
NatureServe Code: Park Special

C.5.6.1 Summary

Data are not available.

C.5.6.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Only one relevé was sampled at Mesa Verde National Park with a dominance of the native forb, *Eurybia glauca*. This relevé was unique to the park, as well as not previously established by NatureServe as a vegetation association. Because this relevé is unique, we decided to include this vegetation type as a park special. If this vegetation type is sampled more extensively in the future, it will then be re-classified by NatureServe as a vegetation association and included in the NatureServe classification. This extensive stand of *Eurybia glauca* may be a result of the 1989 fire and a unique anomaly specific to this one localized relevé.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.6.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES302.765	Colorado Plateau Mixed Bedrock Canyon and Tableland

C.5.6.4 NatureServe Conservation Status

Data are not available.

C.5.6.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—The park special, *Eurybia glauca* Herbaceous Vegetation, was identified from one relevé on an upper slope of an escarpment within Mesa Verde National Park. The vegetation type occurs on the Menefee Formation on the Long Spur of the North Rim.

C.5.6.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This vegetation type is found on sandy soil at an elevation of 2,389 m (7,838 feet). The slope is 39%, with a northeastern aspect. A low cover of sandstone cobbles, stones, and boulders occurs in the relevé. The relevé burned in 1989.

C.5.6.7 Vegetation

Globally—Data are not available.

***Mesa Verde National Park*—**One relevé is classified as *Eurybia glauca* Herbaceous Vegetation [Park Special]. The total shrub cover is 1–5% and the herbaceous cover is 50–75% cover. There is no tree stratum in this relevé. Species richness is 22 species. The shrub stratum is minimal (<5%) and consists of *Amelanchier utahensis*, *Ericameria nauseosa*, and *Quercus gambelii*. The average height of the shrub stratum is 0.5–1 m. The herbaceous stratum is dominated by *Eurybia glauca*, which has 50–75% cover. All other herbaceous species are present in trace amounts.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Herb (field)	*Eurybia glauca*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park*—Achnatherum hymenoides*, *Amelanchier utahensis*, *Castilleja applegatei* ssp. *martinii*, *Elymus elymoides*, *Ericameria nauseosa*, *Quercus gambelii*

C.5.6.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Data are not available.

C.5.7 *Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation [Park Special]

Translated Name: Slender Wild Rye Semi-natural Herbaceous Vegetation [Park Special]
NatureServe Code: Park Special

C.5.7.1 Summary

Data are not available.

C.5.7.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Only one relevé of this vegetation type was identified in the sampling effort at Mesa Verde National Park. The dominant species on this relevé, *Elymus trachycaulus* ssp. *trachycaulus,* has not been previously described as an association dominant. As there was not sufficient data to document the relevé as an association at Mesa Verde NP, it is a park special. This homogenous stand of *Elymus trachycaulus* ssp. *trachycaulus* may be in part a result of the reseeding effort after the 1996 fire and, therefore, may need to be re-sampled later to determine if the community composition alters over time.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.7.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.787	Inter-Mountain Basins Semi-Desert Grassland

C.5.7.4 NatureServe Conservation Status

Data are not available.

C.5.7.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—The park special, *Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation, was identified from one relevé on an eolian deposit on Park Mesa within the park. The vegetation type was identified on the Cliff House Sandstone Formation.

C.5.7.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This vegetation type occurs on sandy soil at an elevation of 2,253 m (7,392 feet). The relevé has a slope of 6%, with an eastern aspect. The relevé burned in 1996 and received a post-fire reseeding treatment with four native grasses.

C.5.7.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—One relevé is classified as *Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation [Park Special]. The total shrub cover is 1–5%, and the herbaceous cover is 75–100% cover. The tree stratum is absent from this relevé. The species richness is 15 species. The shrub stratum is minimal (<5%) and consists of *Cercocarpus montanus* and *Quercus gambelii*. The herbaceous stratum is dominated by *Elymus trachycaulus* ssp. *trachycaulus*, which has 50–75% cover, and *Elymus elymoides*, with 25–50% cover.

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—

Stratum	Species
Herb (field)	*Elymus trachycaulus* spp. *trachycaulus*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—*Balsamorhiza sagittata*, *Carduus nutans* ssp. *macrolepis*, *Carex geyeri*, *Elymus elymoides*, *Lupinus caudatus*

C.5.7.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Data are not available.

C.5.8 *Ericameria nauseosa / Bromus inermis (Pascopyrum smithii)* Shrub Herbaceous [Park Special]

Translated Name: Rubber Rabbitbrush / Smooth Brome - (Western Wheatgrass) Shrub Herbaceous [Park Special]
NatureServe Code: Park Special

C.5.8.1 Summary

Data are not available.

C.5.8.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—This park special was identified on 100 polygons, nearly two-thirds in the park environs. It is documented by 22 accuracy assessment sites.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.8.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.788	Inter-Mountain Basins Semi-Desert Shrub-Steppe

C.5.8.4 NatureServe Conservation Status

Data are not available.

C.5.8.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This park special was identified during the photointerpretation part of the project. It occurs in the northern end of the park, both inside and outside the boundary and in the cuesta of the park.

C.5.8.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—In the north, this park special tends to occur in fallow agricultural fields. The wheat grass was intentionally seeded in some fields and spread to others. In the cuesta areas of the park, this association occurs in open fields and lowlands. Elevation ranged between 1,932 and 2,470 m for the 22 accuracy assessment observation sites of this association.

C.5.8.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—*Ericameria nauseosa* is the dominant shrub. *Gutierrezia sarothrae* also commonly occurs. The herbaceous species generally consist of *Bromus inermis*, a non-native grass,

and *Pascopyrum smithii*.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Tree canopy	*Juniperus osteosperma*
Shrub canopy	*Ericameria nauseosa, Symphoricarpos oreophilus*
Herbaceous canopy	*Bromus inermis, Pascopyrum smithii, Artemisia ludoviciana, Artemisia dracunculus*

***Other Noteworthy Species: Globally*—**Data are not available.
***Mesa Verde National Park*—**Data are not available.

C.5.8.8 Element Sources

Global Description Authors: Data are not available.

Local Description Authors: Data are not available.

References: Data are not available.

C.5.9 Mixed Weedy Herbaceous Vegetation [Park Special]

NatureServe Code: Park Special

C.5.9.1 Summary

Data are not available.

C.5.9.2 Classification

Classification Confidence: 3-Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—This park special was identified on ten polygons. It is field documented by six accuracy assessment sites and noted at ten photointerpreter's locations.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.9.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.787	Inter-Mountain Basins Semi-Desert Grassland

C.5.9.4 NatureServe Conservation Status

Data are not available.

C.5.9.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This park special type was identified during the photointerpretation part of the project. It always occurs in unburned areas.

C.5.9.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This park special occurs on roadsides and other weedy, unburned areas. Elevation on six accuracy assessment sites ranged from 2,109 to 2,399 meters.

C.5.9.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—This park special contains a mix of non-native herbaceous forbs and grasses. The most frequent species include, but are not limited to, *Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*, *Melilotus officinalis*, *Pascopyrum smithii*, and *Hesperostipa comata*.

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—

Stratum	Species
Shrub canopy	*Ericameria nauseosa, Symphoricarpos oreophilus*
Herbaceous canopy	*Artemisia ludoviciana Carduus nutans, Pascopyrum smithii, Symphyotrichum falcatum* var. *falcatum*

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.5.9.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: Data are not available.
References: Data are not available.

C.5.10 Mixed Wetland Herbaceous Vegetation [Park Special]

NatureServe Code: Park Special

C.5.10.1 Summary

Data are not available.

C.5.10.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—This park special was identified by photointerpretation only on six polygons. It is documented by one accuracy assessment site and noted on four photointerpreter's locations. Inspection of the mapped polygons may show them to be dominated by *Juncus balticus*.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.10.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES300.729	North American Arid West Emergent Marsh

C.5.10.4 NatureServe Conservation Status

Data are not available.

C.5.10.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—This park special was identified during the photointerpretation part of the project. This association is only known from the bottom of Prater and Morefield canyons.

C.5.10.6 Environmental Setting

USFWS Wetland System: Palustrine

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This park special occurs in broad canyon bottoms.

C.5.10.7 Vegetation

Globally—Data are not available.

Mesa Verde National Park—Species other than *Juncus balticus* are suspected to be the dominant species. Species present form a thick monoculture.

Most Abundant Species: Globally—Data are not available.

Mesa Verde National Park—Data are not available.

Other Noteworthy Species: Globally—Data are not available.
Mesa Verde National Park—Data are not available.

C.5.10.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: Data are not available.
References: Data are not available.

C.5.11 Post-Fire Mixed Herbaceous Vegetation [Park Special]

NatureServe Code: Park Special

C.5.11.1 Summary

Data are not available.

C.5.11.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—This post-burn local type has a variable vegetation structure and composition, depending on the plant community burned and what species are available to colonize post-burn. It may develop into weedy vegetation, semi-desert grassland or steppe, shrubland, or, eventually, woodlands. Except for stands with fire-adapted species, such as Gambel oak, the future community cannot be predicted. Stands with Gambel oak present will likely develop in a Gambel oak shrubland association.

Mesa Verde National Park—All of the relevés that occur in this community type recently burned. The species composition is variable and likely to change significantly throughout time as natural post-fire successional processes occur. Because the species composition is variable and transitional, we were not able to classify this community based on a single species and instead classified these relevés based on their similar ecological history. The vegetation type will never be included in the NatureServe classification as an NVC association. This preliminary successional community will retain the designation of a park special vegetation type (specific to Mesa Verde National Park).

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.11.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES304.767	Colorado Plateau Pinyon-Juniper Woodland
CES306.818	Rocky Mountain Gambel Oak-Mixed Montane Shrubland

C.5.11.4 NatureServe Conservation Status

Data are not available.

C.5.11.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—The park special Post-Fire Mixed Herbaceous Vegetation occurs on 18 relevés on mesas, hillsides, eolian deposits, and canyon sides and bottoms within Mesa Verde National Park. This vegetation type occurs in the Cliff House Sandstone, Menefee Shale, and Point Lookout Sandstone formations. Relevés of this vegetation type are found on Chapin, Wetherill, Moccasin, and Whites mesas; in Prater, Soda, Little Soda, Morefield, Rock, and Whites canyons; and in the Mancos Valley between Point Lookout and the park entrance.

C.5.11.6 Environmental Setting

USFWS Wetland System: Not applicable
Environmental Summary: Globally—Data are not available.
Mesa Verde National Park—This vegetation type occurs on sandy, sandy clay, and sandy loam soils

between the elevations of 2,169–2,470 m (7,116–8,104 feet), average 2,416 m 7,927 feet). The slope ranges from 0 to 24% (average 5%), with variable aspect. Most of the relevés have a low cover of sandstone gravel, cobble, and stone. A few of the relevés have some cover of sandstone boulders and bedrock. All of the relevés have a fire history dating from 1959, 1996, 2000, and/or 2002. Five of the plots received post-fire reseeding treatments.

C.5.11.7 Vegetation

***Globally*—**Data are not available.

***Mesa Verde National Park*—**Eighteen relevés are classified as Post-Fire Mixed Herbaceous Vegetation [Park Special]. Only one relevé has tree cover, and it has from 1 to 5% cover. The total shrub cover ranges from none to cover class 50–75% (average cover class 6–12%), and the total herbaceous cover ranges between 5–10% and 75–100% (average cover class 38–58%). The species richness is 7–26 species (average of 15 species). A few small *Pinus edulis* trees cover less than 5% of one relevé with a height of 2–5 m. The shrub stratum is variable, with most species occurring in only a few relevés. *Quercus gambelii* and *Ericameria nauseosa* are the most frequent constituents, occurring in more than 30% of the relevés. *Artemisia dracunculus* is the second most-commonly occurring shrub, and is noteworthy for its high coverage (25–100%) in three of the relevés. The shrub stratum ranges from <0.5 to 2 m in height. The herbaceous stratum is also highly variable. Only *Bromus tectorum* and *Carduus nutans* ssp. *macrolepis*, non-native invasive species, and native species *Heliomeris multiflora*, *Penstemon linarioides* ssp. *coloradoensis*, *Poa fendleriana* ssp. *longiligula*, and *Sphaeralcea coccinea* ssp. *coccinea* are present in at least half of the relevés. Although they are not widespread, *Elymus trachycaulus* ssp. *trachycaulus*, *Balsamorhiza sagittata*, *Melilotus officinalis* (a non-native invasive species), *Pascopyrum smithii*, and *Hesperostipa comata* are noteworthy for their high cover in select relevés.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Herb (field)	*Penstemon linarioides* ssp. *coloradoensis, Poa fendleriana* ssp. *longiligula, Sphaeralcea coccinea ssp. coccinea*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park*—Achnatherum hymenoides*, *Elymus trachycaulus* ssp. *trachycaulus*, *Artemisia ludoviciana*, *Artemisia nova*, *Balsamorhiza sagittata*, *Bromus inermis*, *Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*, *Carex geyeri*, *Chenopodium fremontii*, *Elymus elymoides*, *Ericameria nauseosa*, *Eriogonum racemosum Heliomeris multiflora*, *Hesperostipa comata*, *Lactuca serriola*, *Lithospermum ruderale*, *Lupinus ammophilus*, *Lupinus caudatus*, *Lycium pallidum*, *Machaeranthera bigelovii*, *Melilotus officinalis*, *Artemisia dracunculus*, *Pascopyrum smithii*, *Purshia tridentata*, *Quercus gambelii*.

C.5.11.8 Element Sources

Global Description Authors: K. A. Schulz
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Data are not available.

C.5.12 *Stanleya pinnata* Shale Herbaceous [Park Special]

Translated Name: Golden Prince's-plume Shale Herbaceous [Park Special]
NatureServe Code: Park Special

C.5.12.1 Summary

Data are not available.

C.5.12.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Although four relevés were sampled in this vegetation type, not enough information is yet known about this shale-specific vegetation community. Currently, this community is classified by NatureServe as a park special (only known from Mesa Verde National Park). In the future, if additional data are collected about this vegetation community, it may be listed as a new vegetation association and included in the NatureServe classification. This vegetation type has a significant *Pinus edulis* tree canopy and may need to be re-assessed in the classification as a *Pinus edulis* - (*Juniperus* spp.) / *Stanleya pinnata* Sparse Woodland.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.5.12.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES302.765	Canyon Plateau Mixed Bedrock Canyon and Tableland

C.5.12.4 NatureServe Conservation Status

Data are not available.

C.5.12.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—The park special, *Stanleya pinnata* Shale Herbaceous Vegetation, occurs on four relevés on lower slopes, midslopes, and upper slopes of mesas, canyons, and canyon walls within Mesa Verde National Park. This vegetation type was identified exclusively in the Mancos Shale Formation. These relevés were located in the Mancos Valley between Point Lookout and the park entrance and in Mancos Canyon.

C.5.12.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This vegetation type occurs on sand, silt, and silty clay soils between the elevations of 1,935 and 2,218 m (6,348–7,277 feet), average 2,078 m (6,818 feet). The slope ranges from 13 to 36% (average 26%) at a southeast to southwest aspect. Most of the relevés occur in areas without any surface rocks. In a few of the relevés, a low cover of sandstone and shale boulders, cobbles, and gravel is present. Three of the four relevés exhibit some evidence of *Pinus edulis* mortality from *Ips*

*b*ark beetle. One of the relevés occurs in an area with a pre-1900 fire.

C.5.12.7 Vegetation

***Globally*—**Data are not available.

***Mesa Verde National Park*—**Four relevés are classified as *Stanleya pinnata* Shale Herbaceous [Park Special]. The total tree cover ranges from cover class 1–5% to 50–75% (average cover class 19–33%), the total shrub cover ranges from cover class 1–5% to 5–10% (average cover class 4–9%), and the herbaceous cover ranges from cover class 5–10% to 25–50% (average cover class 10–20%). The species richness ranges from 16 to 31 species (average of 23 species). *Pinus edulis* occurs in all of the relevés and ranges between cover classes 1–5% and 25–50% (average cover class 7–16%). One relevé contains *Juniperus osteosperma*, with 5–10% cover, and a second relevé contains *Juniperus scopulorum*, with 25–50% cover. The tree stratum varies in height between 1 and 20 m. The shrub stratum is dominated by *Amelanchier utahensis*, and occurs in three-quarters of the relevés, with up to cover class 5–10% (average cover 4–8%). *Ephedra viridis* occurs frequently in the relevés, with a low cover (<5%). The average height of the shrub stratum is 1–2 m. *Stanleya pinnata* is an indicator species for this vegetation type and ranges between a trace and 5–10% cover (average cover class 3–7%). Also present in the herbaceous stratum are *Astragalus lonchocarpus*, *Astragalus pattersonii*, and *Eriogonum umbellatum* (each covering 5–10% in some relevés) and *Gilia haydenii* (covering 10–25% of one relevé). *Descurainia pinnata* and *Tragopogon pratensis*, non-native invasive species, occur in most of the relevés with a low cover (<5%).

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Tree canopy	*Pinus edulis*
Herb (field)	*Stanleya pinnata*

***Other Noteworthy Species: Globally*—**Data are not available.
Mesa Verde National Park*—Achnatherum hymenoides*, *Amelanchier utahensis*, *Astragalus lonchocarpus*, *Astragalus pattersonii*, *Cercocarpus montanus*, *Ephedra viridis*, *Eriogonum corymbosum*, *Eriogonum umbellatum*, *Gilia haydenii*, *Juniperus osteosperma*, *Juniperus scopulorum*, *Peraphyllum ramosissimum*, *Quercus gambelii*, *Descurainia pinnata*, *Tragopogon pratensis*

C.5.12.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Data are not available.

C.6 Sparse

C.6.1 *Eriogonum corymbosum* Badlands Sparse Vegetation

Translated Name: Crispleaf Wild Buckwheat Badlands Sparse Vegetation
NatureServe Code: CEGL002979

C.6.1.1 Summary

This unusual sparse short-shrub association occurs on barren shale badlands. Sites are flat to gentle to moderately steep, occur between 1,219 and 1,945 m (4,000–6,380 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, or Chinle shales 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*, and *Coleogyne ramosissima*. The herbaceous layer is low in species diversity and provides sparse cover. No species of graminoid or forb provides more than 1% cover; *Pleuraphis jamesii* and *Elymus elymoides* are among the few herbaceous species recorded in this association.

C.6.1.2 Classification

Classification Confidence: 2–Moderate
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Data are not available.

Vegetation Hierarchy		
Physiognomic Class	VII	Sparse Vegetation
Physiognomic Subclass	VII.C.	Unconsolidated material sparse vegetation
Physiognomic Group	VII.C.3.	Sparsely vegetated soil slopes
Physiognomic Subgroup	VII.C.3.N.	Natural/Semi-natural sparsely vegetated soil slopes
Formation Name	VII.C.3.N.b.	Dry slopes
Alliance Name	Painted Desert Sparsely Vegetated Alliance (A.2545), Painted Desert Sparsely Vegetated Alliance	

C.6.1.3 Ecological Systems Placement

Ecological System Unique ID	**Ecological System Name**
CES304.789	Inter-Mountain Basins Shale Badland

C.6.1.4 NatureServe Conservation Status

Global Rank & Reasons: GNR (22-Jan-2002)

C.6.1.5 Distribution

Globally—This association has been described from southern and eastern Utah.

Mesa Verde National Park—This sparse vegetation association occurs on one relevé on the upper slope of a mesa within Mesa Verde National Park. The association is found in the Mancos Shale Formation. This relevé was located in the Mancos Valley between Point Lookout and the park entrance.

C.6.1.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—This unusual sparse short-shrub association occurs on

barren shale badlands. Sites are flat to gentle to moderately steep, occur between 1,219 and 1,945 m (4,000–6,380 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, or Chinle shales that erode to badlands deposits. Vegetation has difficulty taking hold on the highly erosive surface. Soils are rapidly drained sandy clays or silty clays.

Mesa Verde National Park—This relevé occurs on slatey shale soils at an elevation of 2,182 m (7,159 feet) with a small slope of 1%. The large boulders in this relevé are predominantly shale. The relevé that contains this association occurs near the junction between the Mancos Shale and the overlying Point Lookout Sandstone. This relevé has evidence of *Pinus edulis* mortality from *Ips* bark beetle. Evidence of the 1900 fire was recorded from this relevé.

C.6.1.7 Vegetation

Globally—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*, and *Coleogyne ramosissima*. The herbaceous layer is low in species diversity and provides sparse cover. No species of graminoid or forb provides more than 1% cover; *Pleuraphis jamesii*, *Elymus elymoides*, and *Xylorhiza glabriuscula* are among the few herbaceous species recorded in this association.

Mesa Verde National Park—One relevé is classified as *Eriogonum corymbosum* Badlands Sparse Vegetation. The total vegetation tree cover is 5–10%, the total shrub cover is 25–50%, and the herbaceous cover is only a trace. The species richness is 12 species. The tree stratum is dominated by *Pinus edulis*, which has 5–10% cover and ranges in height between 1 and 2 m. The shrub stratum is dominated by *Eriogonum corymbosum*, which has 25–50% cover. *Ephedra viridis*, *Opuntia polyacantha*, and *Peraphyllum ramosissimum* are also present in the shrub stratum, each having 5–10% cover. *Amelanchier utahensis* also occurs in the shrub stratum, with a low cover (<5%). The shrub stratum has a low average height of <0.5 m. The herbaceous stratum is minimal (<0.5% cover), with a low cover of *Alyssum minus* var. *micranthum*, *Astragalus lonchocarpus*, and *Lesquerella rectipes*.

Most Abundant Species: Globally—

Stratum	Species
Short shrub/sapling	*Eriogonum corymbosum*

Mesa Verde National Park—

Stratum	Species
Tree canopy	*Pinus edulis*
Short shrub/sapling	*Eriogonum corymbosum, Peraphyllum ramosissimum, Ephedra viridis*
Herb (field)	*Opuntia polyacantha*

Other Noteworthy Species: Globally—*Bromus tectorum*, *Halogeton glomeratus*

Mesa Verde National Park—*Alyssum parviflorum*

C.6.1.8 Element Sources

Global Description Authors: J. Coles
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Cogan et al. 2004, Western Ecology Working Group n.d.

C.6.2 Sandstone *Pinus edulis - Juniperus osteosperma* Barrens [Park Special]

Translated Name: Sandstone Pinyon Pine - Utah Juniper Barrens [Park Special]
NatureServe Code: Park Special

C.6.2.1 Summary

Data are not available.

C.6.2.2 Classification

Classification Confidence: 3–Weak
Classification Comments: Globally—Data are not available.

Mesa Verde National Park—Only one relevé has been sampled of this vegetation type, and this type has not been previously sampled in areas outside Mesa Verde National Park. If this vegetation type is sampled in other locations, the community type designation will be changed from a park special to a vegetation association and will eventually be included in the NatureServe classification. The understory species composition is so low that it was decided during the classification process to name this vegetation community as a substrate-dependent community, rather than name it after a specific species in the understory.

Vegetation Hierarchy	
Physiognomic Class	Not Applicable
Physiognomic Subclass	Not Applicable
Physiognomic Group	Not Applicable
Physiognomic Subgroup	Not Applicable
Formation Name	Not Applicable
Alliance Name	Not Applicable

C.6.2.3 Ecological Systems Placement

Ecological System Unique ID	Ecological System Name
CES302.765	Colorado Plateau Mixed Bedrock Canyon and Tableland

C.6.2.4 NatureServe Conservation Status

Data are not available.

C.6.2.5 Distribution

Globally—Data are not available.

Mesa Verde National Park—The park special, Sandstone *Pinus edulis - Juniperus osteosperma* Barrens, occurs on one relevé on an upland terrace of an escarpment within Mesa Verde National Park. This vegetation type occurs in the Point Lookout Sandstone Formation on the Long Spur of the North Rim.

C.6.2.6 Environmental Setting

USFWS Wetland System: Not applicable

Environmental Summary: Globally—Data are not available.

Mesa Verde National Park—This vegetation type is found on sandstone outcrops. These sandstone outcrops have small patches of sandy soil in the slickrock depressions and crevices, and these patches are often where the vegetation seems to be the most persistent. The vegetation type occurs at an elevation of 2,358 m (7,736 feet), on level ground. This relevé has 75–100% cover of sandstone bedrock. The relevé has no history of fire.

C.6.2.7 Vegetation

***Globally*—**Data are not available.

***Mesa Verde National Park*—**One relevé is classified as Sandstone *Pinus edulis - Juniperus osteosperma* Barrens [Park Special]. The total vegetation cover is low for all the strata. The tree stratum has 1–5% cover, the shrub stratum has 5–10% cover, and the herbaceous stratum is minimal (<1%). The species richness is 14 species. The tree stratum consists of *Pinus edulis* and *Juniperus osteosperma* (both with 1–5% cover). The tree height was identified as a canopy layer of 2–5 m and a subcanopy layer of 1–2 m. The shrub stratum is dominated by *Quercus gambelii*, which has 1–5% cover. Also present in the shrub stratum are trace amounts of *Prunus virginiana* and *Cercocarpus montanus*. The shrub stratum average height is 1–2 m. The herbaceous stratum is nearly absent and contains no diagnostic species.

***Most Abundant Species: Globally*—**Data are not available.

***Mesa Verde National Park*—**

Stratum	Species
Tree canopy	*Juniperus osteosperma, Pinus edulis*

Other Noteworthy Species: Globally*—Data are not available*.
Mesa Verde National Park*—Quercus gambelii*

C.6.2.8 Element Sources

Global Description Authors: Data are not available.
Local Description Authors: M. McTeague, M. L. Floyd, K. A. Thomas, J. Donald
References: Data are not available.

Literature cited

ANHIC [Alberta Natural Heritage Information Centre]. 2005. Community database files. Alberta Natural Heritage Information Centre, Parks and Protected Areas Division, Alberta Community Development, Edmonton.

Aldous, A. E., and H. L. Shantz. 1924. Types of vegetation in the semiarid portion of the United States and their economic significance. Journal of Agricultural Research **28**(2):99–128.

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. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-143. Fort Collins, CO. 35 pp.

Alexander, B. G., Jr., F. Ronco, Jr., A. S. White, and J. A. Ludwig. 1984. Douglas-fir habitat types of northern Arizona. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-108. Fort Collins, CO. 13 pp.

Bader, E. H. 1932. The vegetation of the Mesa Verde National Park, Colorado. Unpublished thesis, University of Colorado, Boulder. 64 pp.

Baker, W. L. 1982. Natural vegetation of the Piceance Basin, Colorado. Appendix D, pages 1–113 *in* J. S. Peterson and W. L. Baker, eds., Inventory of the Piceance Basin, Colorado. Unpublished report for the Bureau Land Management, Craig, CO.

——. 1984. 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.

Barnes, F. J. 1987. Carbon and water relations across a pinyon-juniper habitat gradient. Unpublished dissertation, New Mexico State University, Las Cruces.

Barrows, J. S., E. W. Mogren, K. Rowdabaugh, and R. Yancik. 1977. The role of fire in ponderosa pine and mixed conifer ecosystems. Final report, Cooperative report between the National Park Service and Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 101 pp.

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. USDA Forest Service, Intermountain Research Station. General Technical Report INT-215. Ogden, UT.

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.

Beetle, A. A., and K. L. Johnson. 1982. Sagebrush in Wyoming. Wyoming Agricultural Experiment Station Bulletin 779. University of Wyoming, Laramie.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968. Vegetation and soils of the Duckwater Watershed. Nevada Agricultural Experiment Station Bulletin R-40. Reno. 76 pp.

——. 1971. Vegetation and soils of the Rock Springs Watershed. Nevada Agricultural Experiment Station Bulletin R-83. Reno. 116 pp.

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.

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1993. 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).

——. 1995. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Desert Plants **11**:2–3.

Bourgeron, P. S., and L. D. Engelking, eds. 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.

Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. USDA Forest Service, Intermountain Research Station. General Technical Report INT-287. Ogden, UT. 128 pp.

Branson, F. A., R. F. Miller, and I. S. McQueen. 1976. Moisture relationships in twelve northern desert shrub communities near Grand Junction, Colorado. Ecology **57**:1104–1124.

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist **44**(2):299–309.

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. Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Report INT-215. 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.

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.

——. No date. Biological and Conservation Data (BCD) System. Unpublished data from field surveys. Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

——. Personal communication. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Caicco, S. L., and C. A. Wellner. 1983. Research Natural Area recommendation for Little Jacks Creek. Unpublished report prepared for USDI Bureau of Land Management, Boise District, Idaho by Idaho Natural Areas Coordinating Committee. 14 pp.

Carmichael, R. S., O. D. Knipe, C. P. Pase, and W. W. Brady. 1978. Arizona chaparral: Plant associations and ecology. USDA Forest Service Research Paper RM-202. 16 pp.

Carsey, K., D. Cooper, K. Decker, D. Culver, and G. Kittel. 2003a. 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. 2003b. 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 and reclamation plan for Alton Mine, Utah International, Inc., Utah Division of Oil, Gas & Mining ACT/025/003.

Christy, J. A. 2004. Native freshwater wetland plant associations of northwestern Oregon. Oregon Natural Heritage Information Center, Oregon State University, Portland, OR.

Clary, W. P. 1992. Ecology and values of Gambel oak woodlands. Pages 87–95 *in* USDA Forest Service General Technical Report RM-218. Ecology and management of oak and associated woodlands. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 224 pp.

Clausnitzer, R. R., and B. A. Zamora. 1987. Forest habitat types of the Colville Indian Reservation. Unpublished report prepared for the Department of Forest and Range Management, Washington State University, Pullman. 110 pp.

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.

Cole, N. K. 1995. Cover type map and vegetation classification of the Hagerman study area, southwestern Idaho. Technical appendix E.3.3-A for new license application: Upper Salmon Falls (FERC No. 2777), Lower Salmon Falls (FERC No. 2061), Bliss (FERC No. 1975). Volume 4. Idaho Power Company, Boise ID. 61 pp. plus appendices.

——. 1996. Cover type map and vegetation classification of the Shoshone Falls study area, southwestern Idaho. Technical appendix E.3.3-A for new license application: Shoshone Falls (FERC No. 2778), Volume 2. Idaho Power Company, Boise ID. 38 pp. plus appendices.

Colorado Natural Heritage Program Ecology Team. 2001. A classification of the native vegetation of Colorado. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

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. 2003. Assessment of Kootenai National Forest vegetation types with potential for *Silene spaldingii* in the Tobacco Plains, Rexford Bench and Salish Range foothills. Unpublished report to Kootenai National Forest, Supervisor's Office. Montana Natural Heritage Program, Helena, MT. 33 pp. plus appendices.

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., K. Neiman, and R. Steele. 1985. Forest habitat types of northern Idaho. Editorial draft. Unpublished report prepared for USDA Forest Service, Intermountain Forest and Range Experiment Station, and Region One, Missoula, MT. 295 pp.

Cooper, S. V., K. E. Neiman, R. Steele, and D. W. Roberts. 1987. Forest habitat types of northern Idaho:

A second approximation. USDA Forest Service, Intermountain Research Station. General Technical Report INT-236. Ogden, UT. 135 pp. [reprinted in 1991]

Copeland, W. N. 1980. The Lawrence Memorial Grassland Preserve, a biophysical inventory with management recommendations. June 1980. Unpublished report prepared by The Nature Conservancy Field Office, Portland, Oregon. 161 pp.

Costello, D. F., and H. E. Schwan. 1946. Conditions and trends on ponderosa pine ranges in Colorado. USDA Forest Service Mimeograph. 33 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.

Crane, M. F. 1982. Fire ecology of Rocky Mountain Region forest habitat types. USDA Forest Service final report. 272 pp.

Crawford, R. C. 2001. Initial riparian and wetland classification and characterization of the Columbia Basin in Washington. Prepared for Environmental Protection Agency and Bureau of Land Management, Spokane District. Washington Natural Heritage Program, Washington Department of Natural Resources, Olympia. 83 pp.

Cronquist, A., A. H. Holmgren, N. H. Holmgren, J. L. Reveal, and P. K. Holmgren. 1977. Intermountain flora: Vascular plants of the Intermountain West, U.S.A. Volume 6: The Monocotyledons. Columbia University Press, New York. 584 pp.

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. USDA Forest Service, Pacific Northwest Region. Technical Paper R6-NR-ECOL-TP-22-97.

Crowe, E., B. Kovalchik, M. J. Kerr, J. Titus, and J. S. Kagan. 2002. Riparian and wetland plant communities of eastern Oregon. Draft report. Oregon Natural Heritage Information Center, Portland, OR.

Currie, P. O. 1975. Grazing management of ponderosa pine–bunchgrass ranges of the central Rocky Mountains: The status of our knowledge. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-159. Fort Collins, CO. 24 pp.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecological Monographs 22(4):301–330.

——. 1975. Floristic plant geography of eastern Washington and northern Idaho. Journal of Biogeography 2:1–18.

——. 1988. Steppe vegetation of Washington. Washington State University Cooperative Extension Service Publication EB1446. (Revised from and replaces Washington Agricultural Experiment Station Publication XT0062.) 131 pp.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62. 131 pp.

Daubenmire, R. F., and J. B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Washington State University Agricultural Experiment Station Technical Bulletin No. 60. 104

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. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-131. Fort Collins, CO. 59 pp.

Dean, M. L. 1960. A taxonomic and ecologic study of the vascular plants of a section of the Owyhee River Canyon in Oregon. M.S. thesis, Oregon State University, Corvallis.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin. 25 pp.

Dick-Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque. 244 pp.

Dillinger, K. C. 1970. Evaluation of mule deer habitat in Mesa Verde National Park. Unpublished thesis, Colorado State University, Fort Collins. 40 pp.

Donart, G. B., D. D. Sylvester, and W. C. Hickey. 1978. Potential natural vegetation–New Mexico. New Mexico Interagency Range Commission Report 11.

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

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., M. Bradley, E. Muldavin, and P. Mehlhop. 1994. A riparian/wetland vegetation community classification of New Mexico: Pecos River Basin. Unpublished report for New Mexico Environment Department Surface Water Quality Bureau.

——. 1995. Riparian/wetland vegetation community classification of Rio Grande: A classification and site evaluation. Unpublished report for New Mexico Environment Department Surface Water Quality Bureau. New Mexico Natural Heritage Program, Albuquerque.

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.

Eddleman, L. E., and R. Jaindl. 1994. Great Basin National Park vegetation analysis. USDI National Park Service Technical Report NPS/PNROSU/NRTR-94/02. USDI National Park Service, Pacific Northwest Region. 110 pp.

Ellis, S., and P. Hackney. 1981. Vegetation baseline report: Clear Creek property. Unpublished report prepared for Chevron Shale Oil Co., Denver, CO, by Environmental Research and Technology Inc., Fort Collins, CO.

Englund, S. R. 2004. *Bromus tectorum* impacts soil carbon storage in semiarid grasslands of Canyon-

lands 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.

——. 1969. Pinyon-juniper succession after fires on residual soils of the Mesa Verde, Colorado. Unpublished dissertation, University of Colorado, Boulder. 81 pp.

——. 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 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.

——. 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.

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. USDA Forest Service, General Technical Report INT-215. Intermountain Research Station, Ogden, UT.

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 [07-20-01].

Faber-Langendoen, D., ed. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. plus appendix (705 pp.).

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.

Fisser, H. G. 1970. Exclosure studies with transects of permanent plots, 1969 results. University of Wyoming Cooperative Research Report to the USDI Bureau of Land Management, sections I–IV. Wyoming Agricultural Experiment Station. Science Report 240. Laramie, WY. 128 pp.

Fisser, H. G., J. R. Wight, J. R. Flesland, and L. D. Robinson. 1965. Halogeton research, 1964 results. University of Wyoming Cooperative Research Report to the USDI Bureau of Land Management, Sections I–VI. Wyoming Agricultural Experiment Station. Mimeographed Circular pages 1–82. University of Wyoming, Laramie.

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. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-145. 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, ed. 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., ed. 2003. Ancient piñon-juniper woodlands: A natural history of Mesa Verde country. Boulder: University Press of Colorado.

Francis, R. E. 1983. Sagebrush-steppe habitat types in northern Colorado: A first approximation. Pages 67–71 *in* Proceedings of the workshop on southwestern habitat types, 6–8 April 1983, Albuquerque, NM. USDA Forest Service, Southwestern Region, Albuquerque, NM.

——. 1986. Phyto-edaphic communities of the Upper Rio Puerco Watershed, New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-272. 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.

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.

Ganskopp, D. C. 1979. Plant communities and habitat types of the Meadow Creek Experimental Watershed. Unpublished thesis, Oregon State University, Corvallis. 162 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.

Hall, F. C. 1967. Vegetation–soil relations as a basis for resource management on the Ochoco National Forest of central Oregon. Unpublished dissertation, Oregon State University, Corvallis. 207 pp.

——. 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, 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.

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

——. 2004b. 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.

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., and J. B. Hall. 2002. Classification and management of the USDI Bureau of Land Management's riparian and wetland sites in eastern and southern Idaho. Unpublished draft prepared for the Upper Snake River District, Bureau of Land Management, by Bitterroot Restoration, Inc., Corvallis, MT.

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.

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.

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.

Henderson, J. S., and M. L. McAllister. 1983. Downey Lake, an inventory of vegetation and wildlife. The Nature Conservancy, Portland, OR.

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.

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.

Hoffman, G. R., and R. R. Alexander. 1976. Forest vegetation of the Bighorn Mountains, Wyoming: A habitat type classification. USDA Forest Service Research Paper RM-170. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 38 pp.

——. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-221. Fort Collins, CO. 41 pp.

——. 1983. Forest vegetation of the White River National Forest in western Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-249. Fort Collins, CO. 36 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.

Holmstead, G. 2001. Vegetation of the Snake River corridor in Hells Canyon-Weiser, Idaho to the Salmon River. Technical Report Appendix E.3.3-1 prepared for FERC License No. 1971, Hells Canyon Complex by Idaho Power Company, Boise, ID. 49 pp. plus appendices.

IDCDC [Idaho Conservation Data Center]. 2002. Unpublished riparian and wetland association occurrence and plot data on file at the Idaho Conservation Data Center, Idaho Department of Fish and Game, Boise, ID.

——. 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., 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. USDA Forest Service, Rocky Mountain Research Station. General Technical Report RMRS-GTR-20. Ogden, UT. 141 pp.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province Wallowa-Whitman National Forest. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. Technical Paper R6-ECOL-TP-255A-86. 399 pp. plus appendices.

Johnson, C. G., and S. A. Simon. 1985. Plant associations of the Wallowa Valley Ranger District, Part II: Steppe. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. 258 pp.

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.

Jones, G. 1992. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

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. P., and W. Fertig. 1996. Plant associations and plant species of special concern in the Jack Morrow Hills ecosystem. Unpublished report prepared for the Bureau of Land Management, Rock Springs District by the Wyoming Natural Diversity Database. 2 volumes.

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.

Kagan, J. S., J. A. Christy, M. P. Murray, and J. A. Titus. 2000. 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 pat-

terns of sexual reproduction in a northern mixed-grass prairie. The American Midland Naturalist 141:227–237.

Kartesz, J. T. 1994. 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.

Keammerer, W. R. 1974. 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, CO.

Keammerer, W. R. 1977. Final report: Vegetation baseline studies, oil shale tract C-b. Unpublished report. Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 183 pp.

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.

Kierstead, J., and T. Pogson. 1976. A summer flora of the Alvord Basin. Appendix 1. Pages 1-1 to 1-54 *in* K. Roberts, ed., 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., 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., E. Van Wie, and M. Damm. 1997. 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., 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, 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.

Knight, D. H., R. J. Hill, and A. T. Harrison. 1976. Potential natural landmarks in the Wyoming Basin, terrestrial and aquatic ecosystems. Unpublished report prepared for the USDI National Park Service. Contract 9900X20047.

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., 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.

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. USDA Forest Service. Research Paper RM-163. 65 pp.

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.

Kudray, G., P. Hendricks, E. Crowe, and S. Cooper. 2004. Riparian forests of the Wild and Scenic Missouri River: Ecology and management. Report to the Lewistown Field Office, Bureau of Land Management. Montana Natural Heritage Program, Helena, MT. 29 pp. plus appendices.

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.

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.

Lesica, P., and R. L. DeVelice. 1992. Plant communities of the Pryor Mountains. Preliminary report prepared by the Montana Natural Heritage Program, Helena, MT.

MTNHP [Montana Natural Heritage Program]. 1988. Draft guide to the natural vegetation of Montana. Montana Natural Heritage Program, Helena. 389 pp.

——. 2002. List of ecological communities for Montana. Montana Natural Heritage Program, Montana State Library, Helena, MT.

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.

——. 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. 1973. 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.

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.

Mauk, R. L., and J. A. Henderson. 1984. Coniferous forest habitat types of northern Utah. USDA Forest Service. General Technical Report INT-170. Intermountain Forest and Range Experiment Station, Ogden, UT. 89 pp.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia, and their relationships to soils. Ecological Monographs **40**(4):403–424.

Midwestern Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Minneapolis, MN.

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, ed., Proceedings: Pinyon-juniper conference, Reno, NV, 13–16 January 1986. USDA Forest Service, Intermountain Forest and Range Experiment Station. General Technical Report. Ogden, UT. 581 pp.

Mueggler, W. F., and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. USDA Forest Service, General Technical Report INT-66. Intermountain Forest and Range Experiment Station. Ogden, UT. 154 pp.

Muldavin, E. 1991. Riparian and wetlands survey, Pecos National Historic Park. Unpublished report prepared for the National Park Service, New Mexico Natural Heritage Program, University of New Mexico, Albuquerque. 30 pp.

——. 1994. Organ Mountains sensitive species and plant community inventory. Unpublished report prepared by the New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E., Y. Chauvin, and G. Harper. 2000a. Vegetation of White Sands Missile Range, New Mexico: Volume I. Handbook of vegetation communities. Final Report to White Sands Missile Range by New Mexico Natural Heritage Program, University of New Mexico, New Mexico. 192 pp.

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. USDA Forest Service General Technical Report RM-GTR-287. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 130 pp.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000b. 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., G. Harper, P. Neville, and Y. Chauvin. 1998. 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., 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., P. Mehlhop, and E. DeBruin. 1994. 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.

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.

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.

NatureServe 2007. International ecological classification standard: Terrestrial ecological classifications. NatureServe Central Databases. Arlington, VA. USA. Data current as of 7 May 2007.

NDNHI [North Dakota Natural Heritage Inventory]. No date. Vegetation classification of North Dakota. North Dakota Natural Heritage Inventory, North Dakota Parks & Recreation Department, Bismarck.

NVNHP [Nevada Natural Heritage Program]. 2003. National Vegetation Classification for Nevada. Nevada Natural Heritage Program, Department of Conservation and Natural Resources, Carson City. 26 September 2003.

Naumann, T. Personal communication. Botanist, National Park Service, Dinosaur National Monument, Dinosaur, CO.

Northcutt, B. E. 1978. The plant ecology of Butler Wash, southeastern Utah. Unpublished thesis, University of Colorado, Boulder. 118 pp.

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.

Padgett, W. G. 1981. Ecology of riparian plant communities in southern Malheur National Forest. M.S. thesis. Oregon State University, Corvallis. 143 pp.

——. 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. 1988. Riparian community type classification of Utah. USDA Forest Service, Intermountain Region Publication R4-ECOL-88-01. Ogden, UT.

——. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

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.

Pfister, R. D. 1977. Ecological classification of forest land in Idaho and Montana. Pages 329–358 *in* Proceedings of Ecological Classification of Forest Land in Canada and Northwestern USA, University of British Columbia, Vancouver.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service. General Technical Report INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT. 174 pp.

Pieper, R. D. 1968. Comparison of vegetation on grazed and ungrazed pinyon-juniper grassland sites in south-central New Mexico. Journal of Range Management **21**:51–53.

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.

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.

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.

Sawyer, J. O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento. 471 pp.

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.

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.

Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver.

Steele, R., R. D. Pfister, R. A. Ryker, and J. A. Kittams. 1981. Forest habitat types of central Idaho. USDA Forest Service General Technical Report INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT. 138 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.

Stewart, B. K. 1940. Plant ecology and paleoecology of the Creede Valley, Colorado. Unpublished dissertation, University of Colorado, Boulder. 154 pp.

Stoddart, L. A. 1941. The palouse grassland association in northern Utah. Ecology **22**(2):158–163.

Strong, L. L. 1980. Estimating phytomass production of habitat types on sagebrush steppe. Unpublished thesis, Colorado State University, Fort Collins. 133 pp.

Stuever, M. C., and J. S. Hayden. 1997a. Plant associations of Arizona and New Mexico. Volume 2: Woodlands. USDA Forest Service, Southwestern Region, Habitat Typing Guides. 196 pp.

——. 1997b. Plant associations of Arizona and New Mexico. Edition 3. Volume 1: Forests. USDA Forest Service, Southwestern Region. Habitat Typing Guides. 291 pp.

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. 1979. 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.

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 Moun-

tain 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. USDA Forest Service. General Technical Report RM-GTR-263. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 60 pp.

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.

Thorne Ecological Institute. 1973. Environmental setting of the Parachute Creek Valley: An ecological inventory. Unpublished report prepared for Colony Development Operations, Atlantic Richfield Company, by Thorne Ecological Institute, Boulder, CO. [Veg.: pages 36–40, map].

Tiedemann, J. A. 1978. Phyto-edaphic classification of the Piceance Basin. Unpublished dissertation, Colorado State University, Fort Collins. 281 pp.

Tiedemann, J. A., R. E. Francis, C. Terwilliger, Jr., and L. H. Carpenter. 1987. Shrub-steppe habitat types of Middle Park, Colorado. USDA Forest Service Research Paper RM-273. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 20 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.

Tisdale, E. W., and A. McLean. 1957. The Douglas fir zone of southern British Columbia. Ecological Monographs **27**:247–266.

Tisdale, E. W., and M. Hironaka. 1981. The sagebrush-grass region: A review of the ecological literature. University of Idaho Forest, Wildlife, and Range Experiment Station Bulletin 33, Contribution 29. Moscow. 31 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.

Trammel, M. A., and J. L. Butler. 1995. Effects of exotic plants on native ungulate use of habitat. Journal of Wildlife Management **59**:804–815.

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.

USFS [U.S. Forest Service]. 1937. Range plant handbook. Dover Publications Inc., New York. 816 pp.

——. 1983. TES-4, Coyote Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

——. 1985. 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.

——. 1985. TES-3, western part Rio Arriba County. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

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.

Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota. USDI Bureau of Reclamation. Technical Memorandum No. 8260-99-02. Denver, CO.

Von Loh, J., D. Cogan, D. J. Butler, D. Faber-Langendoen, D. Crawford, and M. J. Pucherelli. 2000. USGS-NPS Vegetation Mapping Program, Theodore Roosevelt National Park, North Dakota. USBR Technical Service Center. U.S. Department of the Interior, Bureau of Reclamation's Remote Sensing and GIS Group, Denver Federal Center, Denver, CO.

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.

WNHP [Washington Natural Heritage Program]. No date. Unpublished data files. Washington Natural Heritage Program, Department of Natural Resources, Olympia, WA.

Walker, G. R., and J. D. Brotherson. 1982. Habitat relationships of basin wildrye in the high mountain valleys of central Utah. Journal of Range Management **35**(5):628–633.

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.

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.

Western Ecology Working Group of NatureServe. No date. International Ecological Classification Standard: International Vegetation Classification. Terrestrial Vegetation. NatureServe, Boulder, CO.

Williams, C. S. 1961. Distribution of vegetation in the Wind River Canyon, Wyoming. Unpublished thesis, University of Wyoming, Laramie.

Wright, H. A. 1972. Shrub response to fire. Pages 204–217 *in* Wildland shrubs: Their biology and utilization. USDA Forest Service. General Technical Report INT-1.

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. USDA Forest Service General Technical Report INT-58. Intermountain Forest and Range Experiment Station. Ogden, UT.

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.

——. 1978. Population dynamics after wildfires in sagebrush grasslands. Journal of Range Management **31**:283–289.

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.

——. 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. USDA Forest Service, Intermountain Research Station. General Technical Report INT-187. Ogden, UT. 89 pp.

Zamora, B. A. 1983. Forest habitat types of the Spokane Indian Reservation. Agricultural Research Center, Washington State University Research Bulletin XB-0936-1983.

Zamora, B., and P. T. Tueller. 1973. *Artemisia arbuscula*, *A. longiloba*, and *A. nova* habitat types in northern Nevada. Great Basin Naturalist **33**(4):225–242.

Zimmerman, U. D. 1967. Response of a grassland to disturbance in northeastern New Mexico. Unpublished thesis, New Mexico State University, Las Cruces. 30 pp.

Appendix D
Plant Species List

This species list was compiled from plants observed on the classification relevés and accuracy assessment sites during the Mesa Verde National Park vegetation mapping project. Locations for each plant are recorded in the respective databases for these field efforts.

Two hundred ninety-two species were collectively found during both field events, representing 54 different plant families. Asteraceae was represented by the most species (79), followed by Poaceae (24 species), Brassicaceae (22 species), and Fabaceae (22 species). Twenty families were represented by only one species. Thirty species were non-native.

The fields in the following table, and their contents and sources, are:

- Family and Scientific names: The taxonomic name for the plant according to the Integrated Taxonomic Information System (ITIS, http://www.itis.gov) at the time of the field work.
- Common Name: The common name for the plant according to ITIS. In some cases, the ITIS common name is not the common name used regionally or by NatureServe. Where that is the case, we have included regional and common names used in this document.
- TSN code: The ITIS Taxonomic Serial Number (TSN), accessed July 2007.
- Non-native: Plants that are listed as non-native by the USDA PLANTS Database (http://plants.usda.gov/) are indicated.

Scientific name	Common name	Family name	TSN code	Non-native
Acer negundo	ashleaf maple	Aceraceae	28749	
Achillea millefolium	bloodwort	Asteraceae	35423	
Achillea millefolium var. *occidentalis*	common yarrow	Asteraceae	526856	
Achnatherum hymenoides	Indian ricegrass	Poaceae	507943	
Acroptilon repens	hardheads	Asteraceae	36459	
Agropyron desertorum	clustered wheatgrass	Poaceae	40372	X
Agrostis sp.	bentgrass	Poaceae	40389	
Allium acuminatum	tapertip onion	Liliaceae	42707	
Alyssum alyssoides	pale alyssum	Brassicaceae	23030	X
Alyssum minus var. *micranthum*	European madwort	Brassicaceae	531468	
Alyssum sp.	alyssum	Brassicaceae	23029	
Amaranthus sp.	pigweed	Amaranthaceae	20715	
Ambrosia sp.	bursage	Asteraceae	36495	
Amelanchier sp.	serviceberry	Rosaceae	25108	
Amelanchier utahensis	Utah serviceberry	Rosaceae	25121	
Androsace septentrionalis	northern rockjasmine	Primulaceae	23935	
Antennaria parvifolia	little-leaf pussytoes	Asteraceae	36749	
Arabis drummondii	Drummond's rockcress	Brassicaceae	22689	
Arabis holboellii	Holboell's rockcress	Brassicaceae	22702	
Arabis selbyi	Selby's rockcress	Brassicaceae	22731	
Arenaria congesta	ballhead sandwort	Caryophyllaceae	20243	
Arenaria congesta var. *congesta*	ballhead sandwort	Caryophyllaceae	184218	
Artemisia dracunculus	false tarragon	Asteraceae	35462	
Artemisia frigida	fringed sagebrush	Asteraceae	35465	
Artemisia ludoviciana	cudweed sagewort	Asteraceae	35474	
Artemisia nova	black sagebrush	Asteraceae	500971	
Artemisia sp.	wormwood	Asteraceae	35431	
Artemisia tridentata	big sagebrush	Asteraceae	35498	
Artemisia tridentata ssp. *tridentata*	big sagebrush	Asteraceae	35499	
Asclepias speciosa	showy milkweed	Asclepiadaceae	30304	
Asclepias subverticillata	horsetail milkweed	Asclepiadaceae	30308	
Aster sp.	aster	Asteraceae	35510	
Astragalus bisulcatus	two-grooved milkvetch	Fabaceae	25438	
Astragalus lentiginosus	freckled milkvetch	Fabaceae	25559	
Astragalus lonchocarpus	great rushy milkvetch	Fabaceae	25567	
Astragalus pattersonii	Patterson's milkvetch	Fabaceae	25625	
Astragalus schmolliae	Schmoll's milkvetch	Fabaceae	25668	
Astragalus scopulorum	Rocky Mountain milkvetch	Fabaceae	25670	
Astragalus sp.	locoweed	Fabaceae	25392	
Astragalus wingatanus	Fort Wingate milkvetch	Fabaceae	25727	
Atriplex canescens	fourwing saltbush	Chenopodiaceae	20518	
Atriplex confertifolia	shadscale	Chenopodiaceae	20519	
Balsamorhiza sagittata	arrowleaf balsamroot	Asteraceae	36818	
Bouteloua gracilis	blue grama	Poaceae	41493	
Brickellia californica	California brickellbush	Asteraceae	36866	
Brickellia grandiflora	mountain brickellbush	Asteraceae	36878	

Scientific name	Common name	Family name	TSN code	Non-native
Brickellia sp.	brickellbush	Asteraceae	36859	
Bromus anomalus (*Bromus porteri*[3])	nodding bromegrass	Poaceae	565860	
Bromus inermis	awnless brome smooth brome[1]	Poaceae	40502	X
Bromus tectorum	cheatgrass	Poaceae	40524	X
Calochortus gunnisonii	Gunnison mariposa lily	Liliaceae	42849	
Calochortus nuttallii	sego lily	Liliaceae	42863	
Cardaria draba	whiteweed	Brassicaceae	23072	X
Carduus nutans	chardon penche musk thistle[1]	Asteraceae	35787	X
Carduus nutans ssp. *macrolepis*	nodding thistle	Asteraceae	523745	X
Carex geyeri	Geyer's sedge	Cyperaceae	39613	
Carex inops ssp. *heliophila*	sun sedge	Cyperaceae	523761	
Carex occidentalis	western sedge	Cyperaceae	39726	
Castilleja applegatei ssp. *martinii*	desert Indian paintbrush	Scrophulariaceae	525154	
Castilleja linariifolia	Wyoming Indian paintbrush	Scrophulariaceae	33138	
Centaurium exaltatum	desert centaury	Gentianaceae	30030	
Ceratocephala testiculata	bur buttercup	Ranunculaceae	501365	X
Cercocarpus intricatus	littleleaf mountain mahogany	Rosaceae	25133	
Cercocarpus montanus	alderleaf cercocarpus	Rosaceae	25136	
Chaenactis douglasii	dusty-maiden	Asteraceae	36987	
Chaetopappa ericoides	rose heath	Asteraceae	501376	
Chamaesyce fendleri	Fendler's sandmat	Euphorbiaceae	501419	
Chenopodium fremontii	Fremont goosefoot	Chenopodiaceae	20607	
Chenopodium sp.	goosefoot	Chenopodiaceae	20589	
Chrysothamnus depressus	dwarf rabbitbrush	Asteraceae	37051	
Chrysothamnus greenei	Greene rabbitbrush	Asteraceae	37052	
Chrysothamnus linifolius	spearleaf rabbitbrush	Asteraceae	37054	
Cirsium arvense	field thistle	Asteraceae	36335	X
Cirsium calcareum	Cainville thistle	Asteraceae	36346	
Cirsium sp.	thistle	Asteraceae	36334	
Cirsium undulatum	wavyleaf thistle	Asteraceae	36423	
Cirsium undulatum var. *tracyi*	gray thistle	Asteraceae	527386	
Cirsium vulgare	bull thistle	Asteraceae	36428	X
Clematis ligusticifolia	virgin's bower	Ranunculaceae	18702	
Collomia grandiflora	large-flowered collomia	Polemoniaceae	31037	
Comandra umbellata	bastard toadflax	Santalaceae	501614	
Convolvulus arvensis	creeping jenny bindweed[1]	Convolvulaceae	30705	X
Conyza canadensis	Canada horseweed	Asteraceae	37113	
Crepis acuminata	tapertip hawksbeard	Asteraceae	37169	
Crepis acuminata ssp. *acuminata*	tapertip hawksbeard	Asteraceae	37170	
Crepis sp.	hawksbeard	Asteraceae	37168	
Cryptantha ambigua	Wilkes cryptantha	Boraginaceae	31783	
Cryptantha bakeri	Baker catseye	Boraginaceae	31786	
Cryptantha sp.	cryptantha species	Scrophulariaceae	31765	

Scientific name	Common name	Family name	TSN code	Non-native
Dactylis glomerata	cocksfoot orchard grass[1]	Poaceae	193446	X
Delphinium nuttallianum	low larkspur	Ranunculaceae	18483	
Descurainia pinnata	western tansymustard	Brassicaceae	22826	
Descurainia sophia	flaxweed tansymustard	Brassicaceae	22843	X
Descurainia sp.	tansy mustard	Brassicaceae	22819	
Draba cuneifolia	wedgeleaf draba	Brassicaceae	22874	
Draba reptans	creeping draba	Brassicaceae	22908	
Dracocephalum parviflorum	American dragonhead	Lamiaceae	32490	
Echinocereus fendleri	Fendler cactus	Cactaceae	19809	
Elaeagnus angustifolia	oleaster Russian olive[1]	Elaeagnaceae	27770	X
Elymus elymoides	bottlebrush squirreltail	Poaceae	502264	
Elymus trachycaulus	slender wheatgrass	Poaceae	502282	
Elymus trachycaulus ssp. *trachycaulus*	slender wheatgrass	Poaceae	524041	
Ephedra sp.	jointfir	Ephedraceae	183496	
Ephedra torreyana	Torrey's ephedra	Ephedraceae	502318	
Ephedra viridis	green ephedra	Ephedraceae	502319	
Equisetum laevigatum	horsetail	Equisetaceae	17156	
Ericameria nauseosa	goldenbush rubber rabbitbrush[2]	Asteraceae	507594	
Ericameria nauseosa ssp. *nauseosa* var. *nauseosa*	gray rabbitbrush	Asteraceae	566645	
Erigeron divergens	spreading daisy	Asteraceae	35852	
Erigeron engelmannii	Engelmann's fleabane	Asteraceae	35859	
Erigeron sp.	daisy	Asteraceae	35803	
Erigeron speciosus	Oregon fleabane	Asteraceae	35950	
Erigeron speciosus var. *speciosus*	aspen daisy	Asteraceae	527964	
Erigeron utahensis	Utah fleabane	Asteraceae	35967	
Eriogonum alatum	wind wild buckwheat	Polygonaceae	21057	
Eriogonum corymbosum	corymbed buckwheat crispleaf wild buckwheat[2]	Polygonaceae	21103	
Eriogonum fasciculatum	yellow buckwheat	Polygonaceae	21132	
Eriogonum jamesii	James buckwheat	Polygonaceae	21167	
Eriogonum leptophyllum	slender-leaf buckwheat	Polyganaceae	21180	
Eriogonum racemosum	redroot buckwheat	Polygonaceae	21230	
Eriogonum umbellatum	sulphur-flower buckwheat	Polygonaceae	21266	
Eriogonum umbellatum var. *cognatum*	sulphur-flower buckwheat	Polygonaceae	195601	
Erodium cicutarium	alfilaree	Geraniaceae	29147	X
Erysimum sp.	wallflower	Brassicaceae	22926	
Eurybia glauca	gray aster gray wood-aster[2]	Asteraceae	513443	
Fallugia paradoxa	Apache plume	Rosaceae	25167	
Fendlera rupicola	cliff fendlerbush	Hydrangeaceae	24331	
Fragaria vesca	woodland strawberry	Rosaceae	24634	
Gaillardia sp.	blanketflower	Asteraceae	37395	
Galium coloradoense	Colorado bedstraw	Rubiaceae	34847	
Galium sp.	bedstraw	Rubiaceae	34796	

Scientific name	Common name	Family name	TSN code	Non-native
Galium stellatum	starry bedstraw	Rubiaceae	34927	
Gilia haydenii	San Juan Gilia	Polemoniaceae	31124	
Gilia sinuata	rosy gilia	Polemoniaceae	31088	
Glycyrrhiza lepidota	American licorice	Fabaceae	26719	
Grindelia arizonica	Arizona gumweed	Asteraceae	37442	
Grindelia arizonica var. *stenophylla*	Arizona gumweed	Asteraceae	528272	
Grindelia squarrosa var. *serrulata*	curly-cup gumweed	Asteraceae	528288	
Gutierrezia microcephala	threadleaf snakeweed	Asteraceae	37482	
Gutierrezia sarothrae	broom snakeweed	Asteraceae	37483	
Hackelia gracilenta	Mesa Verde stickseed	Boraginaceae	502863	
Halogeton glomeratus	saltlover	Chenopodiaceae	20692	X
Hedysarum boreale	boreal sweetvetch	Fabaceae	26724	
Helianthella quinquenervis	five-nerve heilanthella	Asteraceae	37597	
Helianthus annuus	annual sunflower	Asteraceae	36616	
Helianthus petiolaris	prairie sunflower	Asteraceae	36671	
Heliomeris multiflora	showy goldeneye	Asteraceae	37603	
Hesperostipa comata ssp. *comata*	needle-and-thread	Poaceae	525116	
Heterotheca villosa	hairy false goldaster	Asteraceae	37689	
Heuchera parvifolia	littleleaf alumroot	Saxifragaceae	24366	
Heuchera parvifolia var. *flavescens*	littleleaf alumroot	Saxifragaceae	528420	
Hordeum jubatum	foxtail barley	Poaceae	40871	
Hymenopappus filifolius	fineleaf hymenopappus	Asteraceae	37766	
Hymenopappus filifolius var. *lugens*	Idaho hymenopappus	Asteraceae	528521	
Hymenoxys richardsonii	Colorado rubberweed	Asteraceae	37785	
Ipomopsis aggregata	skyrocket gilia	Polemoniaceae	31192	
Iva xanthifolia	burweed marshelder	Asteraceae	36041	
Juncus arcticus	Arctic rush	Juncaceae	39222	
Juncus arcticus ssp. *littoralis* (*Juncus balticus* var. *littoralis*[3])	Baltic rush	Juncaceae	525995	
Juncus balticus var. *montanus*	mountain rush	Juncaceae	528598	
Juniperus monosperma	one-seed juniper	Cupressaceae	194853	
Juniperus osteosperma	Utah juniper	Cupressaceae	194859	
Juniperus scopulorum	Enebro riparío Rocky Mountain juniper[2]	Cupressaceae	194872	
Koeleria macrantha	junegrass	Poaceae	503284	
Krascheninnikovia lanata	winterfat	Chenopodiaceae	503290	
Lactuca serriola	China lettuce	Asteraceae	36608	X
Lappula occidentalis var. *occidentalis*	desert stickseed	Boraginaceae	528678	
Lathyrus lanszwertii var. *leucanthus*	Nevada pea	Fabaceae	528691	
Lathyrus pauciflorus	few-flower pea	Fabaceae	25867	
Lepidium latifolium	Virginia pepperweed	Brassicaceae	503379	X
Lepidium montanum	Montana pepperweed	Brassicaceae	503381	
Lepidium perfoliatum	clasping pepperweed	Brassicaceae	22974	X
Lepidium sp.	pepperweed	Brassicaceae	22953	
Lesquerella fendleri	Fendler's bladderpod	Brassicaceae	23180	
Lesquerella rectipes	straight bladderpod	Brassicaceae	23224	
Leymus cinereus	basin wildrye	Poaceae	503433	

Scientific name	Common name	Family name	TSN code	Non-native
Lithospermum ruderale	western gromwell	Boraginaceae	31953	
Lomatium dissectum	fernleaf biscuitroot	Apiaceae	503534	
Lomatium grayi	Gray's biscuitroot	Apiaceae	29707	
Lomatium simplex var. *simplex*	Great Basin desert parsley	Apiaceae	528884	
Lotus sp.	trefoil	Fabaceae	26361	
Lupinus ammophilus	sand lupine	Fabaceae	25933	
Lupinus brevicaulis	shortstem lupine	Fabaceae	503576	
Lupinus caudatus	tailcup lupine	Fabaceae	25981	
Lupinus caudatus ssp. *cutleri*	Cutler's spurred lupine	Fabaceae	25984	
Lupinus sp.	lupine	Fabaceae	25916	
Lycium andersonii	water jacket	Solanaceae	30532	
Lycium pallidum	pale desert-thorn	Solanaceae	30544	
Lygodesmia grandiflora	rush-pink	Asteraceae	503622	
Machaeranthera bigelovii	Bigelow's machaeranthera	Asteraceae	37980	
Machaeranthera bigelovii var. *bigelovii*	Bigelow's tansyaster	Asteraceae	529066	
Machaeranthera grindelioides	Nuttall tarweed	Asteraceae	37992	
Machaeranthera parviflora	smallflower tansyaster	Asteraceae	38002	
Machaeranthera sp.	goldenweed	Asteraceae	37970	
Mahonia repens	creeping barberry	Berberidaceae	195045	
Maianthemum racemosum ssp. *amplexicaule*	western Solomon's-seal	Liliaceae	524296	
Maianthemum racemosum ssp. *racemosum*	feathery false Solomon's-seal	Liliaceae	524297	
Maianthemum stellatum	false Solomon's seal	Liliaceae	503656	
Mammillaria sp.	pincushion cactus	Cactaceae	19778	
Marrubium vulgare	horehound	Lamiaceae	32561	X
Melilotus alba	white sweetclover	Fabaceae	26149	X
Melilotus officinalis	yellow sweetclover	Fabaceae	26150	X
Mentzelia albicaulis	white blazingstar	Loasaceae	503757	
Mertensia brevistyla	shortstyle bluebells	Boraginaceae	31676	
Mirabilis multiflora	Colorado four o'clock	Nyctaginaceae	19654	
Mirabilis multiflora var. *glandulosa*	Colorado four o'clock	Nyctaginaceae	529219	
Nicotiana attenuata	coyote tobacco	Solanaceae	30571	
Oenothera caespitosa ssp. *marginata*	tufted evening-primrose	Onagraceae	566061	
Opuntia polyacantha	plains pricklypear	Cactaceae	19726	
Opuntia polyacantha var. *polyacantha*	hair-spine pricklypear	Cactaceae	195296	
Opuntia sp.	pricklypear	Cactaceae	19686	
Opuntia tunicata var. *davisii*	Jeff Davis cholla	Cactaceae	195303	
Orthocarpus purpureoalbus	purple owlclover	Scrophulariaceae	33456	
Packera multilobata	lobeleaf groundsel	Asteraceae	518150	
Pascopyrum smithii	pubescent wheatgrass	Poaceae	504124	
Paxistima myrsinites	boxleaf	Celastraceae	504149	
Pedicularis centranthera	dwarf lousewort	Scrophulariaceae	33367	
Penstemon barbatus	beardlip penstemon	Scrophulariaceae	33825	
Penstemon linarioides	creeping penstemon	Scrophulariaceae	33937	
Penstemon linarioides ssp. *coloradoensis*	toadflax penstemon	Scrophulariaceae	33939	
Penstemon strictus	Rocky Mountain beardtongue	Scrophulariaceae	33772	

Scientific name	Common name	Family name	TSN code	Non-native
Peraphyllum ramosissimum	squaw apple	Rosaceae	25270	
Petradoria pumila	rock goldenrod	Asteraceae	38233	
Phacelia heterophylla	wand phacelia	Hydrophyllaceae	504271	
Philadelphus microphyllus	littleleaf mock orange	Hydrangeaceae	24437	
Phleum pratense	timothy	Poaceae	41062	X
Phlox hoodii	spiny phlox	Polemoniaceae	30948	
Phlox hoodii ssp. *canescens*	carpet phlox	Polemoniaceae	30950	
Phlox longifolia	longleaf phlox	Polemoniaceae	30956	
Phlox sp.	phlox	Polemoniaceae	30897	
Phragmites australis	common reed	Poaceae	41072	
Physaria acutifolia	sharpleaf twinpod	Brassicaceae	23270	
Pinus edulis	Colorado piñon two-needle pinyon[2]	Pinaceae	183336	
Pinus ponderosa	blackjack pine ponderosa pine[1]	Pinaceae	183365	
Plantago lanceolata	buckhorn plantain	Plantaginaceae	32874	X
Plantago major	broadleaf plantain	Plantaginaceae	32887	
Plantago sp.	Indianwheat	Plantaginaceae	32870	
Pleuraphis jamesii	galleta James' galleta[2]	Poaceae	507993	
Poa fendleriana	muttongrass	Poaceae	504467	
Poa fendleriana ssp. *longiligula*	muttongrass	Poaceae	526423	
Poa pratensis	Kentucky bluegrass	Poaceae	41088	
Poaceae sp.	grasses	Poaceae	40351	
Polemonium foliosissimum	towering Jacobsladder	Polemoniaceae	31012	
Populus angustifolia	narrowleaf cottonwood	Salicaceae	22452	
Populus fremontii	cottonwood	Salicaceae	22459	
Populus sp.	cottonwood	Salicaceae	22444	
Populus tremuloides	quaking aspen	Salicaceae	195773	
Populus X *acuminata*	lanceleaf cottonwood	Salicaceae	22450	
Prunus virginiana	chokecherry	Rosaceae	24806	
Pseudostellaria jamesiana	sticky starwort	Caryophyllaceae	20358	
Pseudotsuga menziesii	Douglas fir	Pinaceae	183424	
Purshia stansburiana	Stansbury cliffrose	Rosaceae	195901	
Purshia tridentata	antelope bitterbrush bitterbrush[2]	Rosaceae	25290	
Quercus gambelii	Gambel oak	Fagaceae	19337	
Rhus trilobata	skunkbush	Anacardiaceae	28791	
Rhus trilobata var. *trilobata*	skunkbush sumac	Anacardiaceae	530014	
Ribes aureum	golden currant	Grossulariaceae	24452	
Ribes leptanthum	trumpet gooseberry	Grossulariaceae	24479	
Rosa nutkana	Nootka rose	Rosaceae	24835	
Rosa woodsii	Wood's rose	Rosaceae	24847	
Rumex hymenosepalus	canaigre dock	Polygonaceae	20962	
Rumex sp.	dock	Polyganaceae	20933	
Salix exigua	coyote willow	Salicaceae	22529	
Salsola tragus	prickly Russian thistle	Chenopodiaceae	520950	X

Scientific name	Common name	Family name	TSN code	Non-native
Sarcobatus vermiculatus	black greasewood	Chenopodiaceae	20707	
Senecio flaccidus var. *flaccidus*	threadleaf groundsel	Asteraceae	530313	
Sisymbrium altissimum	Jim Hill mustard	Brassicaceae	23312	X
Solanum jamesii	wild potato	Solanaceae	30437	
Solidago canadensis	Canada goldenrod	Asteraceae	36224	
Solidago sp.	goldenrod	Asteraceae	36223	
Solidago velutina	sparse goldenrod	Asteraceae	505290	
Sphaeralcea coccinea	copper mallow	Malvaceae	21920	
Sphaeralcea coccinea ssp. *coccinea*	scarlet globemallow	Malvaceae	21921	
Sphaeralcea sp.	globemallow	Malvaceae	21909	
Sporobolus cryptandrus	sand dropseed	Poaceae	42132	
Stanleya pinnata	desert prince's plume golden prince's plume	Brassicaceae	23329	
Stenotus armerioides var. *armerioides*	thrifty goldenweed	Asteraceae	530563	
Stephanomeria thurberi	Thurber wire lettuce	Asteraceae	38456	
Symphoricarpos oreophilus	mountain snowberry	Caprifoliaceae	35338	
Symphyotrichum falcatum var. *falcatum*	white prairie aster	Asteraceae	566331	
Tamarix chinensis	five-stamen tamarisk	Tamaricaceae	22308	X
Taraxacum officinale	blowball	Asteraceae	36213	X
Tetradymia canescens	gray horsebrush	Asteraceae	38494	
Thalictrum fendleri	Fendler meadowrue	Ranunculaceae	18670	
Toxicodendron rydbergii	western poison ivy	Anacardiaceae	28822	
Tragopogon pratensis	meadow salsify	Asteraceae	38569	X
Trifolium longipes	long-stalk clover	Fabaceae	26270	
Trifolium pratense	red clover	Fabaceae	26313	X
Typha sp.	cattail	Typhaceae	42324	
Verbascum thapsus	common mullein	Scrophulariaceae	33394	
Verbesina encelioides ssp. *exauriculata*	golden crownbeard	Asteraceae	38603	
Viola adunca	hookedspur violet	Violaceae	22032	
Wyethia arizonica	Arizona mulesears	Asteraceae	38676	
Xanthium strumarium	rough cockleburr	Asteraceae	38692	
Xanthium strumarium var. *canadense*	Canada cocklebur	Asteraceae	530872	
Yucca angustissima	narrowleaf yucca	Agavaceae	43131	
Yucca baccata	banana yucca	Agavaceae	43134	
Zigadenus vaginatus	sheathed deathcamas	Liliaceae	505802	

[1] Regional common name
[2] Name used by NatureServe in Appendix C
[3] Taxonomic name for the plant current to July 2007, if the taxonomy for the plant has changed since the field work.

Appendix E
Plant Community and Map Class Key

This plant community and map class key, developed to identify plant communities (NVC associations, alliances, and park specials) and map classes (base, group, and management), was used in the field during accuracy assessment of the Mesa Verde National Park vegetation mapping project. It can be used at Mesa Verde NP in areas of at least 0.5 ha in size (e.g., a circle with a 40-m radius). Most base map classes key to one plant community, but some are aggregations of more than one plant community and may appear in several places in the dichotomous key.

Because the group and management map classes are aggregations of base map classes, they also appear multiple times in the key. The group map classes represent aggregations of the base map classes to the group level of the National Vegetation Classification Standard (FGDC 2008). Terrestrial ecological systems, as described by NatureServe, were used as a first approximation of the group level. The management map classes were developed in consultation with park staff, with the intent of preserving high map accuracy while maintaining base map classes that are of importance to park managers.

The key begins with a lifeform key that separates the observed vegetation or land cover into one of four lifeform types, each with a subkey. The subkeys consist of decision couplets that describe vegetation characteristics and typical geomorphic setting. Vegetation with the same species can separate into different associations or even lifeforms due to differences in cover and/or habitat. Because of this, both parts of the couplet should be considered before proceeding through the key. As is the case with a botanical key, it is often important to follow a the key a few couplets beyond the point where you believe you may have correctly identified a map label or association because you may find a better fit in subsequent steps or gain increased confidence that your initial choice was correct.

Some map labels, such as Sandstone, are based on substrate, where existing vegetation is very sparse. However, the distinction between sparse geomorphic classes and other sparsely vegetated areas is sometimes difficult to discern. If you use the sparse vegetation subkey and get to a substrate-based map class, you may want to also continue in the key to the next most-representative vegetation lifeform and see if there is a better description of the plant community there. Each of the other subkeys has plant communities that are sparse (<10–15%) cover, and may better characterize the site than the sparse, substrate-based map class.

Lifeform Key

1.	Site is a barren or sparsely vegetated (<10%) geomorphic feature, (for example sandstone), or a sparsely vegetated anthropogenic land use type such as rural residential, erosion control, or agriculture. SPARSE VEGETATION (Key A, go to 4)
1.	Site with >10% vegetation, including sites with sparse vegetation and substrate dominated cover. (2)
2.	Site characterized by grasses and forbs. Trees or shrubs may be present, but with <15% cover and less cover than grasses and forbs. HERBACEOUS VEGETATION (Key B, go to 6)
2.	Site characterized by tree and/or shrub cover. If tree or shrub cover is >15% , grasses and forbs may have higher cover than the trees, but the woody plants are given dominance. If tree or shrub cover is <15%, grasses and forbs, if present, must have less cover than either trees or shrubs. (3)
3.	Site characterized by trees, including evergreen and deciduous species. WOODLANDS AND FORESTS (Key C, go to 18)
3.	Site characterized by shrubs. SHRUBLANDS (Key D, go to 34)

Key A: SPARSE VEGETATION

SPARSE VEGETATION: Cover of vascular plants is low, often with <10% total vegetation cover. In some cases, the total vegetation cover may be as high as 25%; however, the geomorphic feature or anthropogenic land use is the dominant feature.

4.	Site characterized by sandstone rock outcrops. Base Map Class: Sandstone Group Map Class: NA Management Map Class: Sandstone Plant community: NA
4.	Site characterized by anthropogenic land use. (5)
5.	Site characterized by land use (map labels and a brief description are included below) a. Agriculture–This map class consists of large-scale and small-scale agricultural use, including farming and livestock activities. b. Artificial Catchment–These are generally small raised catchments that will fill with water depending on seasonal rainfall, developed for ranching or agricultural purposes. c. Erosion Control–These are areas along the main park road where erosion control features have been used to stabilize the soil and restore vegetation. d. Gravel–This map class consists of gravel pits used for park maintenance. e. Park Facilities–This map class consists of National Park Service buildings for a variety of purposes, including visitor use and facility maintenance. f. Paved Roads–This map class consists of the major paved roads. g. Rural Residential–This map class consists of a variety of developments and land owner uses related to private residential development.
5.	Not as above, return to 1 and re-evaluate land cover

Key B: HERBACEOUS VEGETATION

HERBACEOUS VEGETATION: Total vegetation cover is generally >15%; in particularly dry sites, vegetation cover can be as low as 10%. Tree and shrub cover are either <15% or less than the total herbaceous cover combined. Grasses and forbs are the dominant lifeform.

6. Herbaceous vegetation is restricted to wetland environments. (7)

6. Herbaceous cover occurs in upland environments. (8)

7. *Juncus balticus* is the dominant species and forms a thick monoculture. This association occurs at the bottom of Prater and Morefield Canyons.
   Base Map Class: Baltic Rush Herbaceous Vegetation.
   Group Map Class: Rocky Mountain Alpine-Montane Wet Meadow.
   Management Map Class: Mixed Wetland Herbaceous.
   Association: *Juncus balticus* Herbaceous Vegetation.

7. A mix of riparian herbaceous vegetation occurs in areas with permanent, temporary, or intermittent water flow. Species composition and density vary depending on site differences.
   Base Map Class: Mixed Wetland Herbaceous.
   Group Map Class: Rocky Mountain Alpine-Montane Wet Meadow.
   Management Map Class: Mixed Wetland Herbaceous.
   Park Special: Mixed Wetland Herbaceous Vegetation.

8. The herbaceous cover is dominated by non-native species. (9)

8. The herbaceous cover is dominated by native species. (13)

9. The herbaceous cover is dominant. The shrub cover is at least 5%, but never more than 15% and never more than the total herbaceous cover. *Ericameria nauseosa* is the dominant shrub and *Gutierrezia sarothrae* is common. The herbaceous species generally consist of *Bromus inermis*, and *Pascopyrum smithii*. This map class occasionally is found in old agricultural fields.
   Base Map Class: Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation.
   Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
   Management Map Class: Rabbitbrush Shrub Herbaceous Vegetation.
   Park Special: *Ericameria nauseosa* / *Bromus inermis (Pascopyrum smithii)* Shrub Herbaceous

9. Shrub cover is less than half of the total herbaceous cover. (10)

10. *Bromus inermis* is the dominant species and forms a mostly homogenous stand. In some areas, *Pascopyrum smithii* can occur in the herbaceous layer and sometimes can even co-dominate the vegetation cover. All other herbaceous species have a low cover (<5%). This map class occurs in areas without evidence of fire and all areas were surveyed on the valley floor and/or on alluvial flats.
    Base Map Class: Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Rabbitbrush Shrub Herbaceous Vegetation.
    Association: *Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation.

10. Dominant herbaceous cover not as above. (11)

11. *Bromus tectorum* is the dominant species or is co-dominant with *Pascopyrum smithii*. *Bromus tectorum* is dense and has at least 25% of the total vegetation cover. This map class generally is the result of a wildfire. *Carduus nutans* ssp. *macrolepis*, a non-native forb, can occur with high cover, but never dominates the total vegetation cover. Tree cover is low (<5%) and shrubs are either absent or have up to 15% cover.
    Base Map Class: Cheatgrass Semi-natural Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Disturbed Semi-Natural Vegetation.
    Association: *Bromus tectorum* Semi-natural Herbaceous Vegetation.

11. Dominant herbaceous cover not as above. (12)

12. This map class always occurs in unburned areas and contains a mix of non-native herbaceous forbs and grasses. The most frequent species include, but are not limited to *Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*, *Melilotus officinalis*, *Pascopyrum smithii*, and *Hesperostipa comata*.
    Base Map Class: Mixed Weedy Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Rabbitbrush Shrub Herbaceous Vegetation.
    Park Special: Mixed Weedy Herbaceous Vegetation.

12. This map class always occurs in burned areas. The vegetation consists of a mix of herbaceous species, including native and non-native forbs and grasses. The most frequent species include, but are not limited to *Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*, *Heliomeris multiflora*, *Penstemon linarioides* ssp. *coloradoensis*, *Poa fendleriana* ssp. *longiligula* and *Sphaeralcea coccinea* ssp. *coccinea*. In some of these disturbed areas a single species may dominate or have a particularly high cover and may include, but are not limited to: *Elymus trachycaulus* ssp. *trachycaulus*, *Balsamorhiza sagittata*, *Melilotus officinalis*, *Pascopyrum smithii*, and *Hesperostipa comata*. Tree and shrub cover may occur in this map class and can have up to 20% cover.
    Base Map Class: Post-Fire Mixed Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Disturbed Semi-Natural Vegetation.
    Park Special: Post-Fire Mixed Herbaceous Vegetation.

13. This map class describes a mix of annual and perennial herbaceous species restricted to Mancos Shale. *Stanleya pinnata*, a native forb, often occurs in trace amounts in the herbaceous layer and can act as an indicator species for this map class. Other herbaceous species occurring in this association may include *Astragalus lonchocarpus*, *Astragalus pattersonii*, *Eriogonum umbellatum*, and *Gilia haydenii.* A tree layer of *Pinus edulis, Juniperus osteosperma,* or *Juniperus scopulorum* may occur with <10% cover. The area may have evidence of *Ips* sp. bark beetle infestations. Very low shrub cover can occur, most commonly including *Amelanchier utahensis*.
    Base Map Class: Mancos Shale Herbaceous Vegetation.
    Group Map Class: Mancos Shale Vegetation.
    Management Map Class: Colorado Plateau Mixed Bedrock Canyon and Tableland.
    Park Special: *Stanleya pinnata* Shale Herbaceous Vegetation.

13. Dominant herbaceous cover not as above. (14)

14. *Leymus cinereus* is the dominant species and occurs in dense monocultures. Other herbaceous species in this map class occur only in trace amounts.
    Base Map Class: Basin Wildrye Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Big Sagebrush Shrubland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Leymus cinereus* Herbaceous Vegetation.

14. Dominant herbaceous cover not as above. (15)

15. *Bouteloua gracilis* is the dominant herbaceous species. Other herbaceous species can occur, including *Hesperostipa comata*. This map class is restricted to areas near the Mancos River corridor.
    Base Map Class: Blue Grama Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Colorado Piñon - Utah Juniper / Sagebrush Woodland.
    Association: *Bouteloua gracilis* Herbaceous Vegetation.

15. Dominant herbaceous cover not as above. (16)

16. *Eurybia glauca* is the dominant species. All other herbaceous species occur only in trace amounts. This map class was identified from only one location in a burned area. A low cover of shrubs may occur (<5% cover).
    Base Map Class: Gray Aster Herbaceous Vegetation.
    Group Map Class: Colorado Plateau Mixed Bedrock Canyon and Tableland.
    Management Map Class: Mancos Shale Vegetation.
    Park special: *Eurybia glauca* Herbaceous Vegetation.

16. The dominant species is not as above. (17)

17. *Elymus trachycaulus* ssp. *trachycaulus* is the dominant species. This map class is likely a result of re-seeding post-fire efforts and is only known from one location. *Elymus elymoides* can occur as a significant component of the herbaceous layer.
    Base Map Class: Not mapped
    Park Special: *Elymus trachycaulus* ssp. *trachycaulus* Semi-Natural Herbaceous Vegetation.

17. This map class always occurs in burned areas. The vegetation consists of a mix of herbaceous species, including native and non-native forbs and grasses. The most frequent species include, but are not limited to: *Bromus tectorum*, *Carduus nutans* ssp. *macrolepis*, *Heliomeris multiflora*, *Penstemon linarioides* ssp. *coloradoensis*, *Poa fendleriana* ssp. *longiligula* and *Sphaeralcea coccinea* ssp. *coccinea*. In some of these disturbed areas a single species may dominate (or have a particularly high cover) and may include, but are not limited to *Elymus trachycaulus* ssp. *trachycaulus*, *Balsamorhiza sagittata*, *Melilotus officinalis*, *Pascopyrum smithii*, and *Hesperostipa comata*. Tree and shrubs may have up to 20% covers.

    Base Map Class: Post-Fire Mixed Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Disturbed Semi-Natural Vegetation.
    Park Special: Post-Fire Mixed Herbaceous Vegetation.

Key C: WOODLANDS AND FORESTS

WOODLANDS AND FORESTS: Total vegetation cover is generally greater than 15%, except in dry sites, where total vegetation cover can be as low as 10%. Trees dominate the communities and generally have more than 15% canopy cover, but may include stands with canopy cover of 5–15%. In some areas, canopy cover is dense (>75% cover); these communities are often classified as forests.

18. Tree species are dominated or co-dominated by *Pseudotsuga menziesii* or *Acer negundo*. (19)

18. Tree species not as above. (20)

19. The canopy is dominated or co-dominated by *Pseudotsuga menziesii,* which may form an emergent canopy layer. *Acer negundo* can occasionally co-dominate or dominate the canopy or is a significant component in the shrub understory. Various shrubs may be present, including *Symphoricarpos oreophilus*, *Prunus virginiana,* and *Ribes aureum.* An herbaceous layer may also occur, including *Carex occidentalis, Thalictrum fendleri,* and *Pseudostellaria jamesiana*. This map class mainly occurs in the transition zone between cooler side canyon slopes and the riparian canyon floor. It often occurs in the streambeds of narrow side canyons.
    Base Map Class: Douglas-fir / Boxelder Woodland.
    Group Map Class: Douglas-fir / Boxelder Woodland.
    Management Map Class: Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland.
    Association: *Pseudotsuga menziesii* / *Acer negundo* Woodland.

19. The canopy is dominated by *Pseudotsuga menziesii. Quercus gambelii* is the dominant shrub in the understory. Other shrubs may occur, including *Symphoricarpos oreophilus* and *Rhus trilobata*. The herbaceous cover tends to be low. This map class tends to occur in canyons, at high elevations, or in areas with intermittent flooding.
    Base Map Class: Douglas-fir / Gambel Oak Forest.
    Group Map Class: Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland.
    Management Map Class: Douglas-fir / Gambel Oak Forest.
    Association: *Pseudotsuga menziesii* / *Quercus gambelii* Forest.

20. The canopy is dominated or co-dominated by *Populus angustifolia, Populus* X *acuminata* and/or *Populus fremontii* and often occurs near the Mancos River. Some authorities have reported *Populus deltoides ssp. wislizenii* may also occur at Mesa Verde NP. (21)

20. Tree species not as above. (22)

21. The tree canopy is dominated by *Populus angustifolia, Populus x acuminata* and/or *Populus fremontii.* Shrubs may occur in the understory, including *Rosa woodsii* and *Salix exigua*. The herbaceous understory is dominated by the non-native invasive grass *Bromus inermis,* although other native and non-native herbaceous species in some areas may have higher cover. This map class tends to occur on alluvial flats and fans.
    Base Map Class: Lanceleaf Cottonwood Riparian Woodland.
    Group Map Class: Rocky Mountain Lower Montane Riparian Woodland and Shrubland.
    Management Map Class: Mancos River Woodland and Shrubland.
    Association: *Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland.

21. The tree canopy is dominated or co-dominated by *Populus angustifolia* or *Populus* X *acuminata. Juniperus scopulorum* is always present and often co-dominates the canopy. Shrubs may occur in the understory, including *Salix exigua*. The herbaceous understory may include the non-native invasive grasses *Bromus inermis* and *Poa pratensis* and the non-native forb *Melilotus officinalis*. This map class is restricted to the Mancos River corridor.
    Base Map Class: Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland.
    Group Map Class: Rocky Mountain Lower Montane Riparian Woodland and Shrubland.
    Management Map Class: Mancos River Woodland and Shrubland.
    Association: *Populus angustifolia - Juniperus scopulorum* Woodland.

22. The canopy is either dominated or co-dominated by *Pinus edulis* or *Juniperus osteosperma*. *Pinus edulis* / *Juniperus osteosperma* woodlands are the most common wooded communities in the project area and occur throughout the entire project boundary. (23)

22. Tree species not as above. (33)

23. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The cover for the tree and shrub layers are each very sparse (<10% cover) and the substrate consists of sandstone bedrock.
    Base Map Class: Colorado Piñon - Utah Juniper Sandstone Barrens.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper Sandstone Barrens.
    Park Special: Sandstone *Pinus edulis - Juniperus osteosperma*.

23. The *Pinus edulis* or *Juniperus osteosperma* cover is >10% and does not occur on exposed sandstone bedrock. (24)

24. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory tends to be very sparse (<10% cover) and this map class is restricted to the Mancos Shale. The understory tends to contain species that commonly occur on the Mancos Shale, including the shrub *Eriogonum corymbosum* as well as *Cercocarpus montanus, Amelanchier utahensis,* and *Quercus gambelii*.
    Base Map Class: Colorado Piñon - Utah Juniper / Shale Sparse Woodland.
    Group Map Class: Colorado Plateau Mixed Bedrock Canyon and Tableland.
    Management Map Class: Mancos Shale Vegetation.
    Park Special: *Pinus edulis - Juniperus* spp. / Shale Sparse Woodland.

24. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory is not sparse (>10% cover) and the map class is not restricted to the Mancos Shale. (25)

25. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The shrub layer is dominated by *Purshia tridentata.* This map class always occurs in areas without fire and is indicative of old-growth *Pinus edulis* / *Juniperus osteosperma* communities. The shrub layer can also include other species, such as *Cercocarpus montanus* and *Quercus gambelii*. The herbaceous understory is mainly composed of graminoids and can vary from a low to high cover, generally dominated by *Poa fendleriana*. The herbaceous forb *Pedicularis centranthera* often occurs.
    Base Map Class: Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland.
    Association: *Pinus edulis* / *Purshia tridentata* Woodland.

25. The understory species are not as above. (26)

26. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The shrub layer is the main layer in the understory and is dominated by *Artemisia tridentata*. The herbaceous cover is low to absent. This association is not common in Mesa Verde National Park.
    Base Map Class: Colorado Piñon - Utah Juniper / Big Sagebrush Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Sagebrush Woodland.
    Association: *Pinus edulis - Juniperus osteosperma* / *Artemisia tridentata* (ssp. *wyomingensis,* ssp. *vaseyana*) Woodland.

26. The understory species not as above. (27)

27 *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. *Quercus gambelii* is the dominant species in the shrub layer. In some cases, *Quercus gambelii* may occur as a short tree and co-dominate the canopy. This map class always occurs in unburned areas and occurs throughout Mesa Verde National Park. Other shrubs may also occur in the shrub layer, including *Fendlera rupicola* and *Amelanchier utahensis*. The herbaceous layer has variable cover and may include *Pascopyrum smithii, Machaeranthera bigelovii var. bigelovii*, *Physaria acutifolia*, and/or *Poa fendleriana* ssp. *longiligula*.
    Base Map Class: Colorado Piñon - Utah Juniper / Gambel Oak Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrubland.
    Association: *Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland.

27. The understory is not as above. (28)

28. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory is dominated by *Amelanchier utahensis*. The tree and the shrub strata tend to have equal cover. This map class occurs in unburned areas. This map class is structurally similar to the *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* Woodland association. It was combined with this association for mapping purposes.
    Base Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrubland.
    Association: *Pinus edulis - Juniperus* spp. / *Amelanchier utahensis* Woodland.

28. The understory is not as above. (29)

29. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. *Cercocarpus montanus* is the dominant shrub in the understory. The tree and the shrub strata tend to have equal cover. This map class generally occurs in unburned areas. This map class is structurally similar to *Pinus edulis - Juniperus* spp. / *Amelanchier utahensis* Woodland association. It was combined with this association for mapping purposes.
    Base Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrubland.
    Association: *Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* Mixed Shrubs Woodland.

29. The understory species not as above. (30)

30. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. *Artemisia nova* is the dominant species in the understory. This map class occurs in the uplands in the central to southern regions of the park in areas without a recent fire history. It tends to occur on talus slopes at lower elevations.
    Base Map Class: Colorado Piñon - Utah Juniper / Black Sagebrush Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Sagebrush Woodland.
    Association: *Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland.

30. The understory species not as above. (31)

31. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The main component of the understory is herbaceous, with *Poa fendleriana* as the dominant species. This association is similar to the *Pinus edulis* / *Purshia tridentata* Woodland association, with the exception of low shrub cover, and these two associations were combined for mapping purposes.
    Base Map Class: Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland.
    Association: *Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland.

31. The understory species are not as above. (32)

32. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory is dominated by the herbaceous layer and *Hesperostipa comata* is the dominant herbaceous species. This map class is restricted to the Mancos River corridor.
    Base Map Class: Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland.
    Group Map Class: Colorado Plateau Piñon-Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Sagebrush Woodland.
    Association: *Pinus edulis* - (*Juniperus monosperma*, *Juniperus osteosperma*) / *Hesperostipa comata* Woodland.

32. *Pinus edulis* or *Juniperus osteosperma* dominate the canopy. The understory is dominated by the herbaceous layer and *Pleuraphis jamesii* is the dominant herbaceous species. Other herbaceous species may occur including the non-native invasive species *Acroptilon repens*. Occasionally *Juniperus scopulorum* may occur in the canopy. The shrub layer can have a low cover of shrubs, often including *Artemisia nova*, *Ephedra viridis*, and/or *Ericameria nauseosa*. This map class is only known from the Mancos River corridor.
    Base Map Class: Colorado Piñon - Utah Juniper / James' Galleta Woodland.
    Group Map Class: Colorado Plateau Piñon - Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Sagebrush Woodland.
    Association: *Pinus edulis - Juniperus osteosperma* / *Pleuraphis jamesii* Woodland.

33. *Pinus ponderosa* is the dominant species. The understory varies and can consist of a shrub layer with species such as *Quercus gambelii* and/or *Ericameria nauseosa*. The herbaceous layer is often present, may consist of a combination of native and non-native species, and can include the grasses *Bromus inermis* and *Pascopyrum smithii*.
    Base Map Class: Ponderosa Pine Woodland.
    Group Map Class: Southern Rocky Mountain Ponderosa Pine Woodland.
    Management Map Class: Ponderosa Pine Woodland.
    Association: *Pinus ponderosa* Woodland Alliance.

33. *Juniperus scopulorum* is the dominant species. The understory consists of mix of native and non-native species and can include the grasses *Bromus inermis* and *Pascopyrum smithii.* This map class is only known from the Mancos River corridor.
    Base Map Class: Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland.
    Group Map Class: Colorado Plateau Piñon - Juniper Woodland.
    Management Map Class: Colorado Piñon - Utah Juniper / Mixed Montane Shrubland.
    Park Special: *Juniperus scopulorum* / *Bromus inermis* (*Pascopyrum smithii*) Woodland.

Key D: SHRUBLANDS

SHRUBLANDS: Total vegetation cover is >10%. Tree cover is either less than 15% or less than the total shrub cover. The herbaceous cover is either equal to or less than the total shrub cover. The dominant lifeform is shrubs.

34. Shrublands are dominated or co-dominated by *Quercus gambelii*. (35)

34. Shrublands are not as above. (38)

35. *Quercus gambelii* is the dominant shrub. Other shrubs present may include low to moderate cover of *Purshia tridentata* and/or *Ericameria nauseosa*. This association occurs throughout the Park and can occur in previously burned areas. The tree layer may include *Juniperus scopulorum.* The herbaceous layer can have up to 50-75% cover and may include *Artemisia ludoviciana*, *Bromus tectorum*, and *Elymus elymoides*. The shrubs *Amelanchier utahensis*, *Cercocarpus montanus,* and/or *Symphoricarpos oreophilus* can occur, but always with <1% cover for each species.
    Base Map Class: Gambel Oak Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Assocation: *Quercus gambelii* Shrubland

35. *Quercus gambelii* dominates the shrub layer. *Amelanchier utahensis, Cercocarpus montanus,* and/or *Symphoricarpos oreophilus* occur with >1% cover. (36)

36. *Quercus gambelii* dominates the shrub layer. *Cercocarpus montanus* co-dominates or even dominates the canopy in some areas. *Amelanchier utahensis* can also frequently occur. Although *Carex geyeri* is listed in the association name it is not typically found at Mesa Verde National Park.
    Base Map Class: Gambel Oak - Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Quercus gambelii - Cercocarpus montanus / (Carex geyeri)* Shrubland.

36. *Cercocarpus montanus* does not co-dominate or dominate the canopy. (37)

37. *Quercus gambelii* dominates the shrub layer. *Amelanchier utahensis* is always a significant component to the shrub layer and in some areas can co-dominate the shrub canopy. This association occurs throughout the Park, mainly in previously burned areas. Other shrubs frequently occur with low cover, including *Fendlera rupicola* and *Symphoricarpos oreophilus.* The herbaceous layer ranges from absent to a high cover.
    Base Map Class: Gambel Oak - Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Quercus gambelii - Amelanchier utahensis* Shrubland.

37. *Quercus gambelii* dominates the shrub layer. *Amelanchier utahensis* is not a significant component in the shrub layer. *Symphoricarpos oreophilus* is always present with low to moderate cover. This map class tends to occur in previously burned areas. The herbaceous layer ranges from sparse to moderate.
    Base Map Class: Gambel Oak - Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Quercus gambelii / Symphoricarpos oreophilus* Shrubland.

38. *Amelanchier utahensis* dominates or co-dominates the canopy. (39)

38. Shrublands not as above. (41)

39. *Amelanchier utahensis* dominates or co-dominates the canopy. *Cercocarpus montanus* is a significant shrub component or co-dominates the shrub canopy. *Fendlera rupicola, Purshia tridentata,* and *Quercus gambelii* is commonly present in the shrub layer, but not dominant. The herbaceous cover is low to moderate and may include *Poa fendleriana* ssp. *longiligula*.
    Base Map Class: Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland.

39. *Cercocarpus montanus* is not a significant shrub component in the shrub canopy. (40)

40. *Amelanchier utahensis* dominates or co-dominates the canopy. *Fendlera rupicola* is a significant shrub component or co-dominates the shrub canopy. Other significant shrubs may include *Artemisia nova* or *Tetradymia canescens.* The herbaceous layer can vary between sparse and a high cover (50-75%).
    Base Map Class: Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Amelanchier utahensis - Fendlera rupicola* Shrubland.

40. The shrub layer is not as above and does not have any species other than *Amelanchier utahensis* co-dominating the canopy. Other shrubs present may include *Artemisia tridentata* and *Symphoricarpos oreophilus*, but they do not contribute significantly to the shrub layer. The herbaceous layer ranges from sparse to high cover (50-75%).
    Base Map Class: Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Amelanchier utahensis* Shrubland.

41. The shrub layer is co-dominated by *Cercocarpus montanus* and *Fendlera rupicola*. A sparse tree layer may be present.
    Base Map Class: Mixed Montane Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional].

41. Shrubs not as above. (42)

42. Sarcobatus vermiculatus is the dominant or co-dominant shrub. Artemisia tridentata occurs as a significant component and can dominate or co-dominate the shrub layer. The herbaceous layer may have a high cover of the non-native herbaceous species *Bromus tectorum*.
    Base Map Class: Greasewood - Big Sagebrush Shrubland.
    Group Map Class: Inter-Mountain Basins Big Sagebrush Shrubland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Sarcobatus vermiculatus - Artemisia tridentata* Shrubland.

42. Shrubs not as above. (43)

43. *Artemisia tridentata* is the dominant or co-dominant shrub. (44)

43. Shrubs not as above. (48)

44. The shrub layer is co-dominated by *Artemisia tridentata* and *Ericameria nauseosa*. This association occurs in areas with intermittent flooding. The herbaceous layer has moderate cover, commonly with non-native species such as *Acroptilon repens*, *Bromus inermis*, *Bromus tectorum*, and *Cardaria draba*.
    Base Map Class: Big Sagebrush Shrubland.
    Group Map Class: Inter-Mountain Basins Big Sagebrush Shrubland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi natural Shrubland.

44. The shrub layer is not co-dominated by *Ericameria nauseosa*. (45)

45. The shrub layer is dominated by *Artemisia tridentata*, but has a significant cover of *Sarcobatus vermiculatus*. Go to 42 above and continue to use the key. If this does not work continue onto 46.

45. The shrub layer does not have a significant component of *Sarcobatus vermiculatus*. (46)

46. *Artemisia tridentata* is the main shrub; no other shrubs have significant cover. The herbaceous layer is dominated by *Hesperostipa comata*. This map class tends to occur in Mancos River corridor.
    Base Map Class: Big Sagebrush Shrubland.
    Group Map Class: Inter-Mountain Basins Big Sagebrush Shrubland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland.

46. The herbaceous layer is not as above. (47)

47. *Artemisia tridentata* is the main shrub and dominates the shrub layer. The herbaceous layer is dominated by *Pascopyrum smithii*. *Elymus lanceolatus* occurs in this association outside of Mesa Verde National Park. It has not been observed to co-dominate this association within the park. This map class is restricted to the Mancos River area.
    Base Map Class: Big Sagebrush / Western Wheatgrass Shrubland.
    Group Map Class: Inter-Mountain Basins Big Sagebrush Shrubland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii - (Elymus lanceolatus)* Shrubland.

47. *Artemisia tridentata* is the main shrub and dominates the shrub layer. The herbaceous layer is dominated by *Pleuraphis jamesii*. This map class is restricted to the Mancos River area.
    Base Map Class: Big Sagebrush / James' Galleta Shrubland.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Big Sagebrush Shrubland.
    Association: *Artemisia tridentata* / *Pleuraphis jamesii* Shrubland.

48. The shrub layer is co-dominated by *Artemisia nova* and *Artemisia ludoviciana*. Other shrubs can include *Ericameria nauseosa*, *Tetradymia canescens*, *Amelanchier utahensis, Fendlera rupicola*, and *Opuntia polyacantha.* The dominant herbaceous species is *Hesperostipa comata.*
    Base Map Class: Black Sagebrush Shrub Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Rabbitbrush Shrub Herbaceous Vegetation.
    Association: *Artemisia nova* / *Hesperostipa comata* Shrubland.

48. The shrub layer is not co-dominated by *Artemisia nova* and/or *Artemisia ludoviciana*. (49)

49. The dominant shrub is *Prunus virginiana*. Other shrubs present may include *Quercus gambelii* and *Rosa woodsii*. The herbaceous cover tends to be moderate to high and may include *Carduus nutans* ssp. *macrolepis*, *Taraxacum officinale*, and *Poa fendleriana* ssp. *longiligula*.
    Base Map Class: Choke Cherry Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Prunus virginiana - (Prunus americana)* Shrubland.

49. Shrubs not as above. (50)

50. The shrub layer is dominated by *Purshia tridentata*. The herbaceous layer is dominated by *Achnatherum hymenoides*. This map class is restricted to the tops of mesas. This map class has been impacted by past fires.
    Base Map Class: Bitterbrush / Indian Ricegrass Shrubland.
    Group Map Class: Rocky Mountain Gambel Oak-Mixed Montane Shrubland.
    Management Map Class: Mixed Montane Shrubland.
    Association: *Purshia tridentata* / *Achnatherum hymenoides - Poa fendleriana* Shrubland.

50. Dominant shrubs not as above. (51)

51. *Ericameria nauseosa* is the dominant shrub; *Gutierrezia sarothrae* is also common. The herbaceous species generally include *Bromus inermis*, a non-native grass, and *Pascopyrum smithii*. This map class occasionally is found in old agricultural fields.
    Base Map Class: Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation.
    Group Map Class: Inter-Mountain Basins Semi-Desert Grassland.
    Management Map Class: Rabbitbrush Shrub Herbaceous Vegetation.
    Park Special: *Ericameria nauseosa* / *Bromus inermis (Pascopyrum smithii)* Shrub Herbaceous.

51. Dominant shrubs not as above. (52)

52. The shrub layer is dominated by *Salix exigua.* This map class occurs in fthe Mancos River corridor and in areas with seasonal flooding. Other shrubs such as *Rosa woodsii* may be present.
    Base Map Class: Coyote Willow / Mesic Forb Shrubland.
    Group Map Class: Rocky Mountain Lower Montane Riparian Woodland and Shrubland.
    Management Map Class: Mancos River Woodland and Shrubland.
    Association: *Salix exigua* / Mesic Forbs Shrubland.

52. *Eriogonum corymbosum* is the dominant shrub. A sparse tree layer may be present, including *Pinus edulis.* This association always occurs on Mancos shale.
    Base Map Class: Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation.
    Group Map Class: Colorado Plateau Mixed Bedrock Canyon and Tableland.
    Management Map Class: Mancos Shale Vegetation.
    Association: *Eriogonum corymbosum* Badlands Sparse Vegetation.

Appendix F
Plant Community and Map Class Crosswalk

The table below provides a crosswalk among the plant communities of Mesa Verde National Park (associations, alliances, and park specials) and the base, group, and management map classes to which they were assigned in this project. Each plant community is in only one map class for each schema, but each map class may contain more than one plant community. The CEGL code is the community element code assigned to the associations and alliances that are currently registered in the NatureServe Explorer database (http://www.natureserve.org/explorer/).

	Plant communities (associations, alliances) and park specials	CEGL Code	Base map class code	Group map class code	Management map class code
Forest					
1	*Pseudotsuga menziesii* / *Quercus gambelii* Forest	CEGL000452	62.002	620	62.002
Woodland					
2	*Pinus edulis - (Juniperus monosperma, Juniperus osteosperma)* / *Hesperostipa comata* Woodland	CEGL000797	61.007	610	61.011
3	*Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis* Woodland	CEGL002329	61.006	610	61.010
4	*Pinus edulis - Juniperus osteosperma* / *Artemisia nova* Woodland	CEGL002331	61.003	610	61.013
5	*Pinus edulis - Juniperus osteosperma* / *Pleuraphis jamesii* Woodland	CEGL002379	61.005	610	61.011
6	*Pinus edulis - Juniperus* spp. / *Artemisia tridentata (ssp. wyomingensis, ssp. vaseyana)* Woodland	CEGL000776	61.001	610	61.011
7	*Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* Mixed Shrub Woodland	CEGL000780	61.006	610	61.010
8	*Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland	CEGL000787	61.002	610	61.002
9	*Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland	CEGL000791	61.004	610	61.010
10	*Pinus edulis* / *Purshia tridentata* Woodland	CEGL000789	61.002	610	61.002
11	*Pinus ponderosa* Woodland Alliance	A.530	62.003	630	62.003
12	*Populus angustifolia - Juniperus scopulorum* Woodland	CEGL002640	63.003	640	63.004
13	*Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland	CEGL005847	63.002	640	63.004
14	*Pseudotsuga menziesii* / *Acer negundo* Woodland	CEGL002754	62.001	620	62.001
15	*Juniperus scopulorum* / *Bromus inermis (Pascopyrum smithii)* Woodland	none	61.009	610	61.010
16	*Pinus edulis - Juniperus* spp. / Shale Sparse Woodland	none	31.001	300	31.005
Shrubland					
17	*Amelanchier (utahensis, alnifolia) - Cercocarpus montanus* Shrubland	CEGL001070	53.005	550	53.005
18	*Amelanchier utahensis - Fendlera rupicola* Shrubland	CEGL003817	53.005	550	53.005
19	*Amelanchier utahensis* Shrubland	CEGL001067	53.005	550	53.005

Table F1. Classification and map classes matrix, cont.

	Plant communities (associations, alliances) and park specials	CEGL Code	Base map class code	Group map class code	Management map class code
20	*Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland	CEGL003820	51.001	510	51.001
21	*Artemisia tridentata* ssp. t*ridentata / Pascopyrum smithii - (Elymus lanceolata)* Shrubland	CEGL007017	51.003	510	51.001
Shrubland, cont.					
22	*Artemisia tridentata* ssp. *tridentata / Pleuraphis jamesii* Shrubland	CEGL001015	51.002	510	51.001
23	*Artemisia tridentata* ssp. *wyomingensis / Hesperostipa comata* Colorado Plateau Shrubland	CEGL001051	51.001	510	51.001
24	*Artemisia nova / Hesperostipa comata* Shrubland	CEGL001425	51.004	400	42.007
25	*Cercocarpus montanus - Fendlera rupicola* Shrubland [Provisional]	CEGL003820	53.005	550	53.005
26	*Prunus virginiana - (Prunus americana)* Shrubland	CEGL001108	53.002	550	53.005
27	*Purshia tridentata / Achnatherum hymenoides - Poa fendleriana* Shrubland	CEGL001058	53.001	550	53.005
28	*Quercus gambelii - Amelanchier utahensis* Shrubland	CEGL001110	53.003	550	53.005
29	*Quercus gambelii - Cercocarpus montanus / (Carex geyeri)* Shrubland	CEGL001113	53.003	550	53.005
30	*Quercus gambelii / Symphoricarpos oreophilus* Shrubland	CEGL001117	53.003	550	53.005
31	*Quercus gambelii* Shrubland	CEGL002477	53.004	550	53.005
32	*Salix exigua* / Mesic Forbs Shrubland	CEGL001202	63.001	640	63.004
33	*Sarcobatus vermiculatus - Artemisia tridentata* Shrubland	CEGL001359	52.002	510	51.001
Herbaceous					
34	*Bouteloua gracilis* Herbaceous Vegetation	CEGL001760	41.001	400	61.011
35	*Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation	CEGL005264	42.005	400	42.007
36	*Bromus tectorum* Semi-natural Herbaceous Vegetation	CEGL003019	42.001	400	42.006
37	*Juncus balticus* Herbaceous Vegetation	CEGL001838	43.001	430	43.002
38	*Leymus cinereus* Herbaceous Vegetation	CEGL001479	52.001	510	51.001
39	*Eurybia glauca* Herbaceous Vegetation	none	31.003	300	31.005
40	*Elymus trachycaulus* ssp. *trachycaulus* Semi-natural Herbaceous Vegetation[1]	none	-	-	-
41	*Ericameria nauseosa / Bromus inermis (Pascopyrum smithii)* Shrub Herbaceous	none	42.004	400	42.007
42	Mixed Weedy Herbaceous Vegetation	none	42.002	400	42.007
43	Mixed Wetland Herbaceous Vegetation	none	43.002	430	43.002
44	Post-Fire Mixed Herbaceous Vegetation	none	42.003	400	42.006
45	*Stanleya pinnata* Shale Herbaceous Vegetation	none	31.004	300	31.005
Sparse					
46	*Eriogonum corymbosum* Badlands Sparse Vegetation	CEGL002979	31.002	300	31.005
47	Sandstone *Pinus edulis - Juniperus osteosperma* Barrens	none	61.008	610	61.008

[1]Occurred on only one releve; was combined within larger surrounding vegetation community.

Key to map class codes

Base map classes

31.001	Colorado Piñon – Utah Juniper / Shale Sparse Woodland
31.002	Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation
31.003	Gray Aster Herbaceous Vegetation
31.004	Mancos Shale Herbaceous Vegetation
41.001	Blue Grama Herbaceous Vegetation
42.001	Cheatgrass Semi-natural Herbaceous Vegetation
42.002	Mixed Weedy Herbaceous Vegetation
42.003	Post-Fire Mixed Herbaceous Vegetation
42.004	Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation
42.005	Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation
43.001	Baltic Rush Herbaceous Vegetation
43.002	Mixed Wetland Herbaceous Vegetation
51.001	Big Sagebrush Shrubland
51.002	Big Sagebrush / James' Galleta Shrubland
51.003	Big Sagebrush / Western Wheatgrass Shrubland
51.004	Black Sagebrush Shrub Herbaceous Vegetation
52.001	Basin Wildrye Herbaceous Vegetation
52.002	Greasewood - Big Sagebrush Shrubland
53.001	Bitterbrush / Indian Ricegrass Shrubland
53.002	Choke Cherry Shrubland
53.003	Gambel Oak - Mixed Montane Shrubland
53.004	Gambel Oak Shrubland
53.005	Mixed Montane Shrubland
61.001	Colorado Piñon - Utah Juniper / Big Sagebrush Woodland
61.002	Colorado Piñon - (Utah Juniper) / Bitterbrush / Muttongrass Woodland
61.003	Colorado Piñon – (Utah Juniper) / Black Sagebrush Woodland
61.004	Colorado Piñon – (Utah Juniper) / Gambel Oak Woodland
61.005	Colorado Piñon – Utah Juniper / James' Galleta Woodland
61.006	Colorado Piñon – (Utah Juniper) / Mixed Montane Shrub Woodland
61.007	Colorado Piñon – (Utah Juniper) / Needle-and-Thread Woodland
61.008	Colorado Piñon – Utah Juniper Sandstone Barrens
61.009	Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland
62.001	Douglas-fir / Box elder Woodland
62.002	Douglas-fir / Gambel Oak Forest
62.003	Ponderosa Pine Woodland
63.001	Coyote Willow / Mesic Forb Shrubland
63.002	Lanceleaf Cottonwood Riparian Woodland
63.003	Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland

Group map classes

300	Colorado Plateau Mixed Bedrock Canyon and Tableland
400	Inter-Mountain Basins Semi-Desert Grassland
430	Rocky Mountain Alpine-Montane Wet Meadow
510	Inter-Mountain Basins Big Sagebrush Shrubland
550	Rocky Mountain Gambel Oak-Mixed Montane Shrubland
610	Colorado Plateau Pinyon-Juniper Woodland
620	Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland
630	Southern Rocky Mountain Ponderosa Pine Woodland
640	Rocky Mountain Lower Montane Riparian Woodland and Shrubland

Management map classes

31.005	Mancos Shale Vegetation
42.006	Disturbed Semi-Natural Vegetation
42.007	Rabbitbrush Shrub Herbaceous Vegetation
43.002	Mixed Wetland Herbaceous Vegetation
51.001	Big Sagebrush Shrubland
53.005	Mixed Montane Shrubland
61.002	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland
61.008	Colorado Piñon - Utah Juniper Sandstone Barrens
61.01	Colorado Piñon - Utah Juniper / Mixed Montane Shrubland
61.011	Colorado Piñon - Utah Juniper / Sagebrush Woodland
61.013	Colorado Piñon – Utah Juniper / Black Sagebrush Woodland
62.001	Douglas-fir / Box elder Woodland
62.002	Douglas-fir / Gambel Oak Forest
62.003	Ponderosa Pine Woodland
63.004	Mancos River Woodland and Shrubland

Appendix G
Map Class Summaries

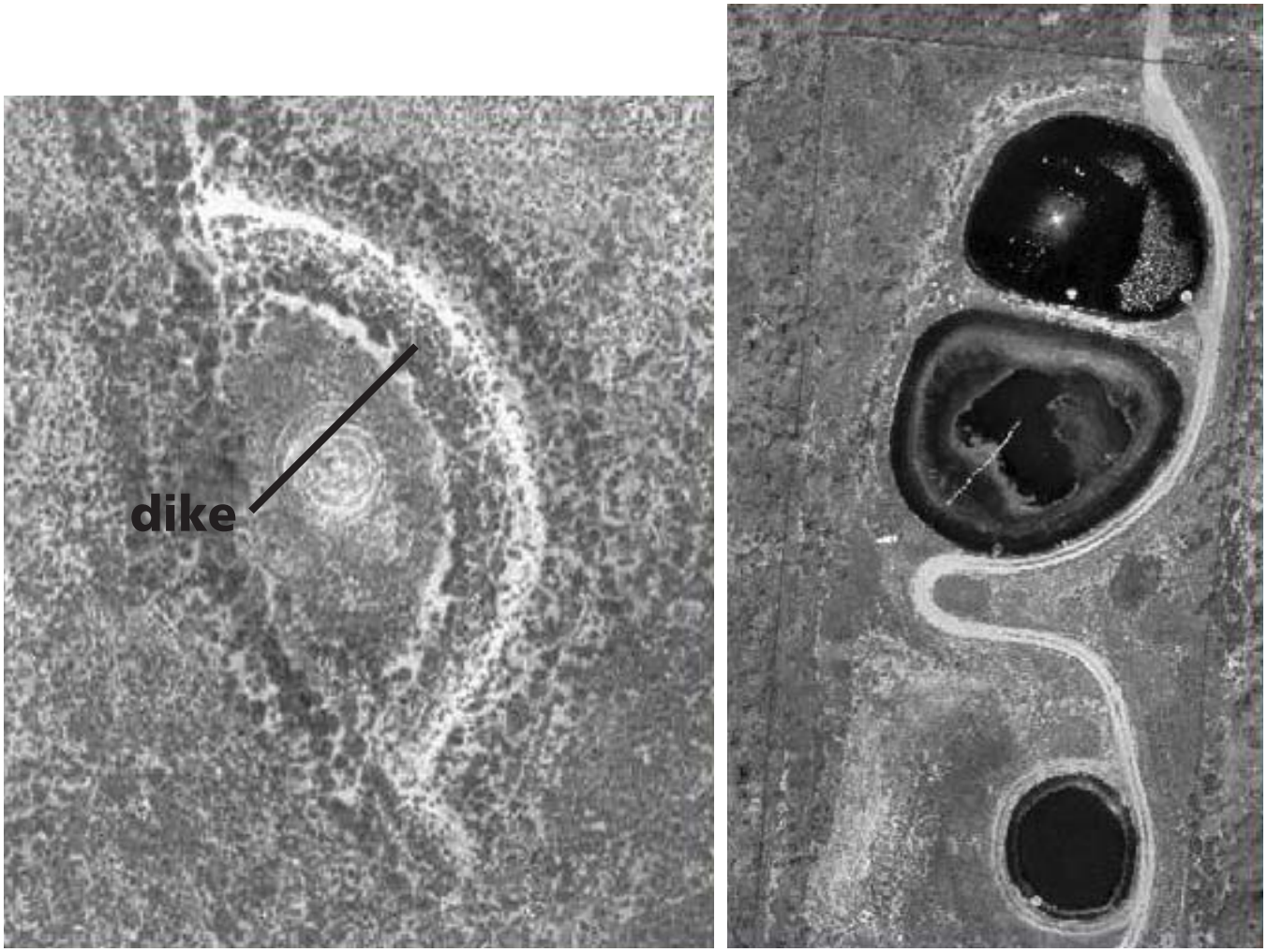
These map class summaries provide statistics for each base map class, list the group and management classes for each base map class, and show accuracy results for all three map-class levels. The photointerpreter provided examples of the base map-class photosignature and comments on the aerial photo interpretation of the base map class. In many cases, two aerial photography views are provided. The gray-toned views are from panchromatic imagery, and the colored views are from the 2003–2004, 1:12,000, true-color imagery. A field photograph of a characteristic view of most, but not all, base map classes is also provided. Field photographs, when available, appear at the beginning of the summaries; photosignature images appear at the end.

1 Artificial Catchment

Plant communities included	NA
Group map class included within	Agriculture (1 of 3)
Management map class included within	Mixed Wetland Herbaceous Vegetation (1 of 3)
Total number of map units in project area	54
Number of map units in park	9
Number of total map units less than 0.5 ha	51 (74.3% of total map class area)
Total area	7.3 ha/18.1 ac
Area in park	2.7 ha/6.7 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	63.1%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user 77.8 (50.4–92.4), producer 100.0 (72.1–100.0)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Most artificial catchments are located in the agricultural areas in the northern end of the study area; however, there are catchments throughout the study area.

Photosignature: Water is readily apparent in most catchment basins, but some are dry. Dry catchment basins are apparent by the crescent- or half-circle-shaped dike on one side of the basin.



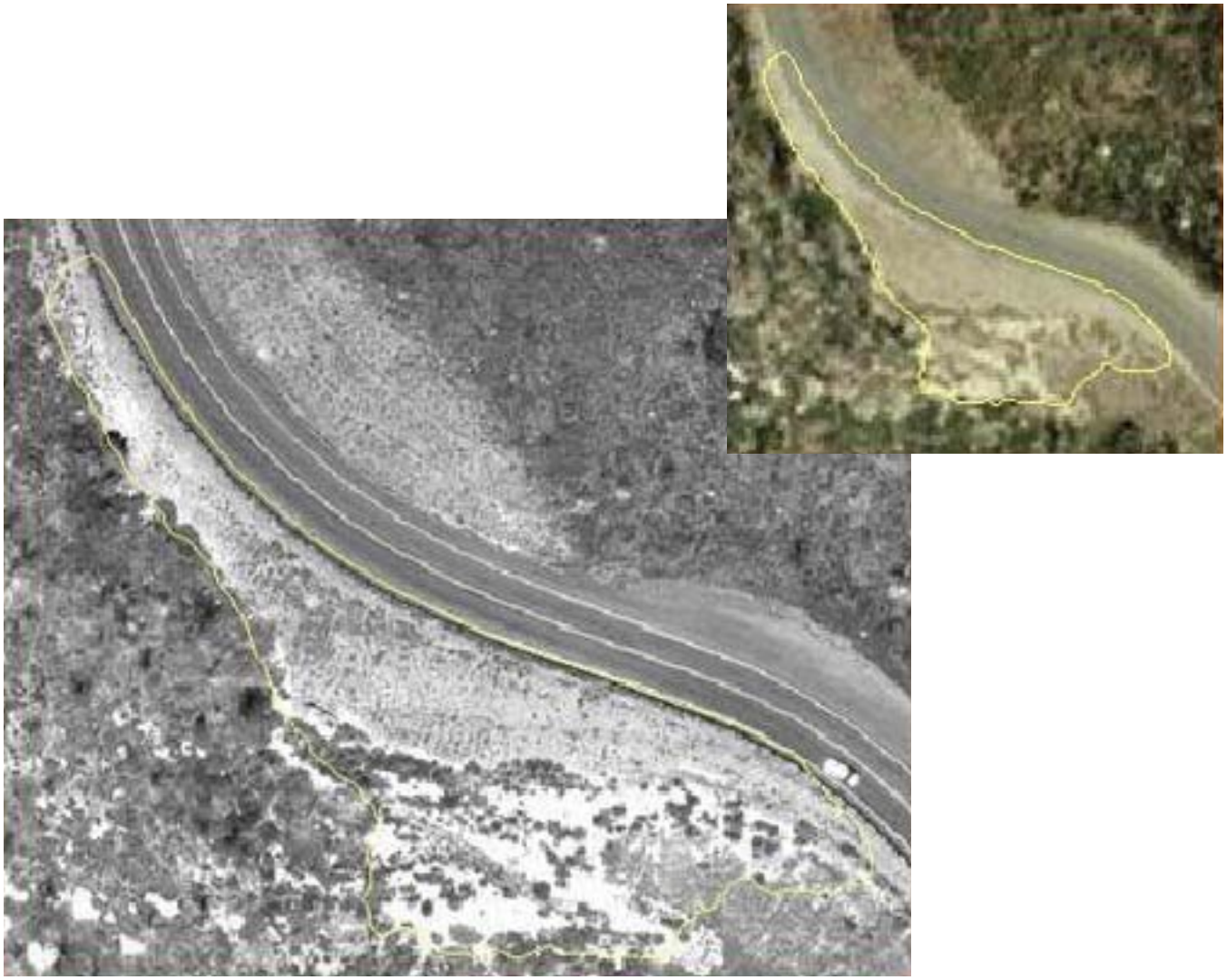


2 Erosion Control

Plant communities included	NA
Group map class included within	Agriculture (1 of 3)
Management map class included within	Erosion Control (1 of 1)
Total number of map units in project area	15
Number of map units in park	15
Number of total map units less than 0.5 ha	12 (28.0% of total map class area)
Total area	5.1 ha/12.5 ac
Area in park	5.1 ha/12.5 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This map class is found in various locations along paved roads throughout the park.

Photosignature: The photosignature for this map class is gray and sparsely mottled.

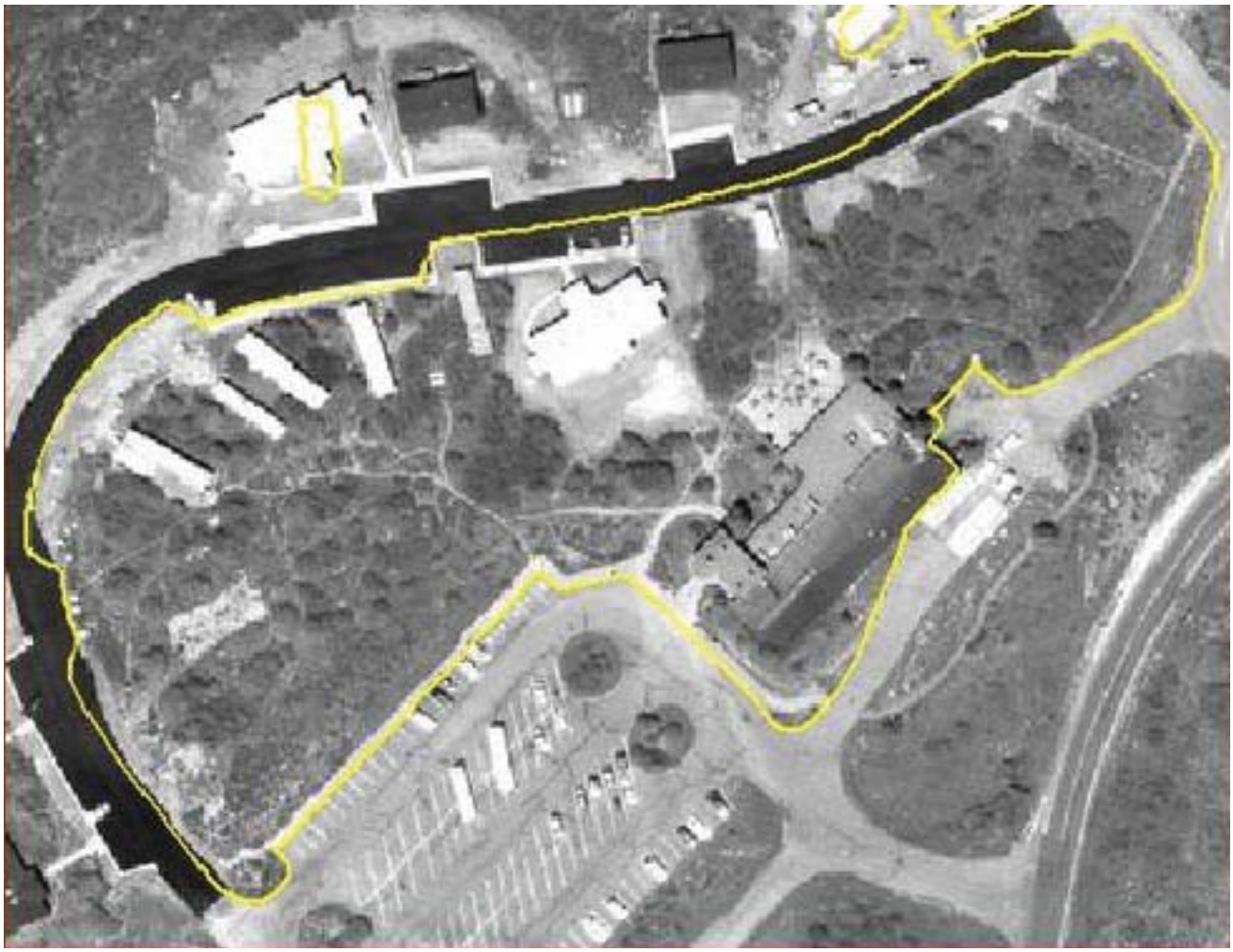


3 Park Facilities

Plant communities included	NA
Group map class included within	Park Facilities (1 of 1)
Management map class included within	Park Facilities (1 of 1)
Total number of map units in project area	51
Number of map units in park	51
Number of total map units less than 0.5 ha	46 (41.7% of total map class area)
Total area	10.0 ha/24.7 ac
Area in park	10.0 ha/24.7 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This map class is found throughout the park.

Photosignature: Buildings typically have a bright white or gray signature with square corners and flat sides. Structures within the park boundary are mapped as park facilities; outside the park boundary, buildings are labeled as the Rural Residential map class.

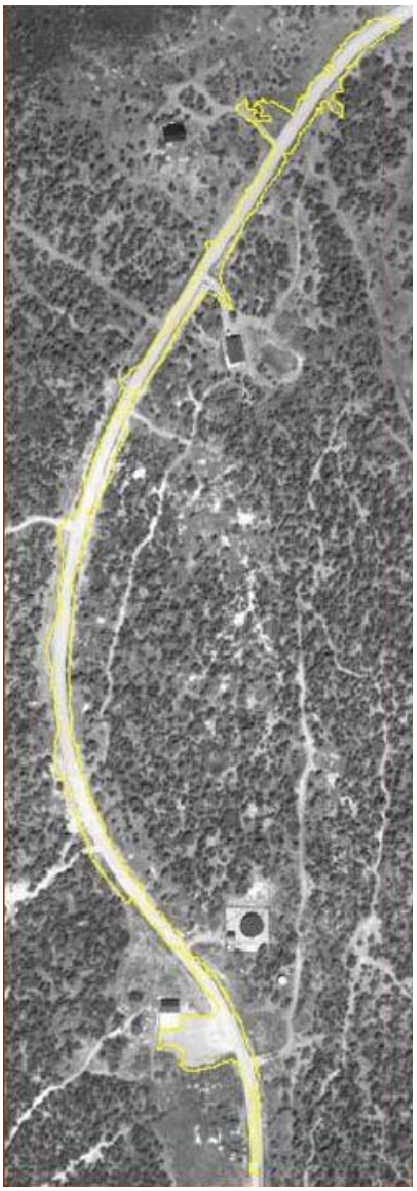


4 Paved Roads

Plant communities included	NA
Group map class included within	Transportation (1 of 1)
Management map class included within	Paved Roads (1 of 1)
Total number of map units in project area	3
Number of map units in park	2
Number of total map units less than 0.5 ha	1 (0.0% of total map class area)
Total area	81.3 ha/201.0 ac
Area in park	70.8 ha/174.9 ac
Proportion of land cover in park	0.3%
Proportion of map class in project environs	12.9%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Pavement occurs throughout the park and the park environs. Pavement within park boundaries was previously mapped by the park GIS staff. Paved areas outside of the park were mapped using Definiens Professional to determine polygon boundaries.

Photosignature: Pavement has a smooth and perfect texture and boundaries.



5 Rural Residential

Plant communities included	NA
Group map class included within	Residential (1 of 1)
Management map class included within	Rural Residential (1 of 1)
Total number of map units in project area	44
Number of map units in park	2
Number of total map units less than 0.5 ha	40 (30.6% of total map class area)
Total area	15.9 ha/39.3 ac
Area in park	0.3 ha/0.7 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	98.3%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This map class is found at the north end of the park outside the boundary.

Photosignature: Buildings have a bright signature, usually white or gray. This land-cover class is identifiable by the many small buildings clustered together outside the park boundaries. Within park boundaries, clusters of buildings are mapped as the Park Facilities map class.



6 Agriculture

Plant communities included	NA
Group map class included within	Agriculture (1 of 3)
Management map class included within	Agriculture (1 of 1)
Total number of map units in project area	14
Number of map units in park	2
Number of total map units less than 0.5 ha	0 (0% of total map class area)
Total area	201.5 ha/498.0 ac
Area in park	11.6 ha/28.8 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	94.2%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Agricultural use is located outside of the park boundary in the northeastern end of the study area.

Photosignature: The photosignature is smooth, with a consistent, repeating texture over a large area. There are often parallel lines from plowing.

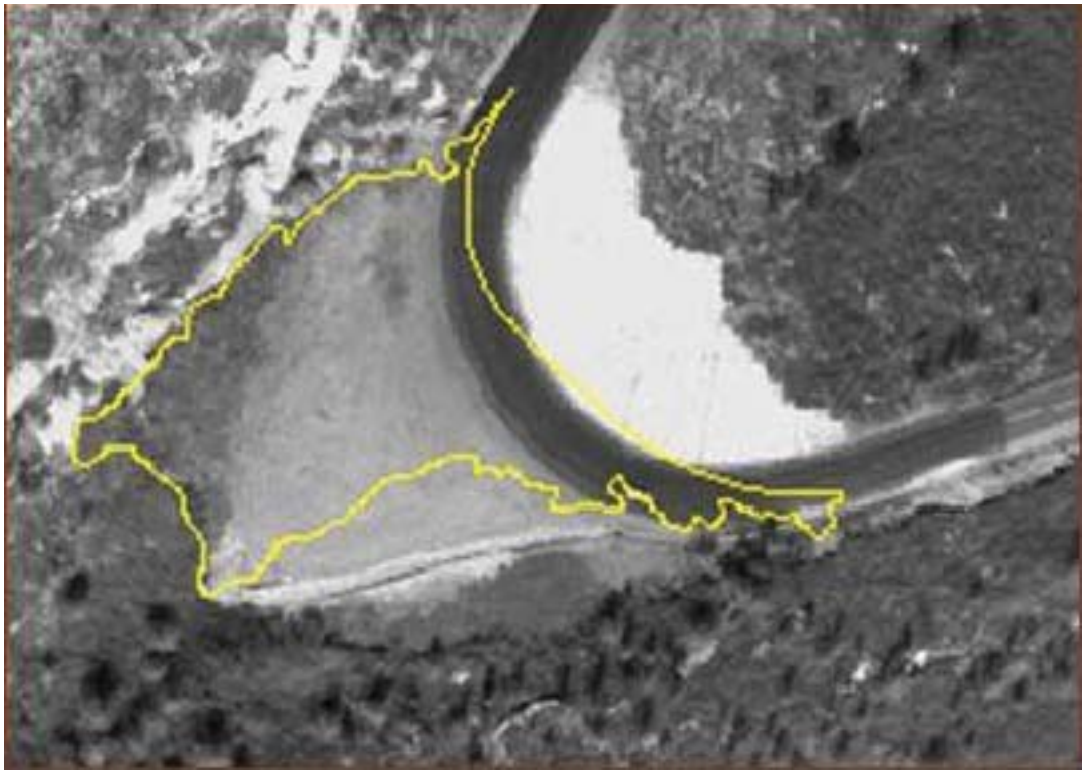


7 Gravel

Plant communities included	NA
Group map class included within	Barren (1 of 2)
Management map class included within	Gravel
Total number of map units in project area	1
Number of map units in park	1
Number of total map units less than 0.5 ha	1
Total area	0.33 ha (0.81 ac)
Area in park	0.33 ha (0.81 ac)
Proportion of land cover in park	<0.002%
Proportion of map class in project environs	0%
Base map class accuracy	Not sampled
Group map class accuracy	Not sampled
Management map class accuracy	Not sampled
Documentation for base map class	From photointerpretation

Location: This map class was mapped in one location along a paved road in the park.

Photosignature: The photosignature is an even, gray slope along a paved road. The lack of vegetation and regular texture alongside the road indicates gravel.

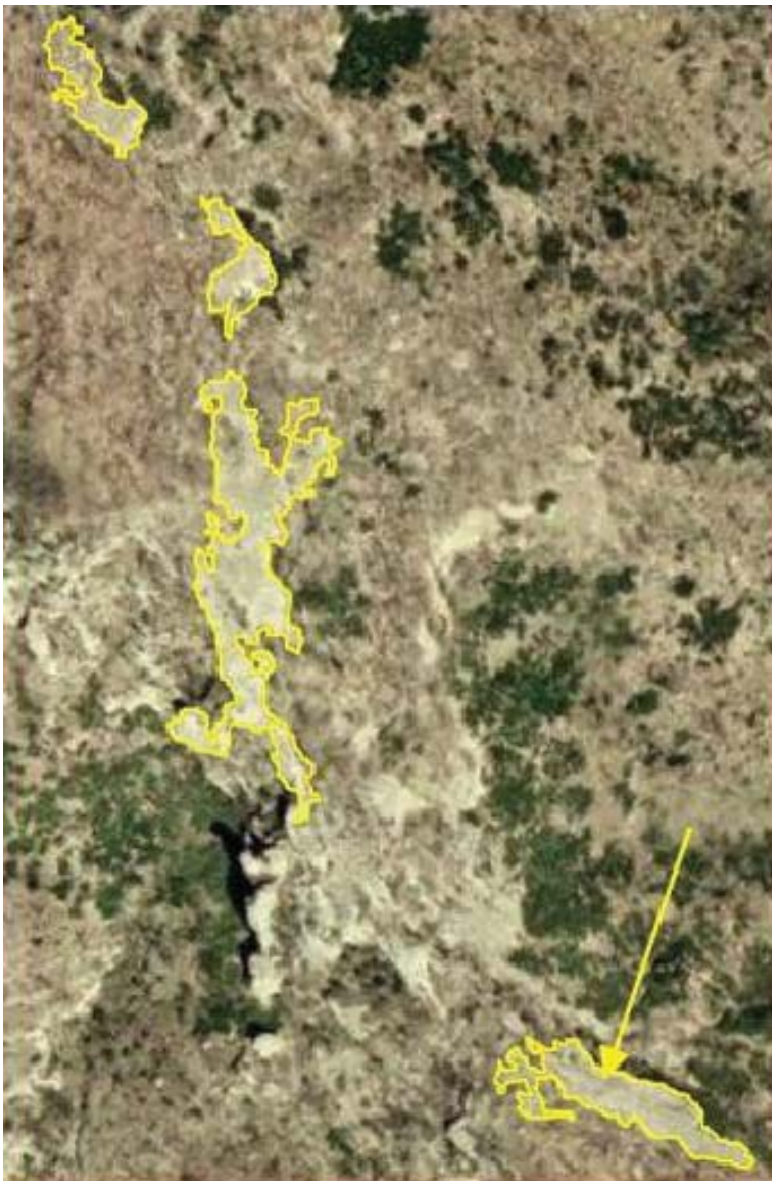


8 Sandstone

Plant communities included	NA
Group map class included within	Barren (1 of 2)
Management map class included within	Sandstone (1 of 1)
Total number of map units in project area	474
Number of map units in park	429
Number of total map units less than 0.5 ha	457 (68.6% of total map class area)
Total area	48.7 ha/120.4 ac
Area in park	41.5 ha/102.5 ac
Proportion of land cover in park	0.2%
Proportion of map class in project environs	14.9%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user NS, producer 0.0
Management map class accuracy	user NS, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Most exposed sandstone is in the southern end of the park, on the edges of mesas.

Photosignature: Bare sandstone is generally evenly colored and textured and occurs in small, irregularly-shaped patches. The yellow arrows indicate sandstone patches.



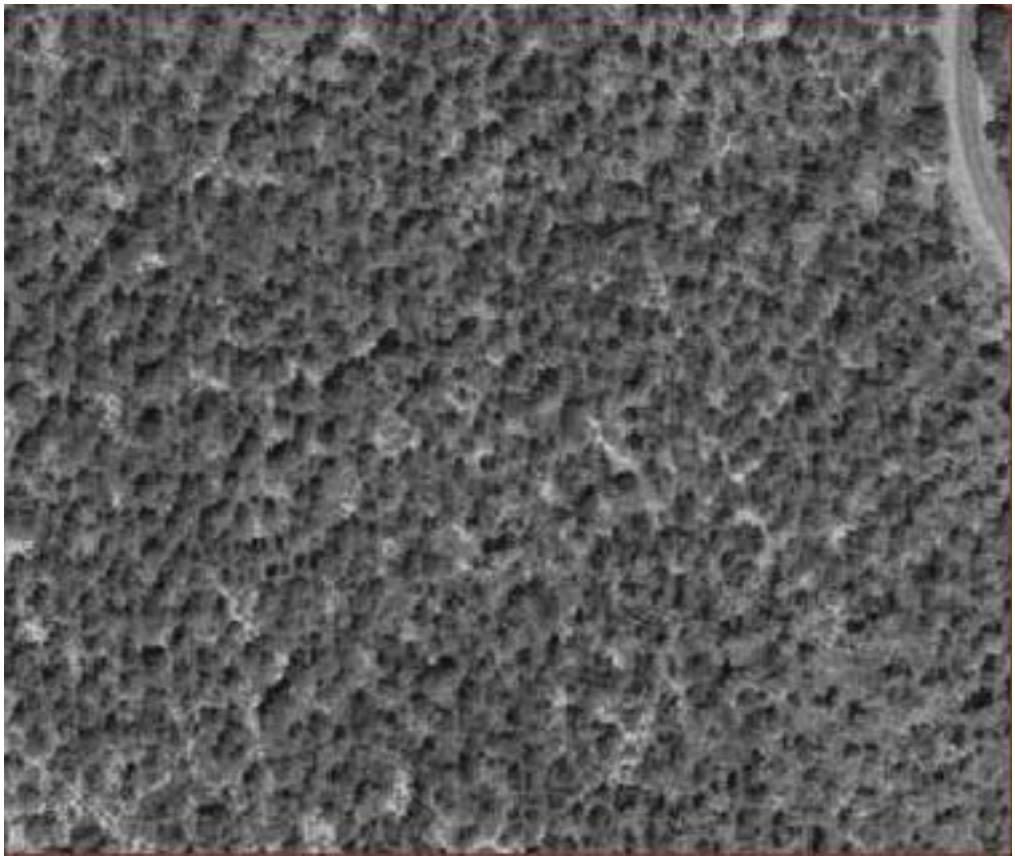


9 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland

Plant communities included	*Pinus edulis - Juniperus* spp. / *Poa fendleriana* Woodland, *Pinus edulis* / *Purshia tridentata* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland (1 of 1)
Total number of map units in project area	79
Number of map units in park	73
Number of total map units less than 0.5 ha	5 (0.1% of total map class area)
Total area	1,910.9 ha/4,722.0 ac
Area in park	1,639.3 ha/4,050.9 ac
Proportion of land cover in park	7.6%
Proportion of map class in project environs	14.2%
Base map class accuracy	user 90.5 (74.9–96.8), producer 67.9 (52.3–80.2)
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 90.5 (74.9–96.8), producer 67.9 (52.3–80.2)
Documentation for base map class	15 2004 relevés, 25 1993 relevés, 35 AA observation sites

Location: This vegetation is found throughout the southwest piñon-juniper woodlands on mesas.

Photosignature: Dense to open piñon-juniper canopy without a dense understory signature. Colorado Piñon - Utah Juniper / Gambel Oak Woodland has a dense dark green understory; Colorado Piñon - Utah Juniper / Big Sagebrush Woodland has a yellow tinted understory with an open canopy. Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland is distinguished by the lack of distinctive understory photosignature on mesas.



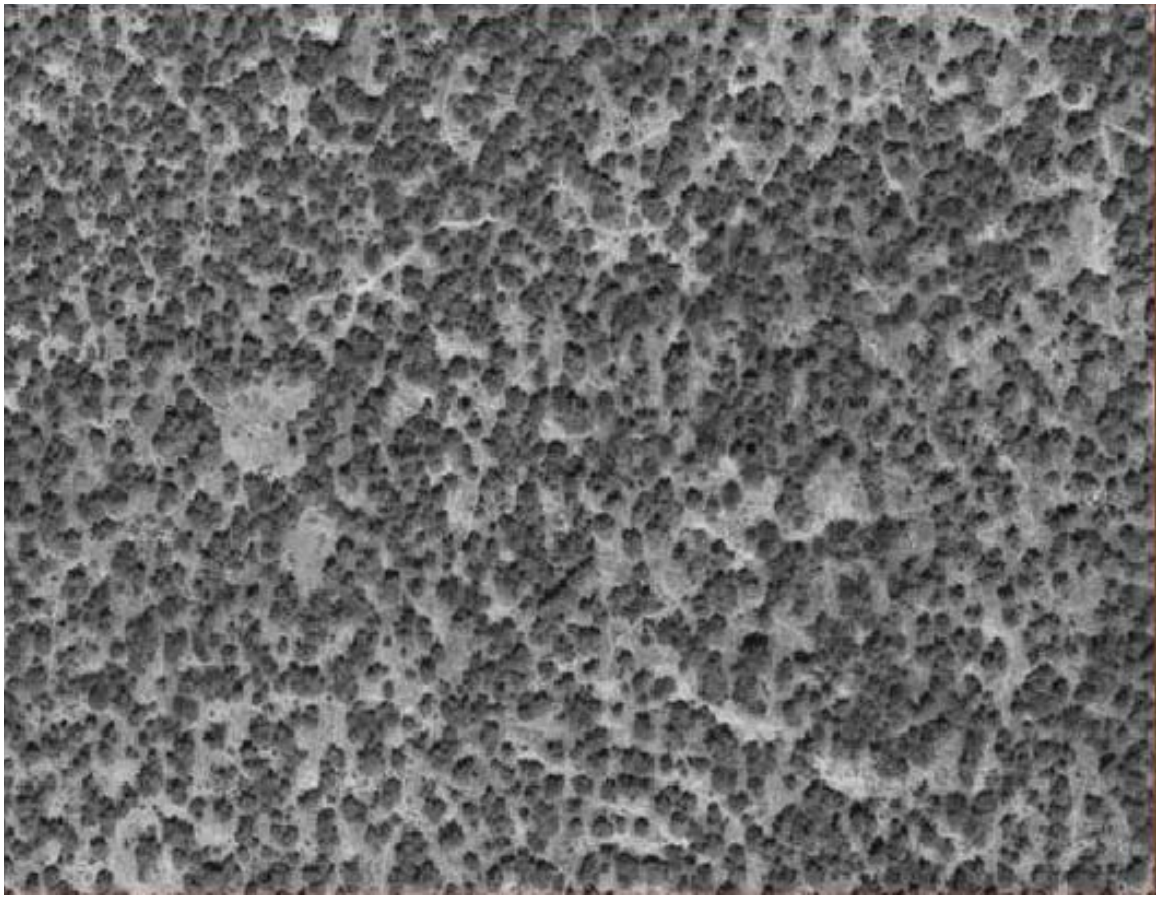


10 Colorado Piñon - Utah Juniper / Big Sagebrush Woodland

Plant communities included	*Pinus edulis - Juniperus* spp. / *Artemisia tridentata* (ssp. *wyomingensis*, ssp. *vaseyana*) Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Sagebrush Woodland (1 of 3)
Total number of map units in project area	141
Number of map units in park	80
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	1,133.5 ha/2,800.8 ac
Area in park	360.3 ha/890.3 ac
Proportion of land cover in park	1.7%
Proportion of map class in project environs	68.2%
Base map class accuracy	user 25.0 (11.8–45.5), producer 36.4 (17.5–60.6)
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 33.3 (19.2–51.3), producer 63.6 (39.4–82.5)
Documentation for base map class	2 2004 relevés, 0 1993 relevés, 16 AA observation sites

Location: This vegetation is found at the southern end of the park, on mesa tops and south-aspect talus skirts. It is also found in dry, flat, piñon-juniper stands in the Mancos River Valley and on the skirts of the escarpment at the far northern end of the study area.

Photosignature: The piñon-juniper canopy is generally sparse. The fine stippling is clearly visible with magnification in the open areas, indicating *Artemisia tridentata*. In true-color photography, these areas have a yellowish tone, which makes it easier to differentiate piñon-juniper stands with *Artemisia tridentata* from piñon-juniper stands with other understory shrubs.

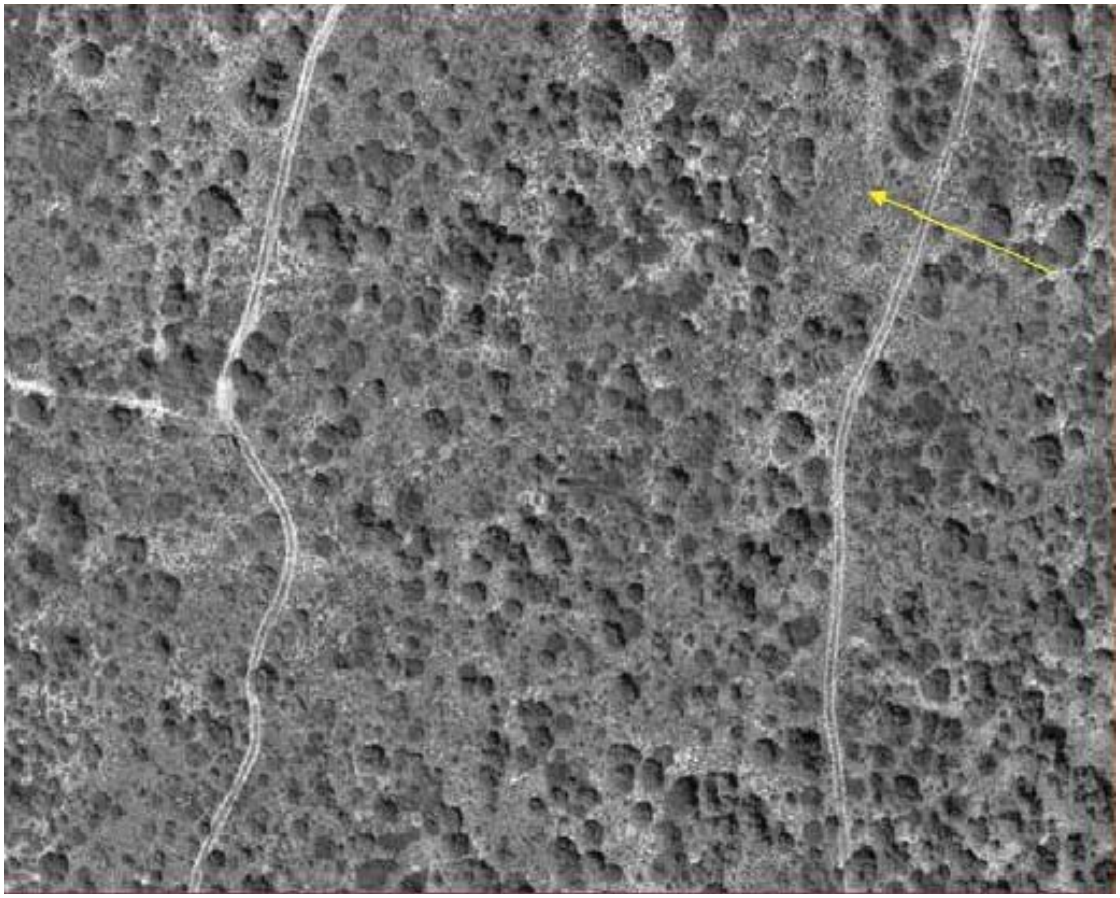


11 Colorado Piñon - Utah Juniper / Black Sagebrush Woodland

Plant communities included	*Pinus edulis - Juniperus osteosperma / Artemisia nova* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Black Sagebrush Woodland (1 of 1)
Total number of map units in project area	79
Number of map units in park	73
Number of total map units less than 0.5 ha	1 (0.1% of total map class area)
Total area	1,910.9 ha/4,722.0 ac
Area in park	1,639.3 ha/4,050.9 ac
Proportion of land cover in park	7.6%
Proportion of map class in project environs	14.2%
Base map class accuracy	user 0.0, producer 0.0
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 0.0, producer 0.0
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class is found on mesas.

Photosignature: The characteristic dark color and sandpaper texture of sagebrush is evident among the piñon-juniper trees. The higher resolution and contrast of the panchromatic imagery makes the *Artemisia* more obvious as a coarse sandpaper texture. The yellow arrow indicates a patch of *Artemisia nova*. In true-color orthophotography, *Artemisia tridentata* understory has a yellowish tone, differentiating it from *Artemisia nova*, which has a dark green color.





12 Colorado Piñon - Utah Juniper / Gambel Oak Woodland

Plant communities included	*Pinus edulis - Juniperus* spp. / *Quercus gambelii* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Mixed Montane Shrubland (1 of 3)
Total number of map units in project area	278
Number of map units in park	246
Number of total map units less than 0.5 ha	2 (0.0% of total map class area)
Total area	1,437.3 ha/3,551.7 ac
Area in park	1,154.1 ha/2,851.8 ac
Proportion of land cover in park	5.3%
Proportion of map class in project environs	19.7%
Base map class accuracy	user 33.3 (19.2–51.3), producer 41.2 (24.1–60.7)
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 66.7 (54.0–77.3), producer 62.2 (50.0–73.1)
Documentation for base map class	8 2004 relevés, 14 1993 relevés, 27 AA observation sites

Location: This vegetation occurs throughout the piñon-juniper woodlands of the park, both in the north and south, on the cuesta and the escarpment. This vegetation class may occur on mesas or on canyon slopes or canyon bottoms. It is most commonly in more sheltered, narrow, and shallow canyon draws.

Photosignature: The oak understory is dense and homogeneously dark green, generally a more vivid shade of green than the piñon-juniper overstory, but just as dark. The piñon-juniper trees appear to be growing out of a dense green carpet.



13 Colorado Piñon - Utah Juniper / James' Galleta Woodland

Plant communities included	*Pinus edulis - Juniperus osteosperma / Pleuraphis jamesii* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Sagebrush Woodland (1 of 3)
Total number of map units in project area	20
Number of map units in park	17
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	194.6 ha/480.9 ac
Area in park	125.8 ha/310.9 ac
Proportion of land cover in park	0.6%
Proportion of map class in project environs	35.3%
Base map class accuracy	user 0.0, producer NS
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 33.3 (19.2–51.3), producer 63.6 (39.4–82.5)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class is located in the Mancos River Valley. This vegetation class occurs on upland slopes adjacent to the river.

Photosignature: Stand boundaries were identified by field observation. The signature is similar to Colorado Piñon - Utah Juniper / Shale Sparse Vegetation. The tree canopy and understory are both sparse, exposing the upslope shale substrate, which appears bright on the panchromatic photography. The two classes were distinguished through field identification.



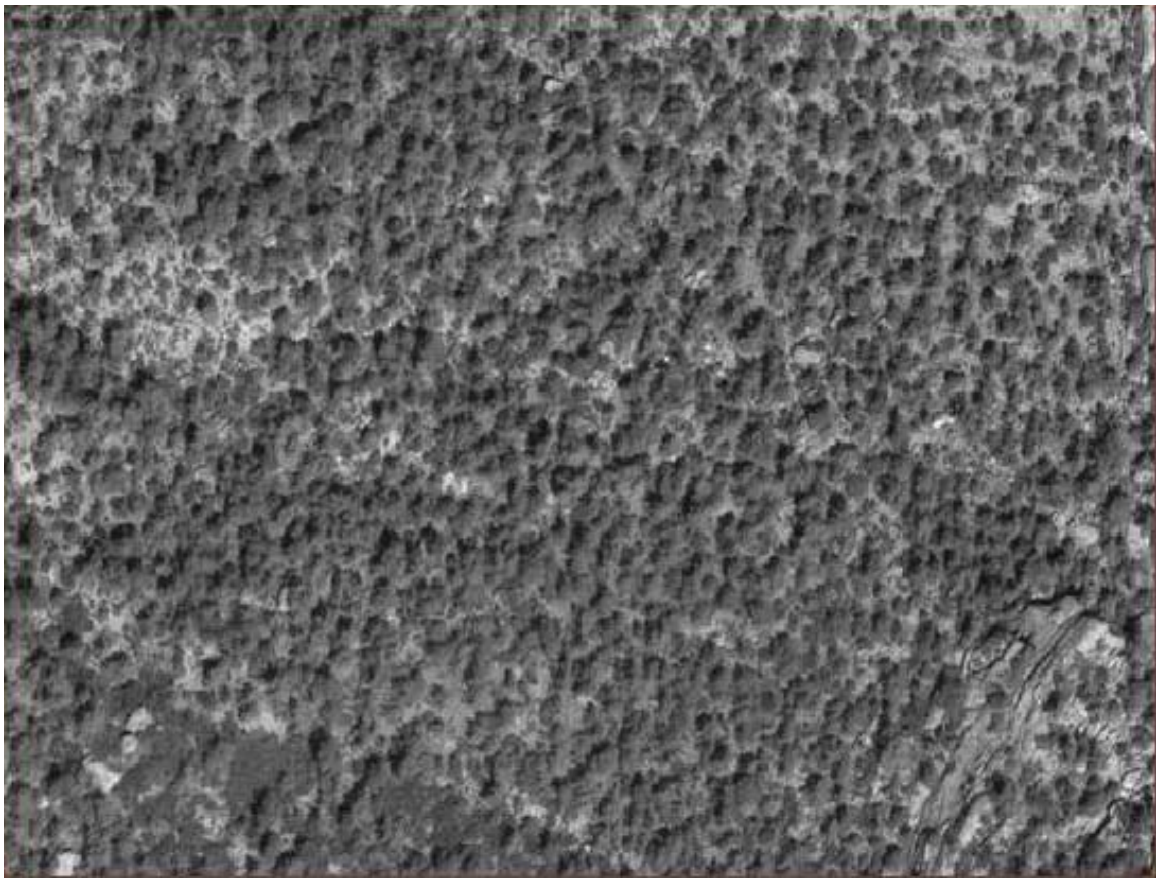


14 Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland

Plant communities included	*Pinus edulis - Juniperus* spp. / *Cercocarpus montanus* Mixed Shrub Woodland, *Pinus edulis - Juniperus osteosperma* / *Amelanchier utahensis* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Mixed Montane Shrubland (1 of 3)
Total number of map units in project area	295
Number of map units in park	263
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	4,956.9 ha/12,248.9 ac
Area in park	2,444.4 ha/6,040.2 ac
Proportion of land cover in park	11.3%
Proportion of map class in project environs	50.7%
Base map class accuracy	user 42.9 (26.9–60.4), producer 32.1 (19.8–47.7)
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 66.7 (54.0–77.3), producer 62.2 (50.0–73.1)
Documentation for base map class	2 2004 relevés, 2 1993 relevés, 40 AA observation sites

Location: This woodland occurs on mesas and in canyons on any aspect and slope, but is more likely on steeper slopes in canyons.

Photosignature: Because Colorado Piñon - Utah Juniper / Mixed Montane Shrub Woodland is a mosaic of other piñon-juniper woodland classes, the density and pattern of the canopy and understory shrubs is highly variable and includes photosignatures from other piñon-juniper woodland classes.



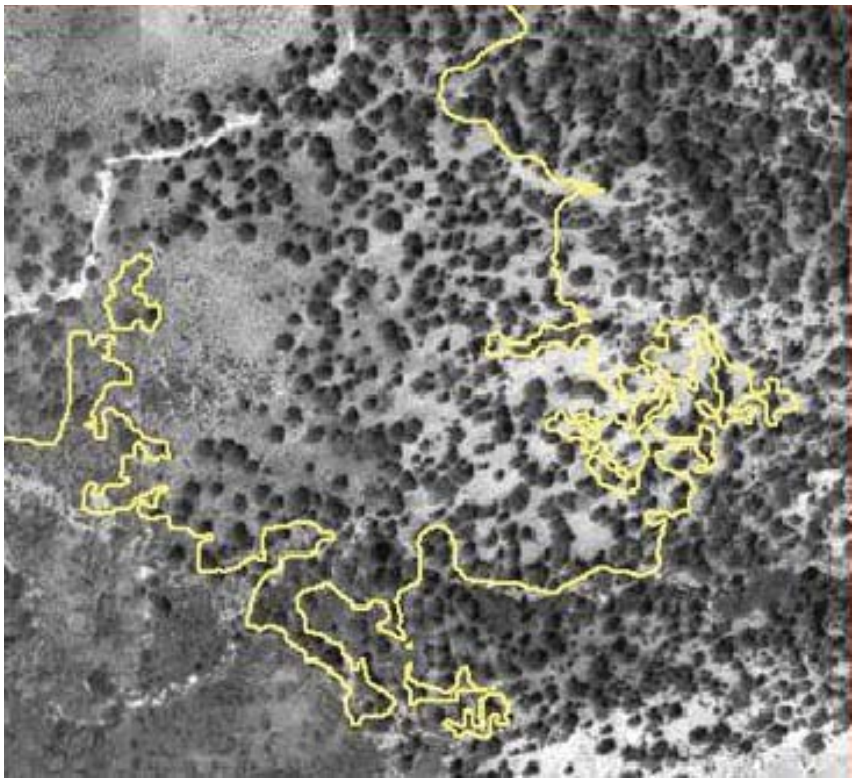


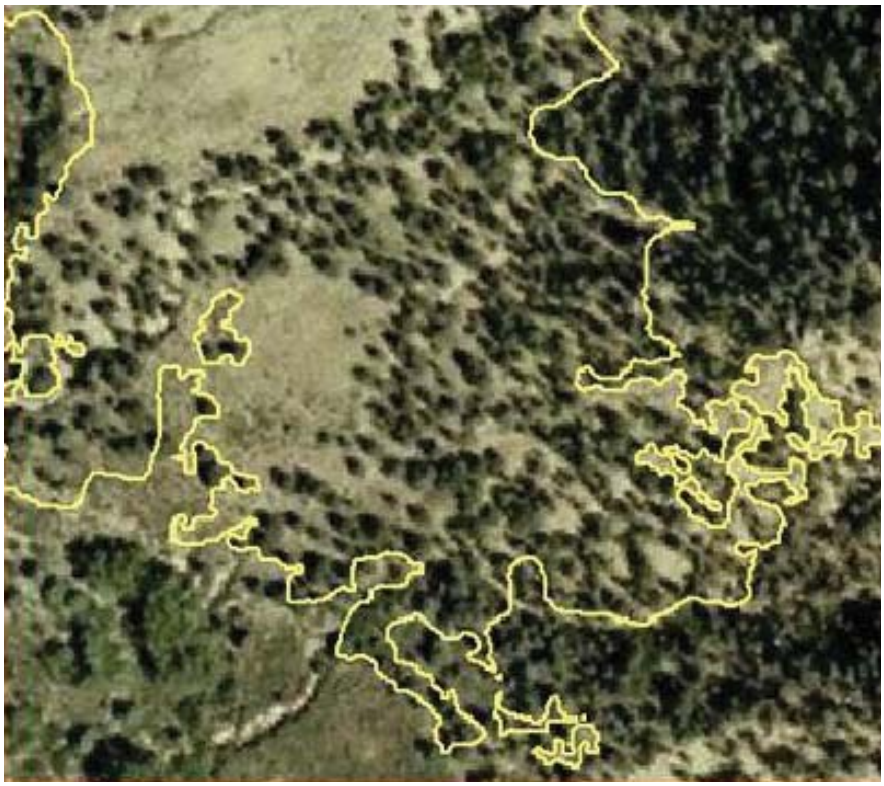
15 Colorado Piñon - Utah Juniper / Needle-and-Thread Woodland

Plant communities included	*Pinus edulis* - (*Juniperus monosperma*, *Juniperus osteosperma*) / *Hesperostipa comata* Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Sagebrush Woodland (1 of 3)
Total number of map units in project area	2
Number of map units in park	5
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	11.1 ha/27.5 ac
Area in park	5.5 ha/13.5 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	51.1%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 33.3 (19.2–51.3), producer 63.6 (39.4–82.5)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 1 AA observation sites

Location: This vegetation is located in the Mancos River Valley on upland slopes adjacent to the river.

Photosignature: Stand boundaries were identified by field observation. The signature appears to be similar to Colorado Piñon - Utah Juniper / Shale Sparse Woodland. The tree canopy and understory are both sparse, exposing the upslope shale substrate, which appears bright on the panchromatic photography. The two classes were distinguished through field identification of Colorado Piñon - Utah Juniper / Needle and Thread Woodland.





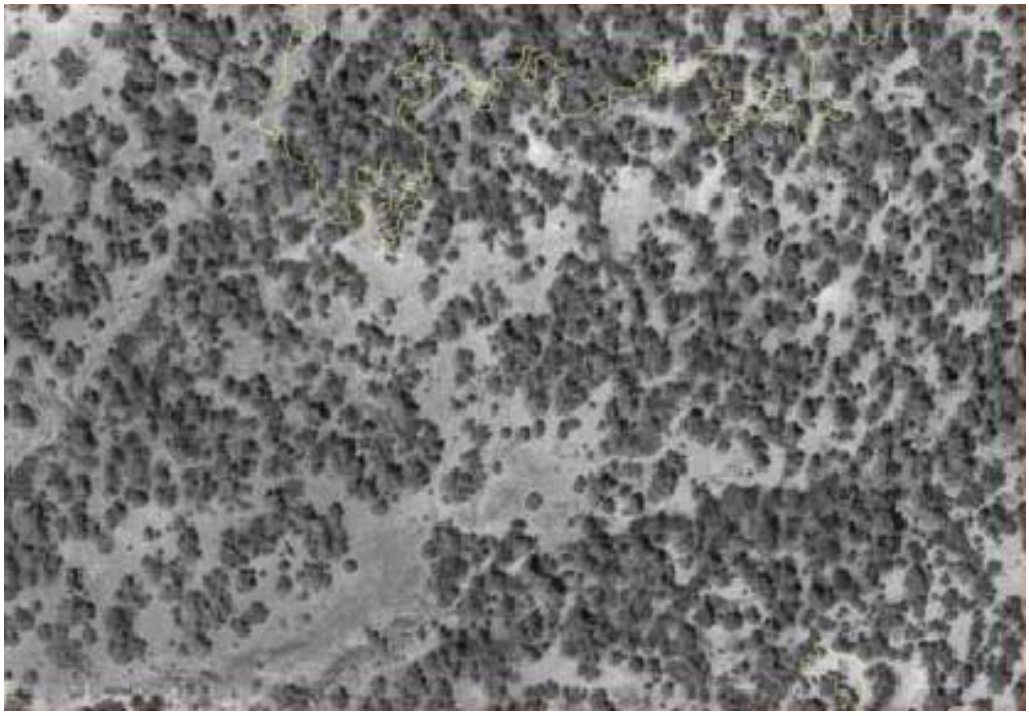


16 Colorado Piñon - Utah Juniper / Shale Sparse Woodland

Plant communities included	*Pinus edulis - Juniperus* spp. / Shale Sparse Woodland [Park Special]
Group map class included within	Colorado Plateau Mixed Bedrock Canyon and Tableland (1 of 4)
Management map class included within	Mancos Shale Vegetation (1 of 4)
Total number of map units in project area	223
Number of map units in park	145
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	1,101.1 ha/2,720.9 ac
Area in park	332.2 ha/820.8 ac
Proportion of land cover in park	1.5%
Proportion of map class in project environs	69.8%
Base map class accuracy	user 27.8 (14.2–47.1), producer 45.5 (24.2–68.5)
Group map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Management map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 14 AA observation sites

Location: This vegetation occurs throughout the lower elevations of the escarpment in the north and upslope of the Mancos River Valley in the east. This vegetation class occurs on shale slopes.

Photosignature: The signature is a sparse to dense piñon-juniper overstory with very sparse understory. Shrubs are generally not obvious and not dense enough to form any notable texture or signature. The pale shale substrate is clearly visible between the trees. This vegetation class was distinguished from similar Colorado Piñon - Utah Juniper / James' Galleta and Colorado Piñon - Utah Juniper / Needle and Thread woodlands by field identification.





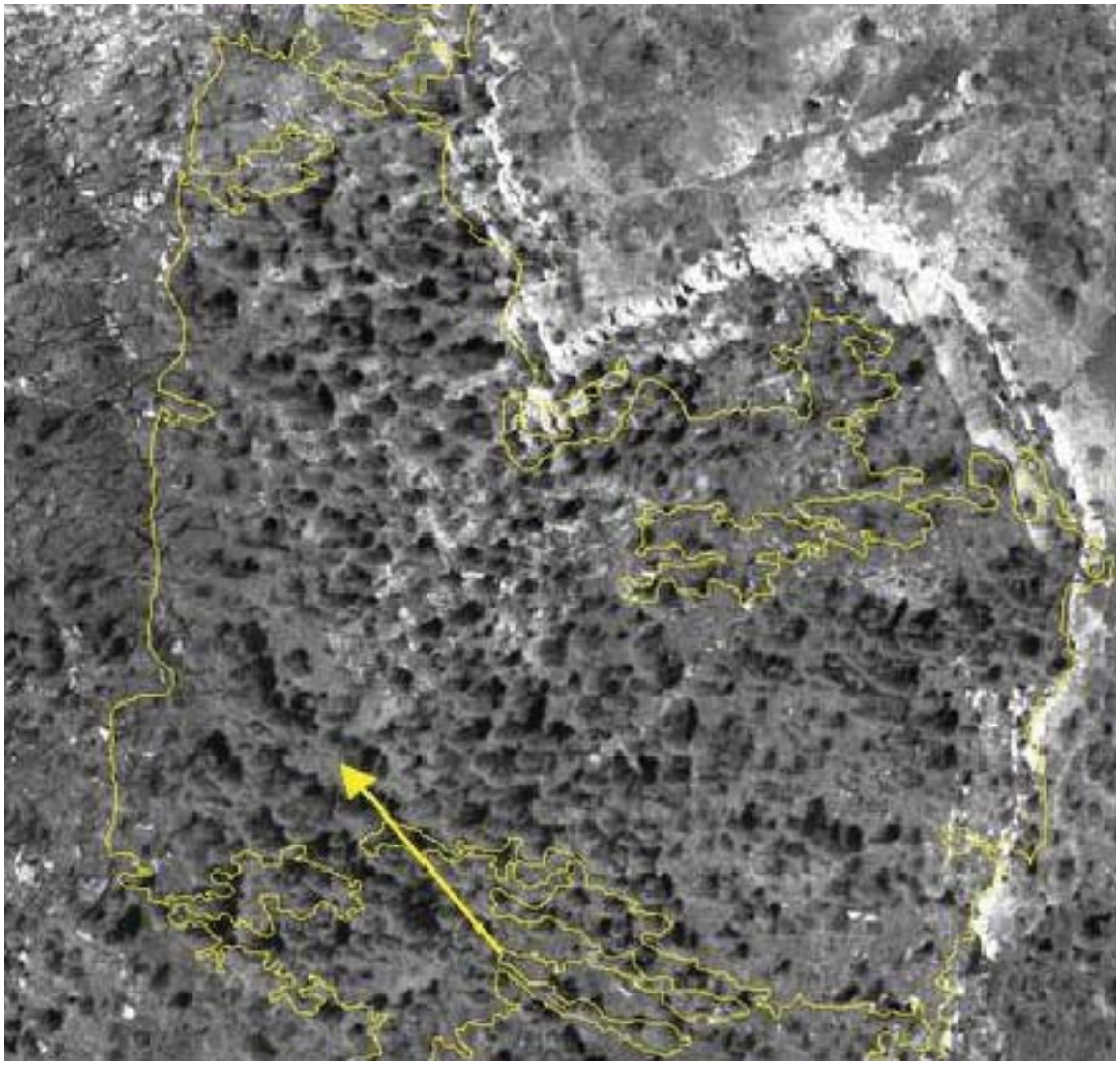


17 Douglas-fir / Boxelder Woodland

Plant communities included	*Pseudotsuga menziesii* / *Acer negundo* Woodland
Group map class included within	Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland (1 of 2)
Management map class included within	Douglas-fir / Boxelder Woodland (1 of 1)
Total number of map units in project area	1
Number of map units in park	1
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	6.4 ha/15.9 ac
Area in park	6.4 ha/15.9 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 100 (27.0–100.0), producer 100 (27.0–100.0)
Group map class accuracy	user 77.8 (50.4–92.3), producer 100 (72.1–100.0)
Management map class accuracy	user 100 (27.0–100.0), producer 100 (27.0–100.0)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 1 AA observation sites

Location: Douglas-fir / Boxelder Woodland occurs at one location to the west of Morefield Campground. The stand is nestled at the base of two slopes at the head of a small canyon.

Photosignature: This type is not easily visible on true-color or panchromatic digital photography. It is more easily seen on hard-copy aerial photographs due to the difference in color wash on these photos. The Douglas-fir is obvious as large, conical canopies. The boxelder can be seen on the hard-copy photos as lighter green, shorter understory with a fluffy texture, filling in the gaps between the Douglas-fir crowns. The yellow arrow below is pointing to a higher density of boxelder.



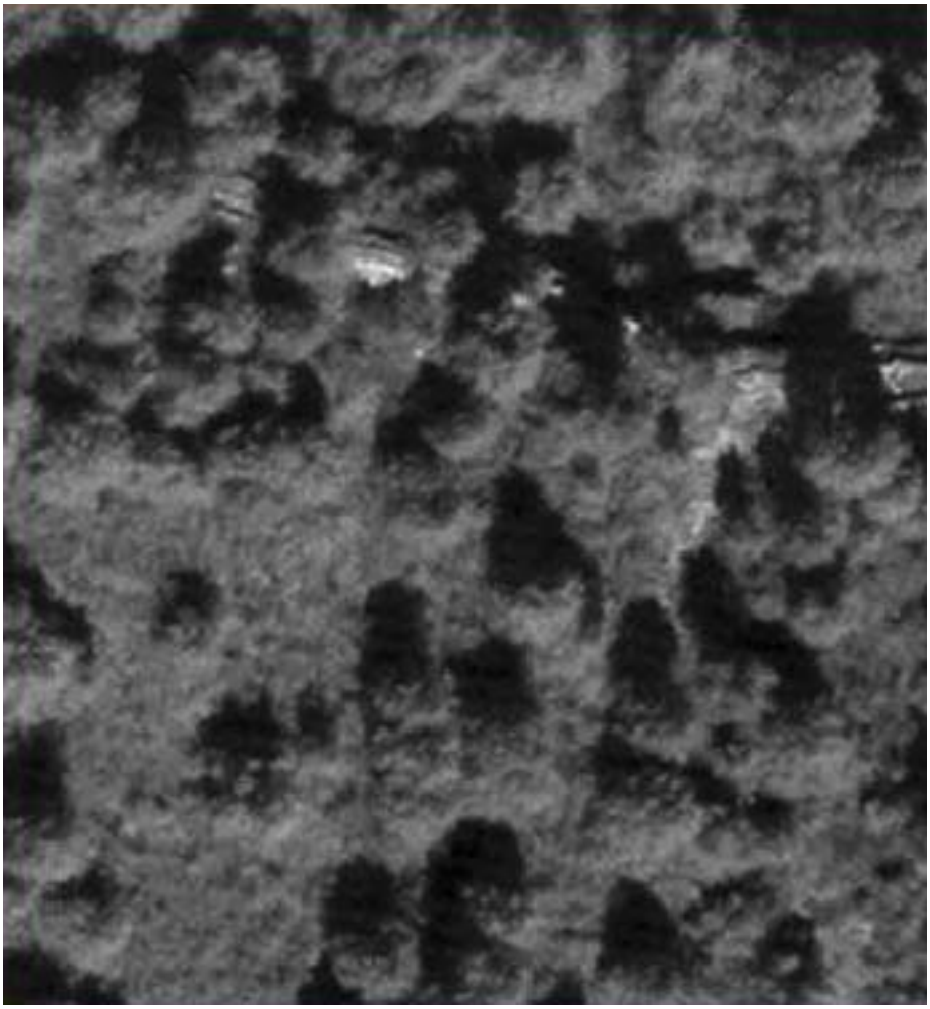


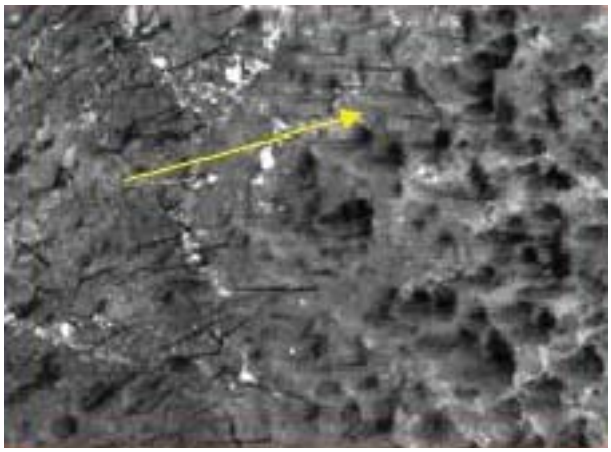
18 Douglas-fir / Gambel Oak Forest

Plant communities included	*Pseudotsuga menziesii* / *Quercus gambelii* Forest
Group map class included within	Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland (1 of 2)
Management map class included within	Douglas-fir / Gambel Oak Forest (1 of 1)
Total number of map units in project area	282
Number of map units in park	272
Number of total map units less than 0.5 ha	212 (7.0% of total map class area)
Total area	271.2 ha/670.1 ac
Area in park	245.0 ha/617.7 ac
Proportion of land cover in park	1.2%
Proportion of map class in project environs	7.8%
Base map class accuracy	user 75.0 (46.0–91.3), producer 100.0 (68.9–100.0)
Group map class accuracy	user 77.8 (50.4–92.3), producer 100 (72.1–100.0)
Management map class accuracy	user 75.0 (46.0–91.3), producer 100.0 (68.9–100.0)
Documentation for base map class	2 2004 relevés, 1 1993 relevés, 10 AA observation sites

Location: Douglas-fir stands are generally found in deep, narrow canyons. In such canyons, they may occur on any slope and aspect. Douglas-fir stands also occur on steep, north to northwest-facing open slopes. Although sites in deep canyons may show signs of intermittent flooding, on steep upland slopes they occur without signs of flooding.

Photosignature: Douglas-fir stands have a distinctive texture of large, individual crowns. Depending on the angle of the image, the trees may look softly rounded or conical. The image shows the density of Gambel oak in the understory at this site, which is typical of this vegetation class. To reliably distinguish between living trees and dead, it is useful to refer to both the true-color and panchromatic imagery. In panchromatic imagery, dead trees are generally clearly visible as bare trunks. The two images on the bottom are from the same site. The yellow arrow indicates several dead *Pseudotsuga menziesii*.









19 Lanceleaf Cottonwood Riparian Woodland

Plant communities included	*Populus angustifolia* / Invasive Perennial Grasses Semi-natural Woodland
Group map class included within	Rocky Mountain Lower Montane Riparian Woodland and Shrubland (1 of 3)
Management map class included within	Mancos River Woodland and Shrubland (1 of 3)
Total number of map units in project area	24
Number of map units in park	33
Number of total map units less than 0.5 ha	20 (8.9% of total map class area)
Total area	18.7 ha/46.1 ac
Area in park	16.2 ha/40.0 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	13.2%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Management map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Documentation for base map class	2 2004 relevés, 3 1993 relevés, 0 AA observation sites

Location: This vegetation class occurs along the Mancos River corridor on flats immediately adjacent to the river.

Photosignature: Cottonwood trees have broad, fluffy canopies. The *Bromus inermis* understory is generally a deep, rich green but may vary somewhat in tone and texture. The color of herbaceous vegetation varies greatly with its phenological status, which can vary from location to location at the same time of season. As such, timing of photography acquisition over different locations will show the same herbaceous vegetation classes displaying different colors. The yellow arrows indicate cottonwood trees.





20 Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland

Plant communities included	*Populus angustifolia - Juniperus scopulorum* Woodland
Group map class included within	Rocky Mountain Lower Montane Riparian Woodland and Shrubland (1 of 3)
Management map class included within	Mancos River Woodland and Shrubland (1 of 3)
Total number of map units in project area	36
Number of map units in park	43
Number of total map units less than 0.5 ha	23 (6.4% of total map class area)
Total area	42.5 ha/104.9 ac
Area in park	20.0 ha/49.5 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	52.8%
Base map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Group map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Management map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 2 AA observation sites

Location: Mancos River Valley riparian area. This vegetation class occurs on flats adjacent to the active river channel.

Photosignature: Cottonwood has large round crowns. The stands of cottonwood and juniper are generally dense and a somewhat lighter shade of green than piñon-juniper stands. The yellow arrows are pointing to the same cottonwood trees.

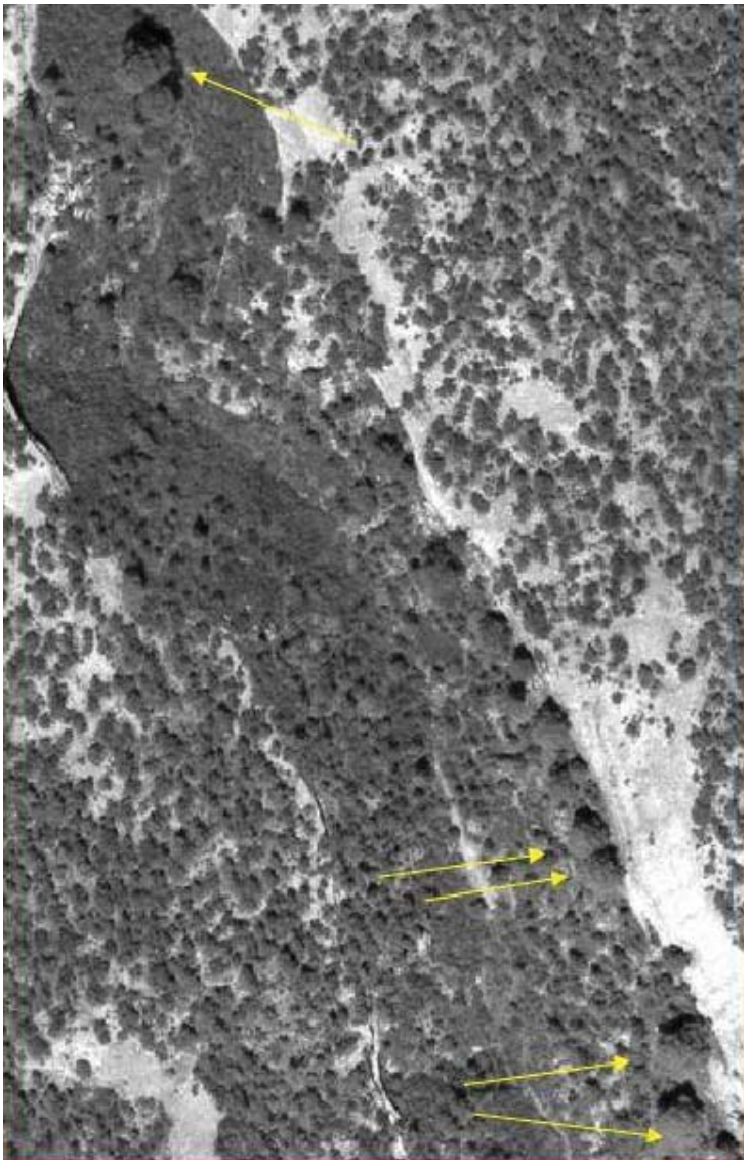


21 Ponderosa Pine Woodland

Plant communities included	*Pinus ponderosa* Woodland Alliance
Group map class included within	Southern Rocky Mountain Ponderosa Pine Woodland (1 of 1)
Management map class included within	Ponderosa Pine Woodland (1 of 1)
Total number of map units in project area	13
Number of map units in park	9
Number of total map units less than 0.5 ha	11 (28.2% of total map class area)
Total area	2.9 ha/7.1 ac
Area in park	1.4 ha/3.5 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	51.1%
Base map class accuracy	user 0.0, producer NS
Group map class accuracy	user 0.0, producer NS
Management map class accuracy	user 0.0, producer NS
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Ponderosa pine woodlands occur throughout the cuesta of the park. Individual ponderosa pine trees have been recorded by GPS by park personnel as part of a separate effort and are available as a separate dataset from the park GIS coordinator.

Photosignature: Ponderosa pines have large, round crowns. They tend to occur in small groups, and individual trees are clearly visible. On aerial photography, this tree can be confused with Douglas-fir superficially, but comparison to known stands of Douglas-fir show that Douglas-fir crowns are significantly smaller. The yellow arrows point to individual ponderosa pine trees.

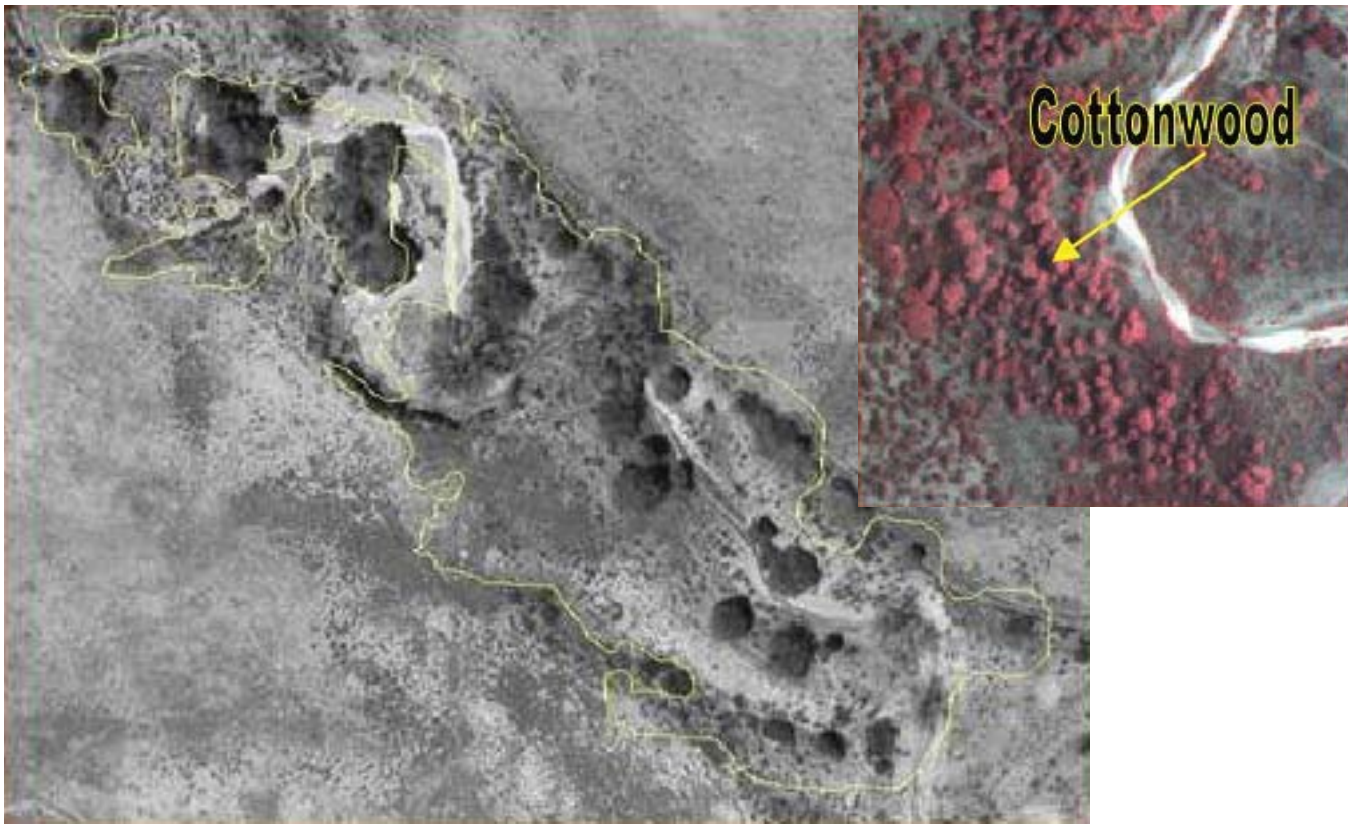


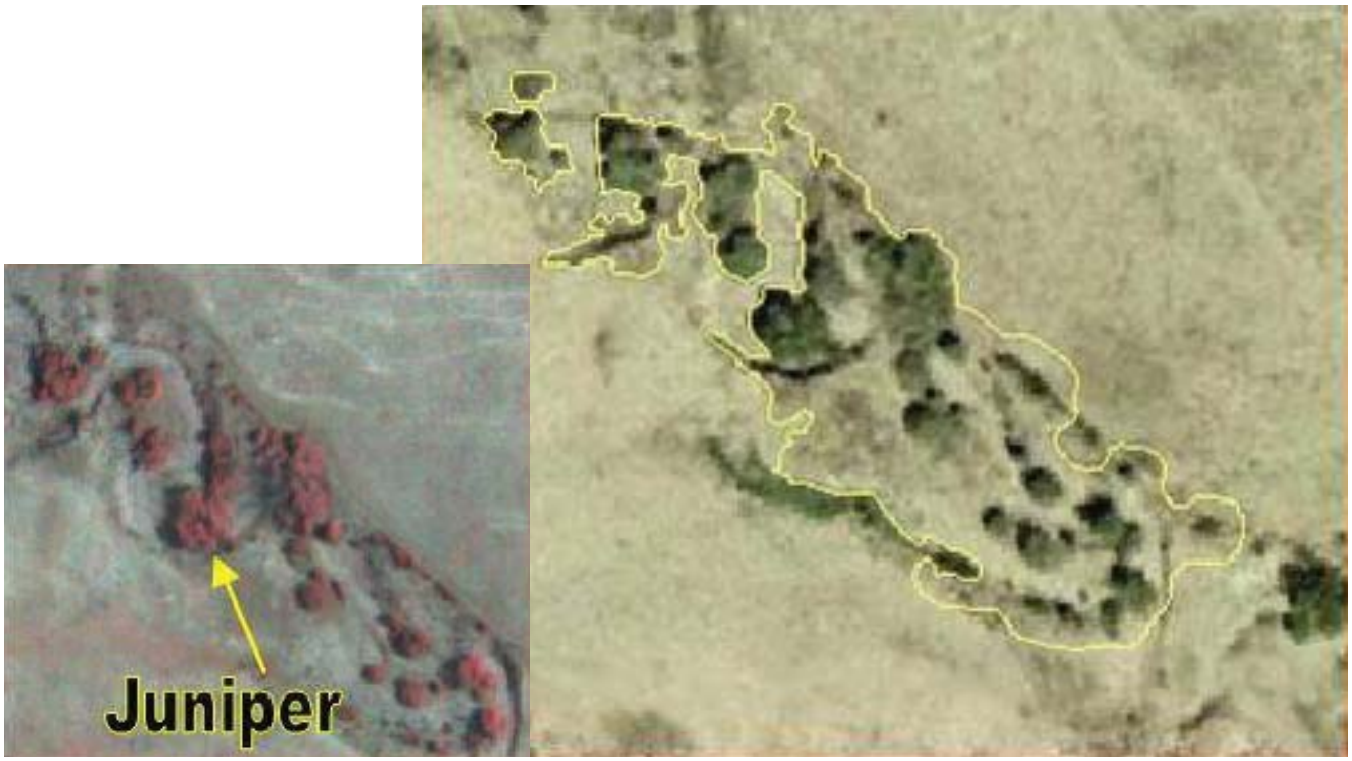
22 Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland

Plant communities included	*Juniperus scopulorum* / *Bromus inermis* (*Pascopyrum smithii*) Woodland
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper / Mixed Montane Shrubland (1 of 3)
Total number of map units in project area	1
Number of map units in park	0
Number of total map units less than 0.5 ha	# (0.1% of total map class area)
Total area	0.7 ha/1.8 ac
Area in park	0 ha/0 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	100.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 85.2 (77.9–90.4), producer 84.3 (76.9–89.6)
Management map class accuracy	user 66.7 (54.0–77.3), producer 62.2 (50.0–73.1)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class is located in the Mancos River Valley. This vegetation class occurs along drainages and the river channel.

Photosignature: The large canopies of *Juniperus scopulorum* are clearly visible against the grassland understory. These canopies can be confused with cottonwoods based on location (streamside) and size and shape. The *Juniperus scopulorum* canopies can be distinguished from cottonwood using color-infrared photography. The canopies of cottonwood are a brighter red, more pink, than the *Juniperus scopulorum* canopies. The two infrared photographs compare the two signatures. The juniper canopies in the Mancos River Valley are larger than elsewhere in the park, most likely due to the more available water and deeper soils.


Cottonwood


Juniper

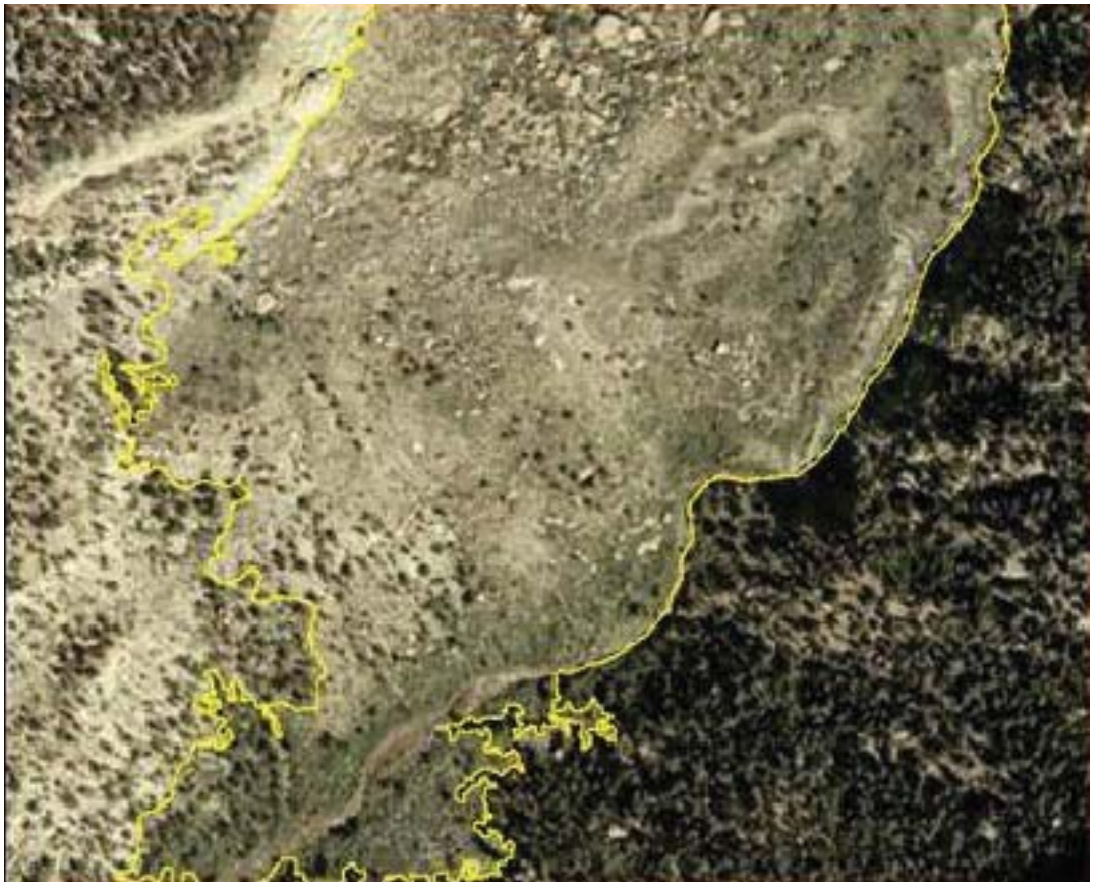


23 Big Sagebrush Shrubland

Plant communities included	*Artemisia tridentata* ssp. *wyomingensis* / *Hesperostipa comata* Colorado Plateau Shrubland, *Artemisia tridentata* - (*Ericameria nauseosa*) / *Bromus tectorum* Semi-natural Shrubland
Group map class included within	Inter-Mountain Basins Big Sagebrush Shrubland (1 of 5)
Management map class included within	Big Sagebrush Shrubland (1 of 5)
Total number of map units in project area	138
Number of map units in park	111
Number of total map units less than 0.5 ha	1 (0.0% of total map class area)
Total area	927.8 ha/2292.6 ac
Area in park	189.1 ha/467.3 ac
Proportion of land cover in park	0.9%
Proportion of map class in project environs	79.6%
Base map class accuracy	user 40.0 (24.2–58.1), producer 57.1 (36.0–75.9)
Group map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Management map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Documentation for base map class	2 2004 relevés, 0 1993 relevés, 13 AA observation sites

Location: This vegetation class occurs north of the escarpment outside of the park, within the Mancos River Valley, and on talus slopes in the southern canyons.

Photosignature: *Artemisia tridentata* shrublands tend to have dark, dense signatures. On true-color photography, the tone is brown to gray-brown with some moderate mottling; the overall texture is like sandpaper. On panchromatic photography, the signature is quite dark and dense and the texture is similar to the appearance on true-color imagery.

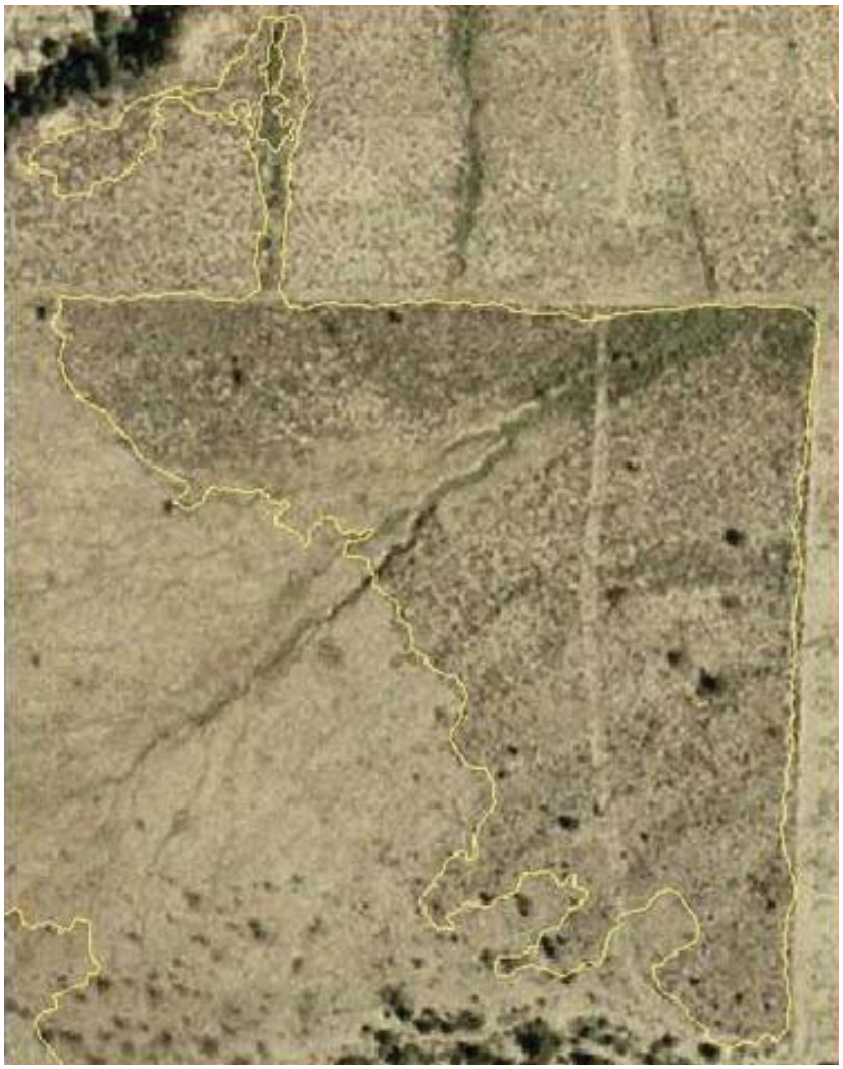


24 Big Sagebrush / James' Galleta Shrubland

Plant communities included	*Artemisia tridentata* ssp. *tridentata* / *Pleuraphis jamesii* Shrubland
Group map class included within	Inter-Mountain Basins Big Sagebrush Shrubland (1 of 5)
Management map class included within	Big Sagebrush Shrubland (1 of 5)
Total number of map units in project area	4
Number of map units in park	3
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	21.1 ha/52.0 ac
Area in park	18.6 ha/45.9 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	11.7%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Management map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: Identified by park resource management during field observation in spring 2006. This vegetation class occurs in the Mancos River area on fallow agricultural fields.

Photosignature: Dark and dense stippling indicates dense *Artemisia*. The grass understory was identified in the field as *Pleuraphis jamesii*.





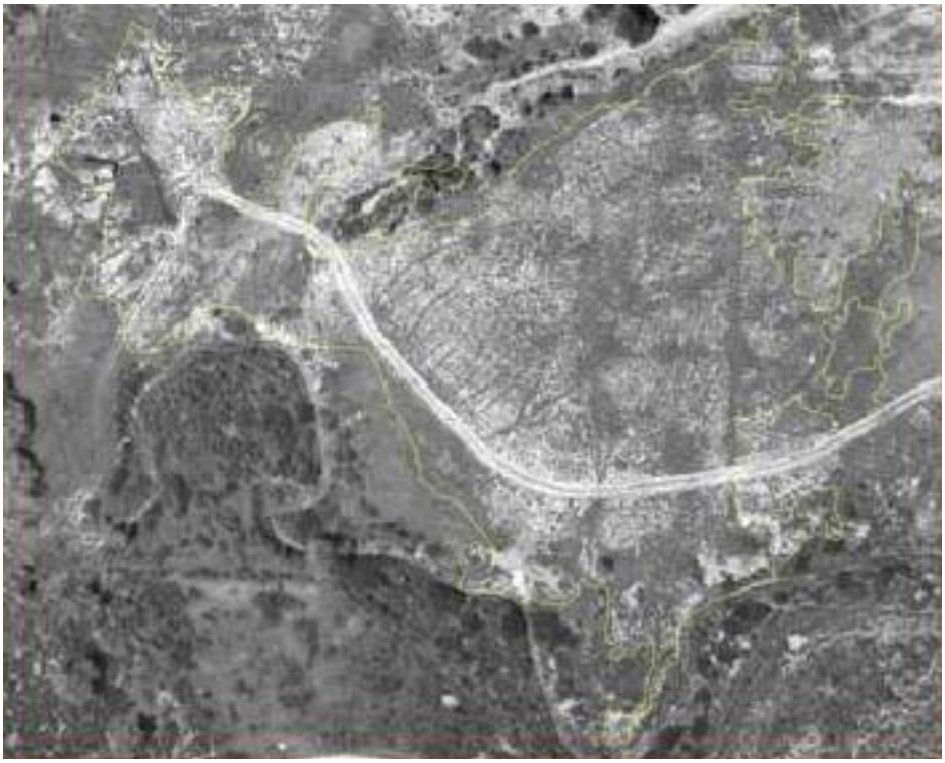
25 Big Sagebrush / Western Wheatgrass Shrubland

Plant communities included	*Artemisia tridentata* ssp. *tridentata* / *Pascopyrum smithii* - (*Elymus lanceolatus*) Shrubland
Group map class included within	Inter-Mountain Basins Big Sagebrush Shrubland (1 of 5)
Management map class included within	Big Sagebrush Shrubland (1 of 5)
Total number of map units in project area	1
Number of map units in park	0
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	1.6 ha/3.9 ac
Area in park	0 ha/0 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	100.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Management map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 1 AA observation sites

Location: This vegetation class occurs in the Mancos River Valley on broad flats of land cleared for agriculture.

Photosignature: On both types of photography, this type is mottled and blotchy. Dark green pockets of *Artemisia* occur in deeper rills and alternate with flat and open wheatgrass meadow. The darker lines visible in the true-color photograph are rills. The pale tan color in the true-color photography and the stippled light gray in the panchromatic photography indicate wheatgrass meadow.





26 Bitterbrush / Indian Ricegrass Shrubland

Plant communities included	*Purshia tridentata* / *Achnatherum hymenoides* - *Poa fendleriana* Shrubland [Park Special]
Group map class included within	Rocky Mountain Gambel Oak-Mixed Montane Shrubland (1 of 5)
Management map class included within	Mixed Montane Shrubland (1 of 5)
Total number of map units in project area	3
Number of map units in park	4
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	13.8 ha/34.1 ac
Area in park	12.1 ha/29.8 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	12.6%
Base map class accuracy	user 0.0, producer NS
Group map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.4)
Management map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.1)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class is located on mesa tops in recently burned areas.

Photosignature: There is no obvious signature to differentiate this vegetation class from other mixed shrubs. Polygons were labeled using field observations. Site boundaries were extrapolated based on similarity of texture and tone in the immediate vicinity of the observation point.



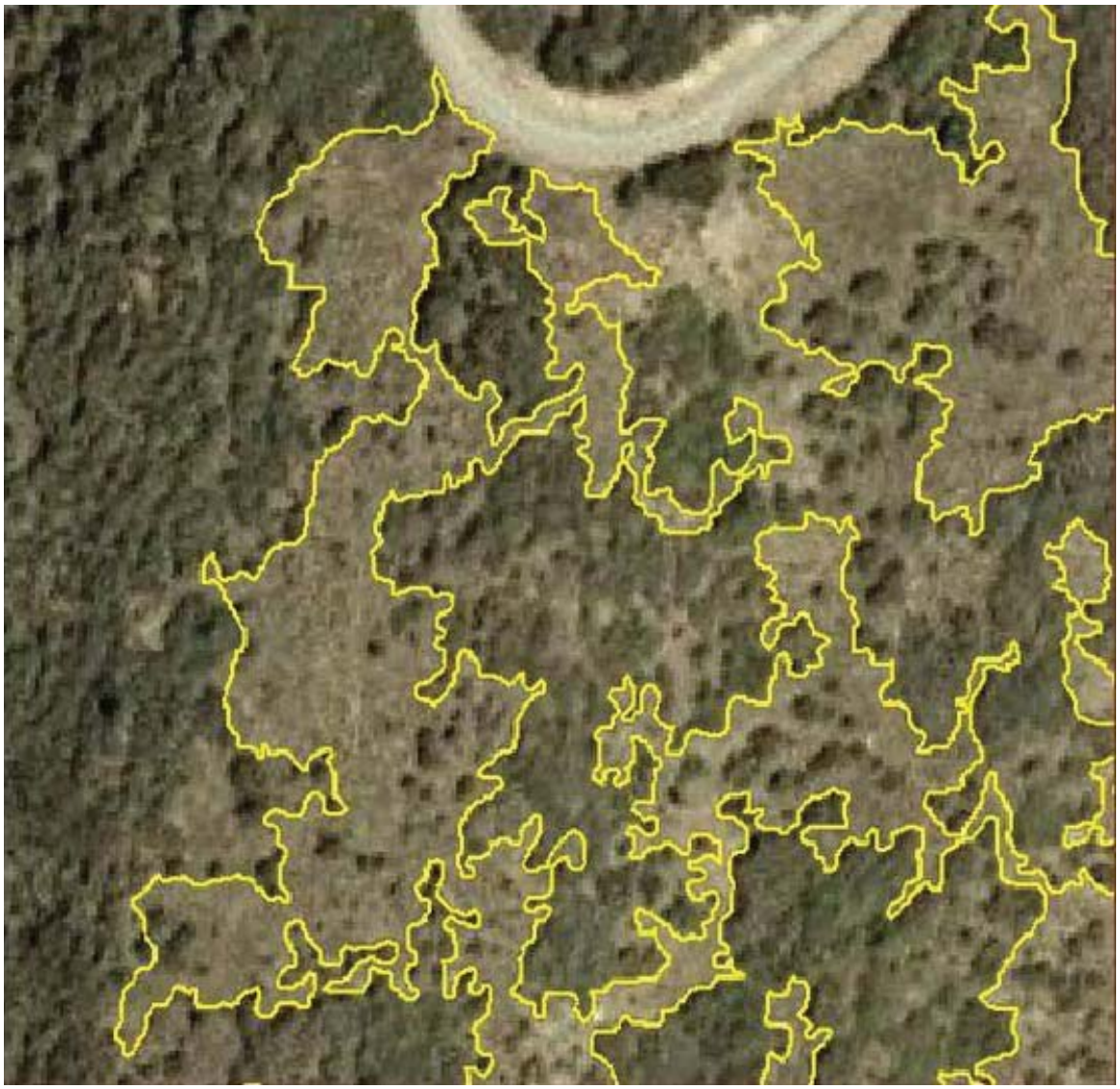


27 Black Sagebrush Shrub Herbaceous Vegetation

Plant communities included	*Artemisia nova* / *Hesperostipa comata* Shrubland
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Rabbitbrush Shrub Herbaceous Vegetation (1 of 4)
Total number of map units in project area	6
Number of map units in park	6
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	15.9 ha/39.4 ac
Area in park	15.9 ha/39.4 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 16.7 (3.8–50.2), producer 33.3 (7.8–74.6)
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 68.4 (55.2–79.2), producer 72.2 (58.7–82.6)
Documentation for base map class	3 2004 relevés, 0 1993 relevés, 5 AA observation sites

Location: This vegetation class is located near the top (north) of the cuesta towards the middle of the park. This vegetation is found amidst oak and mixed shrubs in a general shrubland environment. *Artemisia nova* occurring in woodland areas belongs to the Colorado Piñon - Utah Juniper) / Black Sagebrush Woodland.

Photosignature: The photosignature of this vegetation shows some of the characteristic sandpaper texture associated with sagebrush, but it is not as dark and dense as the *Artemisia tridentata* signature. There is more grass in this vegetation class, so the texture is less coarse and the color and tone tend more to green and tan than the gray and gray-brown of an *Artemisia tridentata* site.





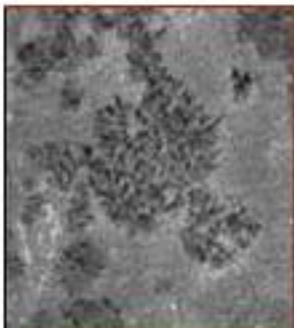
28 Choke Cherry Shrubland

Plant communities included	*Prunus virginiana* - (*Prunus americana*) Shrubland
Group map class included within	Rocky Mountain Gambel Oak-Mixed Montane Shrubland (1 of 5)
Management map class included within	Mixed Montane Shrubland (1 of 5)
Total number of map units in project area	5
Number of map units in park	5
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	21.8 ha/53.9 ac
Area in park	21.8 ha/53.9 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 20.0 (4.6–56.5), producer 50.0 (12.1–87.9)
Group map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.4)
Management map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.1)
Documentation for base map class	2 2004 relevés, 0 1993 relevés, 2 AA observation sites

Location: This vegetation class is located near the north end of the cuesta near the middle of the park, in a gently sloping valley surrounded by hills of oak and mixed shrubland.

Photosignature: The choke cherry shrublands have a special texture that is dissimilar to other tree and shrub photosignatures. The texture is reminiscent of polarized graphite filings. The color is dense and dark green, similar to the surrounding oak.





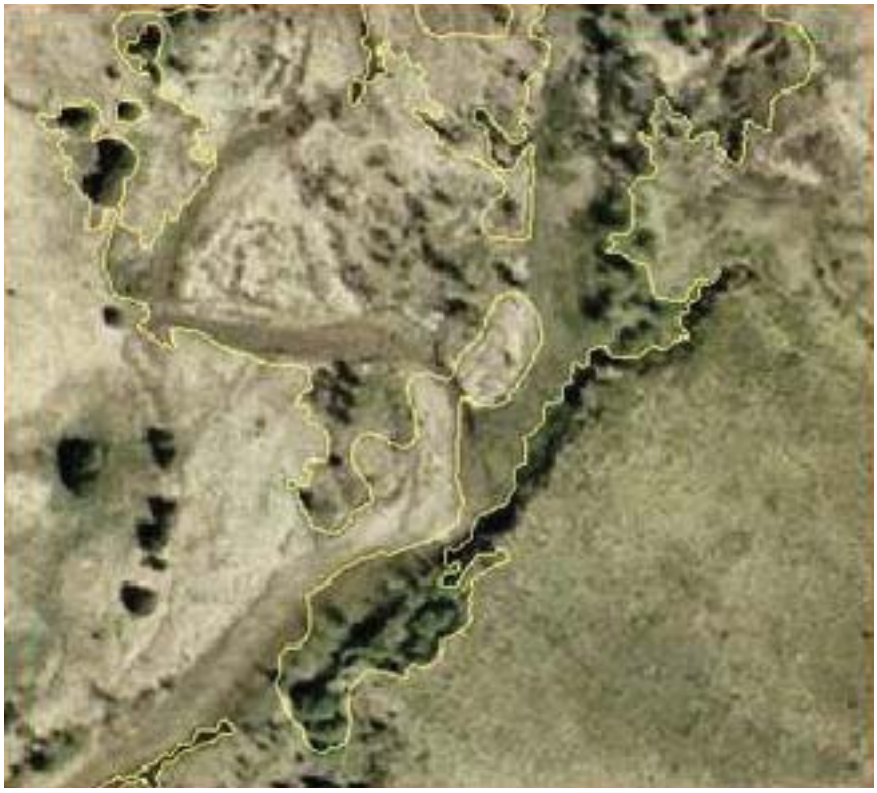


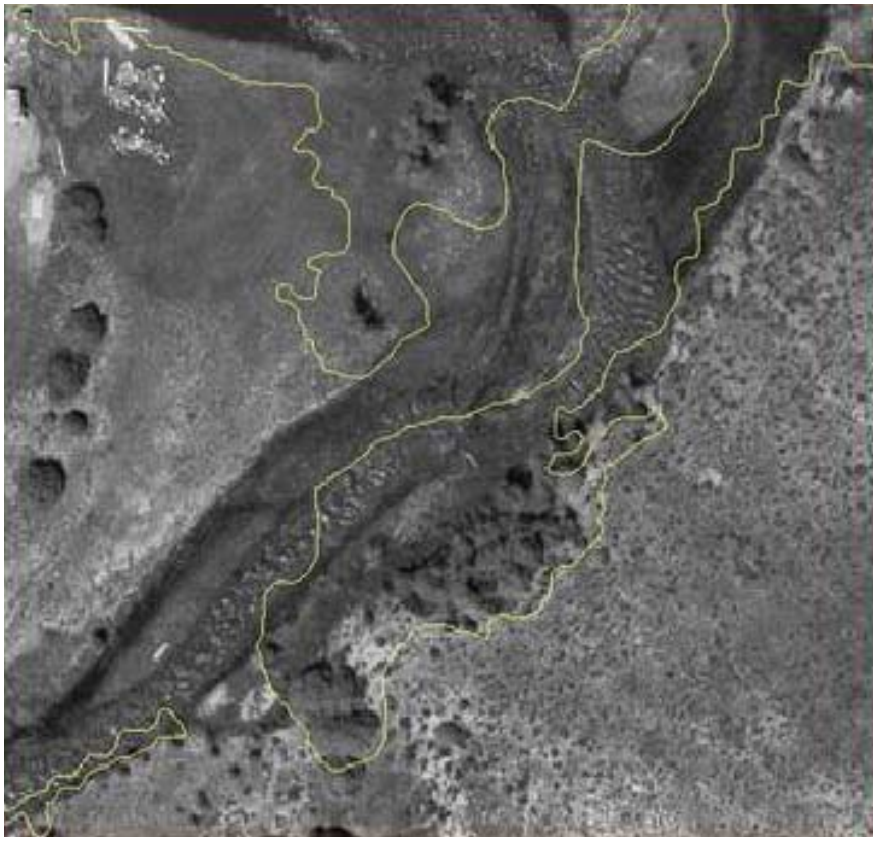
29 Coyote Willow / Mesic Forb Shrubland

Plant communities included	*Salix exigua* / Mesic Forbs Shrubland
Group map class included within	Rocky Mountain Lower Montane Riparian Woodland and Shrubland (1 of 3)
Management map class included within	Mancos River Woodland and Shrubland (1 of 3)
Total number of map units in project area	9
Number of map units in park	9
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	28.8 ha/71.3 ac
Area in park	5.0 ha/12.4 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	82.6%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Management map class accuracy	user 50.0 (12.1–87.9), producer 100.0 (27.0–100.0)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 2 AA observation sites

Location: This vegetation class is located within the Mancos River Valley directly alongside waterways.

Photosignature: Willow canopies are smaller, and the stands often denser, than cottonwood canopies and stands. The herbaceous component of the vegetation is highly variable in signature, as it is composed of different groups of herbs and forbs and phenological state varies from site to site.





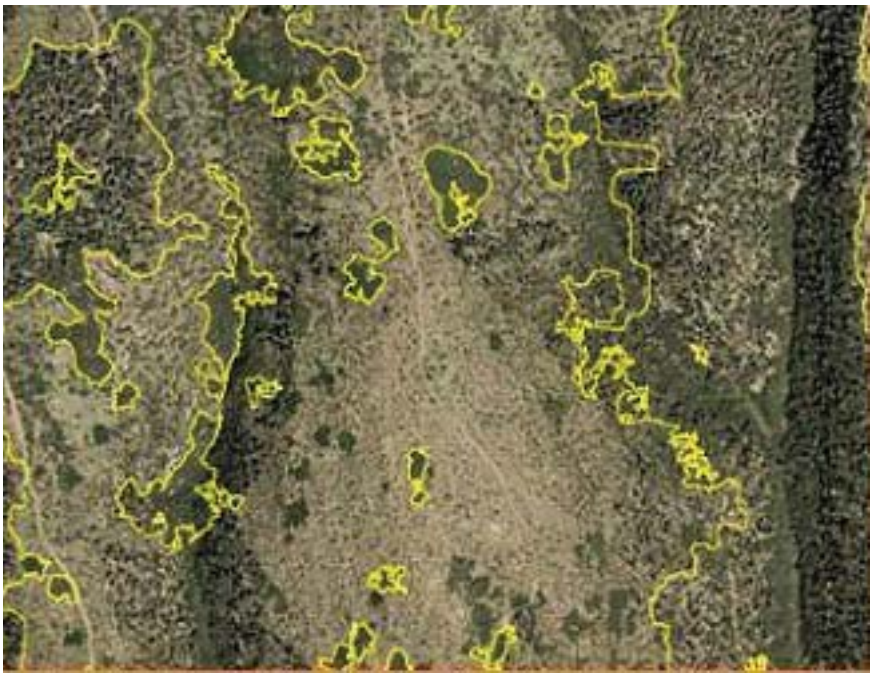


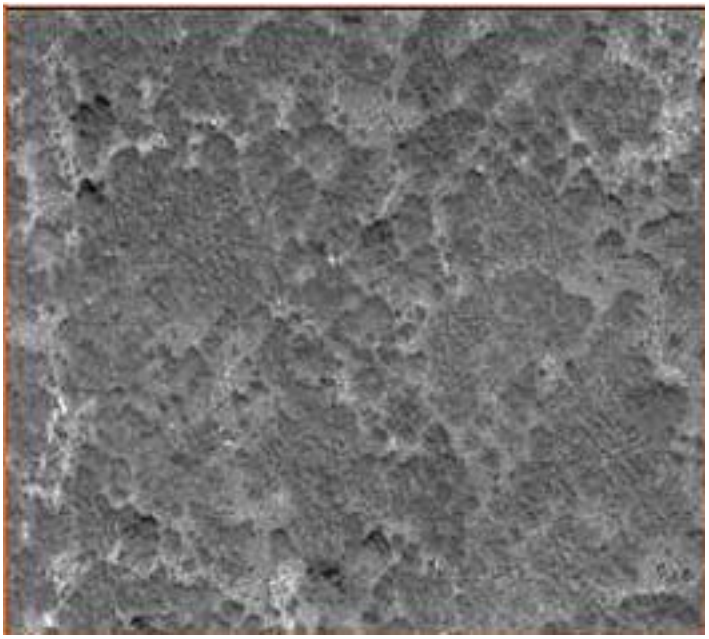
30 Gambel Oak - Mixed Montane Shrubland

Plant communities included	*Quercus gambelii - Amelanchier utahensis* Shrubland, *Quercus gambelii - Cercocarpus montanus* / (*Carex geyeri*) Shrubland, *Quercus gambelii / Symphoricarpos oreophilus* Shrubland
Group map class included within	Rocky Mountain Gambel Oak-Mixed Montane Shrubland (1 of 5)
Management map class included within	Mixed Montane Shrubland (1 of 5)
Total number of map units in project area	325
Number of map units in park	316
Number of total map units less than 0.5 ha	9 (0.0% of total map class area)
Total area	3,879.3 ha/9,586.0 ac
Area in park	3,113.6 ha/7,693.9 ac
Proportion of land cover in park	14.4%
Proportion of map class in project environs	19.7%
Base map class accuracy	user 70.8 (54.1–83.3), producer 31.5 (22.2–42.5)
Group map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.4)
Management map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.1)
Documentation for base map class	42 2004 relevés, 11 1993 relevés, 72 AA observation sites

Location: Mostly upper cuesta historic post-fire mesas and slopes.

Photosignature: This vegetation class has a mixture of two signatures: finely alternating patches of dense, greener oak with browner, sparser mixed shrubs.





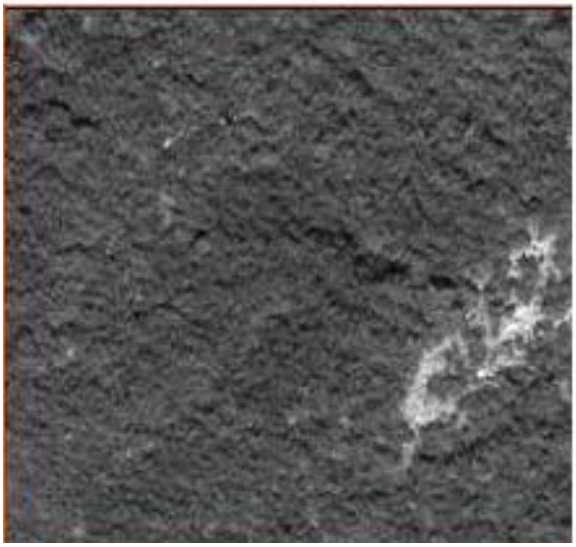


31 Gambel Oak Shrubland

Plant communities included	*Quercus gambelii* Shrubland
Group map class included within	Rocky Mountain Gambel Oak-Mixed Montane Shrubland (1 of 5)
Management map class included within	Mixed Montane Shrubland (1 of 5)
Total number of map units in project area	516
Number of map units in park	508
Number of total map units less than 0.5 ha	2 (.1% of total map class area)
Total area	5,126.8 ha/12,668.5 ac
Area in park	4,670.9 ha/11,542.0 ac
Proportion of land cover in park	21.6%
Proportion of map class in project environs	8.9%
Base map class accuracy	user 10.0 (4.1–22.6), producer 60.0 (27.2–85.7)
Group map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.4)
Management map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.1)
Documentation for base map class	5 2004 relevés, 0 1993 relevés, 10 AA observation sites

Location: Canyon bottoms, mesa slopes and mesa tops as well as slopes on the escarpment. Dense or open stands of oak occur throughout the park.

Photosignature: Oak tends to occur in dense, homogeneous stands. The color is dark and even. The texture on true-color photography is generally quite smooth. The texture on panchromatic photography is not as smooth, more "fleecy," and clumped.





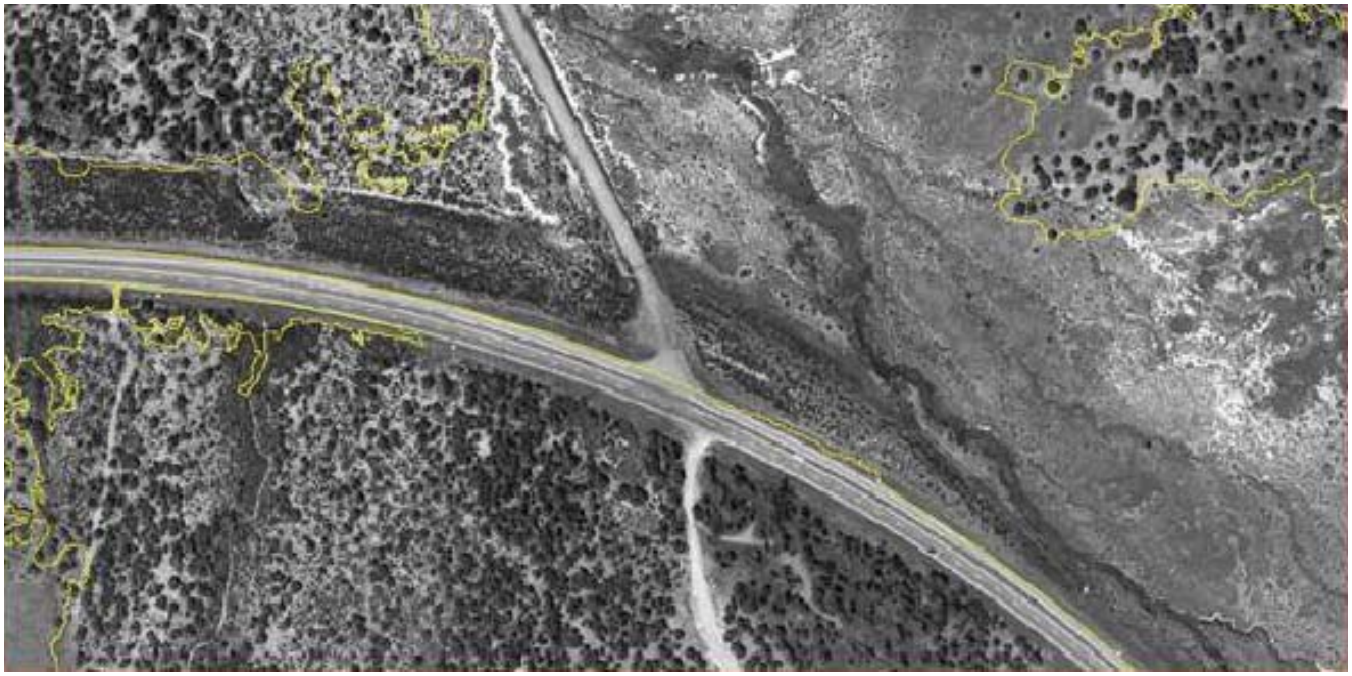


32 Greasewood - Big Sagebrush Shrubland

Plant communities included	*Sarcobatus vermiculatus - Artemisia tridentata* Shrubland
Group map class included within	Inter-Mountain Basins Big Sagebrush Shrubland (1 of 5)
Management map class included within	Big Sagebrush Shrubland (1 of 5)
Total number of map units in project area	6
Number of map units in park	7
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	121.0 ha/299.0 ac
Area in park	13.9 ha/34.2 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	88.5%
Base map class accuracy	user 50.0 (12.1–87.9), producer 20.0 (4.6–56.5)
Group map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Management map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 6 AA observation sites

Location: This vegetation class is located north of escarpment, generally outside the park boundary. There is one stand of this community in a canyon valley in the southern end of the park.

Photosignature: The photosignature is of dark, dense speckling of shrubs in an open shrubland with few to no trees.





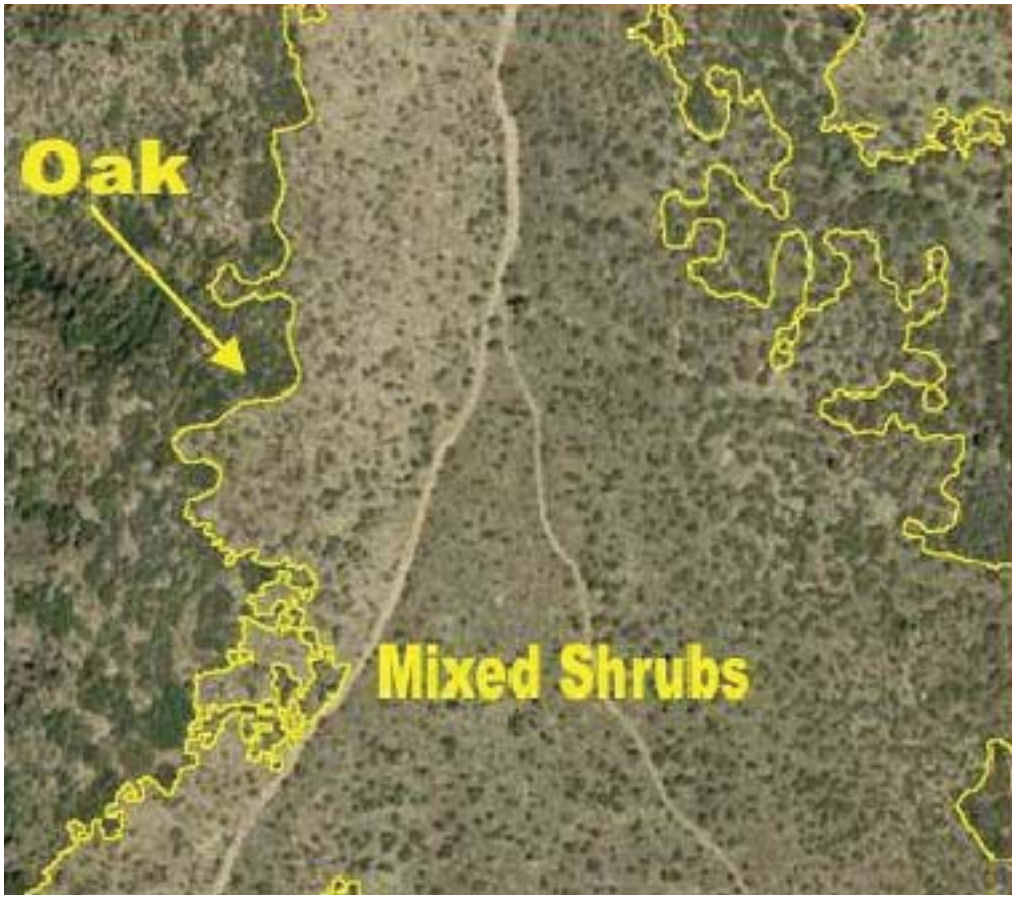


33 Mixed Montane Shrubland

Plant communities included	*Amelanchier* (*utahensis*, *alnifolia*) - *Cercocarpus montanus* Shrubland, *Amelanchier utahensis* Shrubland, *Amelanchier utahensis* - *Fendlera rupicola* Shrubland, C*ercocarpus montanus* - *Fendlera rupicola* Shrubland [Provisional]
Group map class included within	Rocky Mountain Gambel Oak-Mixed Montane Shrubland (1 of 5)
Management map class included within	Mixed Montane Shrubland (1 of 5)
Total number of map units in project area	268
Number of map units in park	255
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	4,132.7 ha/10,212.2 ac
Area in park	3,913.3 ha/9,670.0 ac
Proportion of land cover in park	18.1%
Proportion of map class in project environs	5.3%
Base map class accuracy	user 36.0 (22.3–52.4), producer 26.5 (16.1–40.3)
Group map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.4)
Management map class accuracy	user 89.4 (82.7–93.7), producer 79.2 (71.6–85.1)
Documentation for base map class	18 2004 relevés, 0 1993 relevés, 44 AA observation sites

Location: This vegetation class is located throughout the study area.

Photosignature: Shrubland canopies are generally low and the dark blotchiness is obviously flat and shadowless. Shrublands are distinguished from woodlands by height. Shrubs are shorter than trees. Mixed montane shrubs in upland mesa areas tend to be larger blotches and spots than sagebrush or rabbitbrush. These shrubs do not generally form dense, clumped stands to the degree that oak does. Oak patches tend to be much larger and denser, and the color of oak on true-color photography is generally greener where the mixed shrubs tend to be browner.





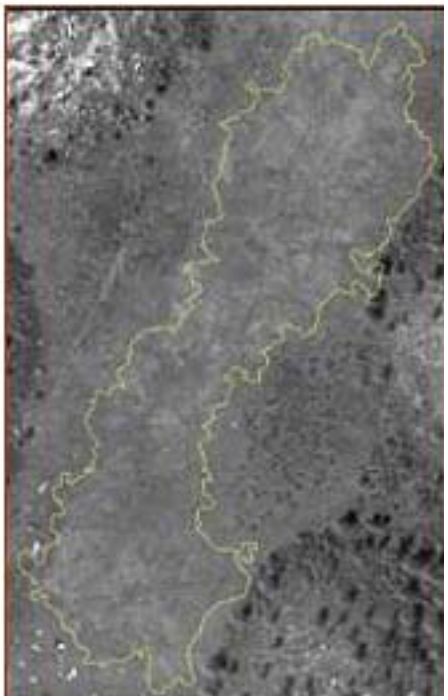
34 Baltic Rush Herbaceous Vegetation

Plant communities included	*Juncus balticus* Herbaceous Vegetation
Group map class included within	Rocky Mountain Alpine-Montane Wet Meadow (1 of 2)
Management map class included within	Mixed Wetland Herbaceous Vegetation (1 of 3)
Total number of map units in project area	9
Number of map units in park	9
Number of total map units less than 0.5 ha	2 (1.3% of total map class area)
Total area	14.6 ha/36.1 ac
Area in park	14.6 ha/36.1 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 40.0 (14.3–72.8), producer 66.7 (25.3–92.2)
Group map class accuracy	user 66.7 (39.8–85.8), producer 100.0 (68.9–100.0)
Management map class accuracy	user 77.8 (50.4–92.4), producer 100.0 (72.1–100.0)
Documentation for base map class	2 2004 relevés, 0 1993 relevés, 4 AA observation sites

Location: This vegetation occurs in broad canyon bottoms near the top of the cuesta. The homogeneous stands of *Juncus balticus* alternate with more mixed wetland herbaceous types and *Ericameria nauseosa* shrubland.

Photosignature: On true-color photography, the color is evenly deep green, the homogeneity of the type apparent on the image. On panchromatic photography, some mottling is evident. The texture is smooth despite the tonal variation.





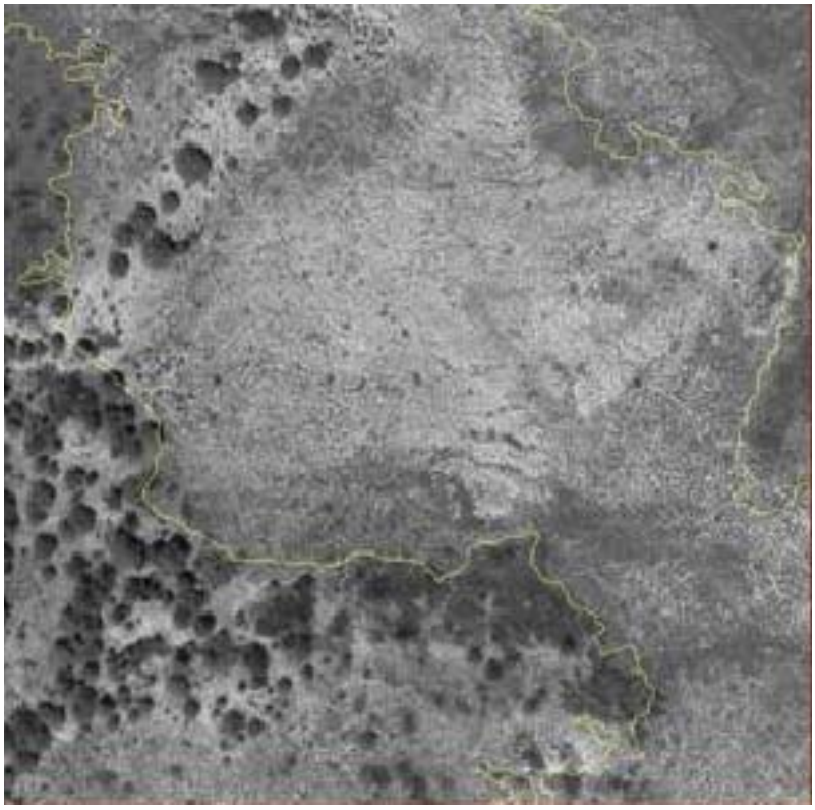


35 Basin Wildrye Herbaceous Vegetation

Plant communities included	*Leymus cinereus* Herbaceous Vegetation
Group map class included within	Inter-Mountain Basins Big Sagebrush Shrubland (1 of 5)
Management map class included within	Big Sagebrush Shrubland (1 of 5)
Total number of map units in project area	2
Number of map units in park	2
Number of total map units less than 0.5 ha	1 (.1% of total map class area)
Total area	9.6 ha/23.7 ac
Area in park	9.6 ha/23.7 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Management map class accuracy	user 54.5 (37.6–70.5), producer 63.2 (44.4–78.6)
Documentation for base map class	1 2004 relevé, 0 1993 relevés, 0 AA observation sites

Location: This vegetation type is located in the Mancos River Valley.

Photosignature: Identified by field observation.

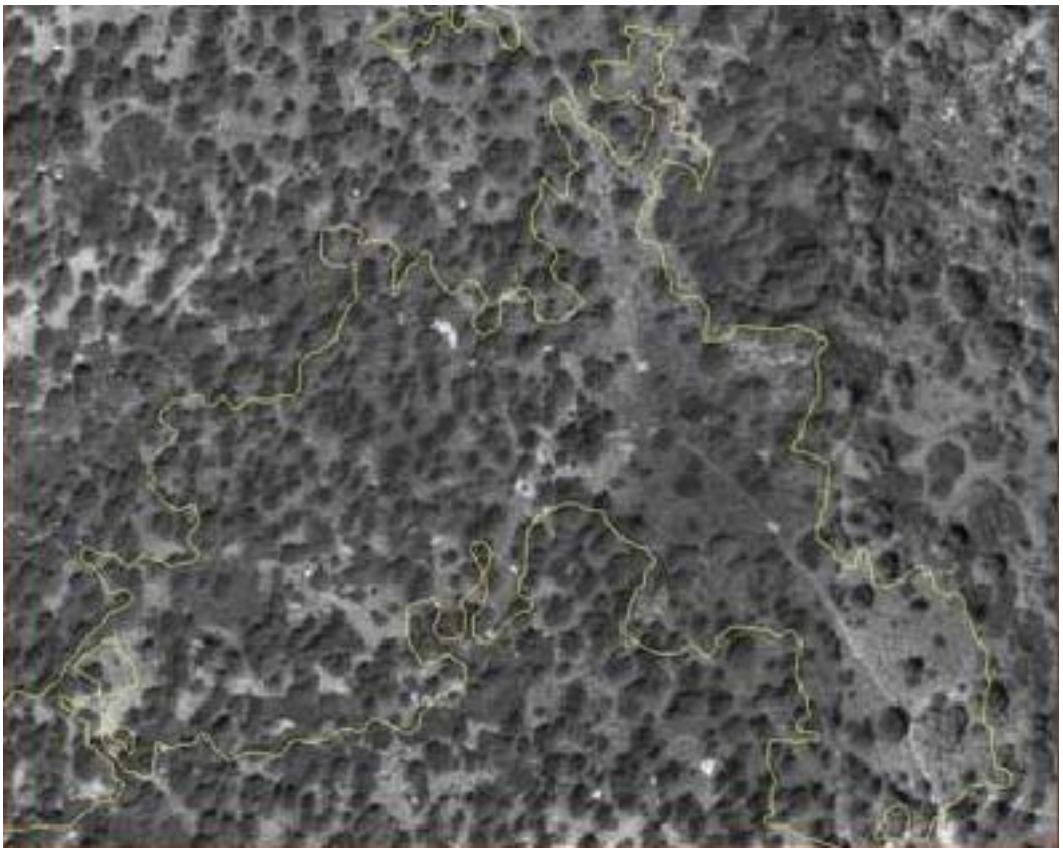


36 Blue Grama Herbaceous Vegetation

Plant communities included	*Bouteloua gracilis* Herbaceous Vegetation
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Colorado Piñon - Utah Juniper / Sagebrush Woodland (1 of 1)
Total number of map units in project area	1
Number of map units in park	1
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	1.5 ha/3.6 ac
Area in park	1.5 ha/3.6 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 33.3 (19.2–51.3), producer 63.6 (39.4–82.5)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class is located in the Mancos River Valley, in upslope areas away from the main watercourse.

Photosignature: Identified by field observation.





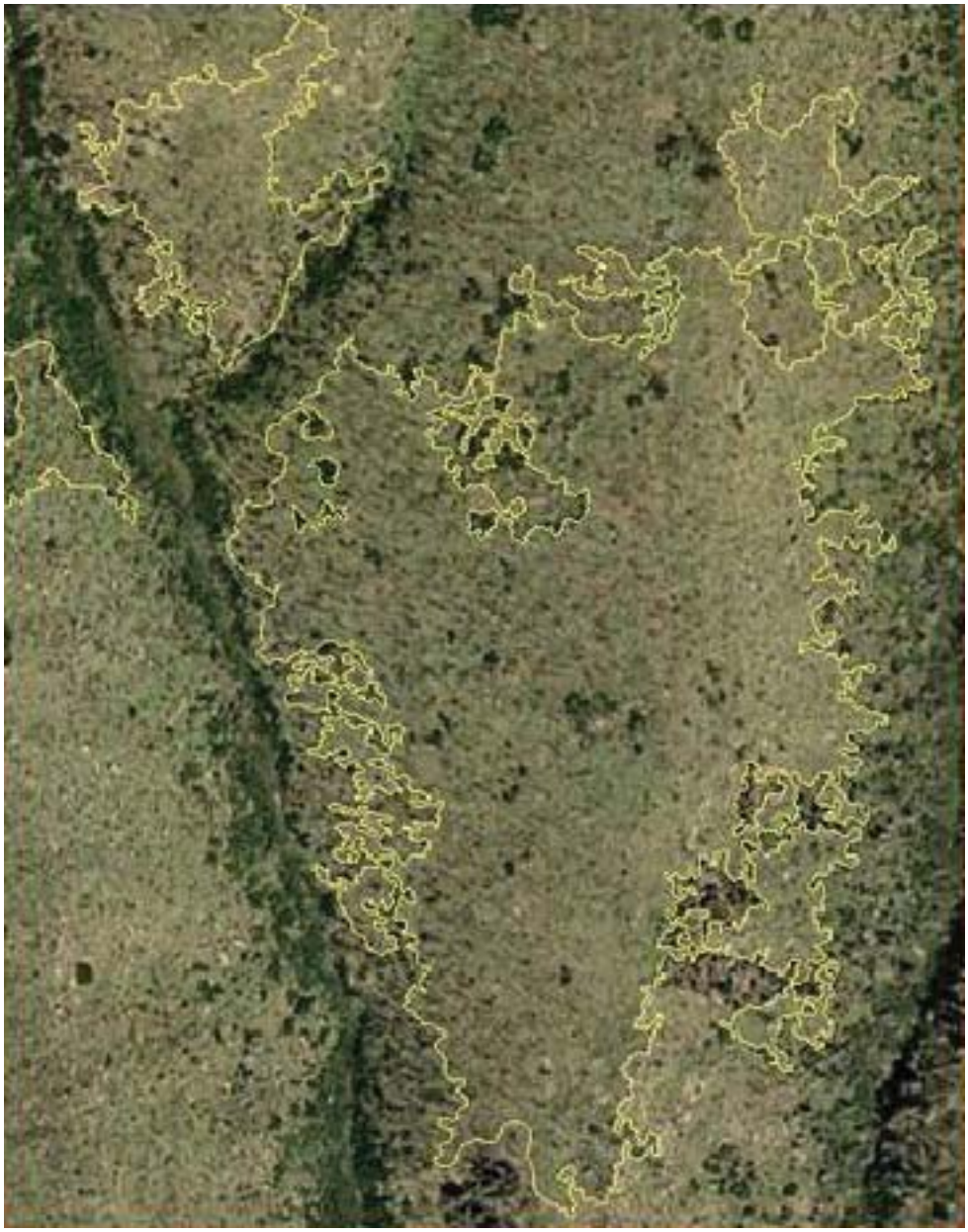


37 Cheatgrass Semi-natural Herbaceous Vegetation

Plant communities included	*Bromus tectorum* Semi-natural Herbaceous Vegetation
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Disturbed Semi-Natural Vegetation (1 of 2)
Total number of map units in project area	29
Number of map units in park	34
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	114.0 ha/281.6 ac
Area in park	104.6 ha/258.4 ac
Proportion of land cover in park	0.5%
Proportion of map class in project environs	8.2%
Base map class accuracy	user 11.1 (2.5–37.7), producer 100.0 (27.0–100.0)
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 92.9 (80.6–97.6), producer 81.3 (67.6–90.0)
Documentation for base map class	8 2004 relevés, 0 1993 relevés, 4 AA observation sites

Location: Cheatgrass Semi-natural Herbaceous Vegetation occurs throughout the recent post-fire areas of the park. *Bromus tectorum* may be the dominant vegetation anywhere in the post-fire areas where trees and shrubs have been destroyed.

Photosignature: Cheatgrass is not easily identified from aerial photography, as the difference in signature between cheatgrass and post-fire mixed herbaceous vegetation is in the color variation. Because of the timing of the true-color aerial photography, the cheatgrass stands tend to have more green than the post-fire mixed herbaceous vegetation. Because its phenological state varies with location and elevation, using this photosignature to differentiate between cheatgrass and post-fire mixed vegetation will have undoubtedly missed some cheatgrass and misidentified post-fire mixed herbaceous vegetation as cheatgrass.



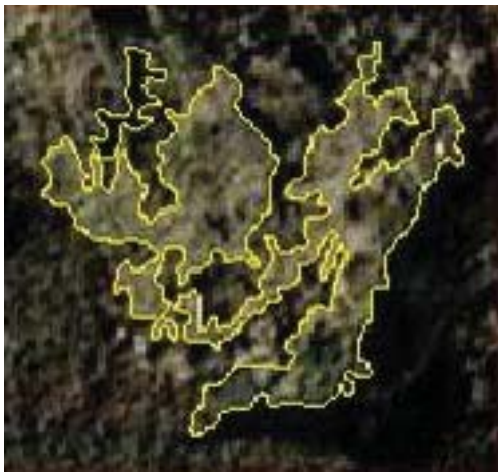


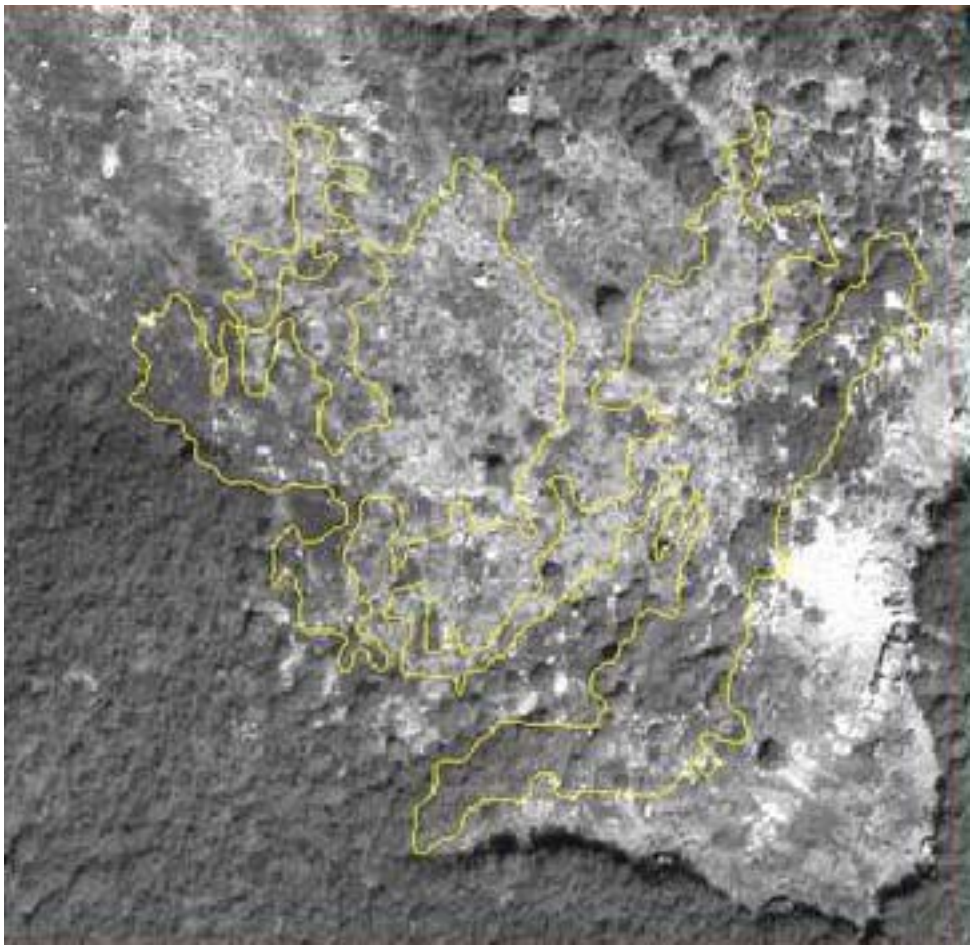
38 Gray Aster Herbaceous Vegetation

Plant communities included	*Eurybia glauca* Herbaceous Vegetation [Park Special]
Group map class included within	Colorado Plateau Mixed Bedrock Canyon and Tableland (1 of 4)
Management map class included within	Mancos Shale Vegetation (1 of 4)
Total number of map units in project area	4
Number of map units in park	4
Number of total map units less than 0.5 ha	3 (8.7% of total map class area)
Total area	3.8 ha/9.3 ac
Area in park	3.8 ha/9.3 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 100 (27.0–100.0), producer 100 (27.0–100.0)
Group map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Management map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 0 AA observation sites

Location: This vegetation class occurs on a recent escarpment landslide. The vegetation is an abundant occurrence of *Eurybia glauca* mixed with various montane shrubs, including oak and serviceberry.

Photosignature: Landslides are apparent on the escarpment face as abrupt changes in color and texture. The vegetation is obviously disturbed.





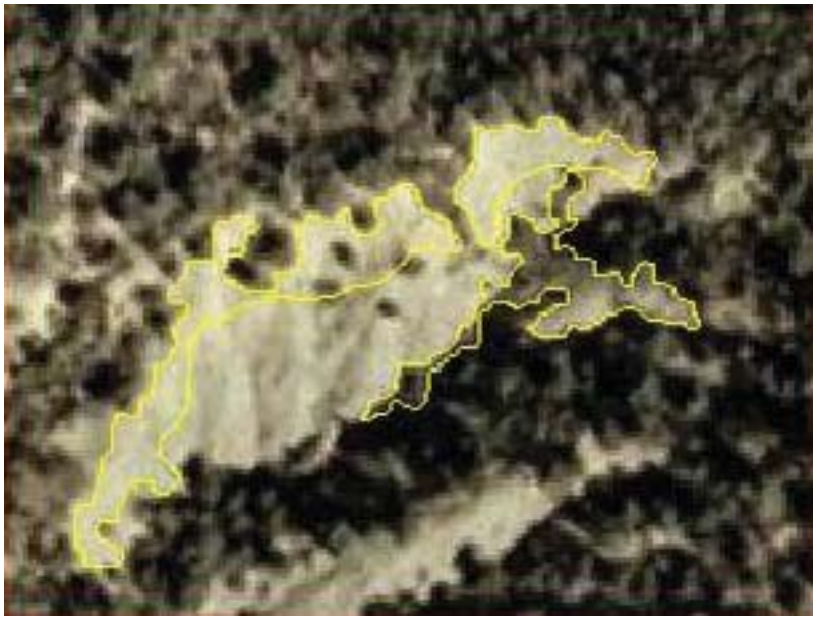


39 Mancos Shale Herbaceous Vegetation

Plant communities included	*Stanleya pinnata* Shale Herbaceous Vegetation [Park Special]
Group map class included within	Colorado Plateau Mixed Bedrock Canyon and Tableland (1 of 4)
Management map class included within	Mancos Shale Vegetation (1 of 4)
Total number of map units in project area	56
Number of map units in park	42
Number of total map units less than 0.5 ha	55 (82.1% of total map class area)
Total area	4.7 ha/11.5 ac
Area in park	3.2 ha/8.0 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	31.1%
Base map class accuracy	user NS, producer 0.0
Group map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Management map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Documentation for base map class	4 2004 relevés, 0 1993 relevés, 2 AA observation sites

Location: This vegetation class occurs throughout the Mancos shale deposits of the study area. These shale deposits are to the north of the escarpment and to the west and east of the Mancos River Valley.

Photosignature: The photosignature for this vegetation class is open areas with little to no woody vegetation. Exposed shale slopes are bright white on both panchromatic and true-color photography. Shale slopes with higher densities of shrubs are likely to be *Eriogonum corymbosum* Badlands.





40 Mixed Weedy Herbaceous Vegetation

Plant communities included	Mixed Weedy Herbaceous Vegetation [Park Special]
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Rabbitbrush Shrub Herbaceous Vegetation (1 of 4)
Total number of map units in project area	10
Number of map units in park	10
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	36.2 ha/89.3 ac
Area in park	36.2 ha/89.3 ac
Proportion of land cover in park	0.2%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 0.0, producer 0.0
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 68.4 (55.2–79.2), producer 72.2 (58.7–82.6)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 6 AA observation sites

Location: Roadsides and other weedy, unburned sites within the study area.

Photosignature: The photosignature for this type is smooth textured and of varying shades of green and tan. There are few to no shrubs, although surrounding vegetation may have varying shrub cover.





41 Mixed Wetland Herbaceous Vegetation

Plant communities included	Mixed Wetland Herbaceous Vegetation [Park Special]
Group map class included within	Rocky Mountain Alpine-Montane Wet Meadow (1 of 2)
Management map class included within	Mixed Wetland Herbaceous Vegetation (1 of 3)
Total number of map units in project area	6
Number of map units in park	6
Number of total map units less than 0.5 ha	2 (3.5% of total map class area)
Total area	5.7 ha/14.1 ac
Area in park	5.7 ha/14.1 ac
Proportion of land cover in park	0.0%
Proportion of map class in project environs	0.0%
Base map class accuracy	user 25.0 (57.9–64.4), producer 33.3 (7.8–74.6)
Group map class accuracy	user 66.7 (39.8–85.8), producer 100.0 (68.9–100.0)
Management map class accuracy	user 77.8 (50.4–92.4), producer 100.0 (72.1–100.0)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 1 AA observation sites

Location: This vegetation occurs in flat canyon bottoms and in the Mancos River Valley.

Photosignature: The vegetation occurs in moist canyon bottoms not belonging to the *Juncus balticus* vegetation class or *Ericameria nauseosa* / *Bromus inermis* vegetation class. *Juncus balticus* is a darker green and has a more consistent tone. *Ericameria nauseosa* / *Bromus inermis* vegetation has more stippling in its texture and is not as green as mixed wetlands. However, the field documentation for this base map class is slight and inspection of mapped polygons may show them to have substantial cover of *Juncus balticus*.





42 Post-Fire Mixed Herbaceous Vegetation

Plant communities included	Post-Fire Mixed Herbaceous Vegetation [Park Special]
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Disturbed Semi-Natural Vegetation (1 of 2)
Total number of map units in project area	143
Number of map units in park	177
Number of total map units less than 0.5 ha	7 (0.0% of total map class area)
Total area	3,664.7 ha/9,055.7 ac
Area in park	2,344.0 ha/5,792.1 ac
Proportion of land cover in park	10.8%
Proportion of map class in project environs	36.0%
Base map class accuracy	user 94.7 (79.6–98.8), producer 56.3 (41.9–69.6)
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 92.9 (80.6–97.6), producer 81.3 (67.6–90.0)
Documentation for base map class	18 2004 relevés, 0 1993 relevés, 29 AA observation sites

Location: This vegetation class occurs in recently burned areas throughout the study area.

Photosignature: This photosignature can be difficult to discern from the photosignature of shrub vegetation classes as standing deadwood confuses the signature. It is generally a medium tan color on true-color photography. Dead and down woody debris often appears as dark speckling throughout the area and the individual shrubs look smudgy and long, rather than having the round blotchy look of living shrubs.



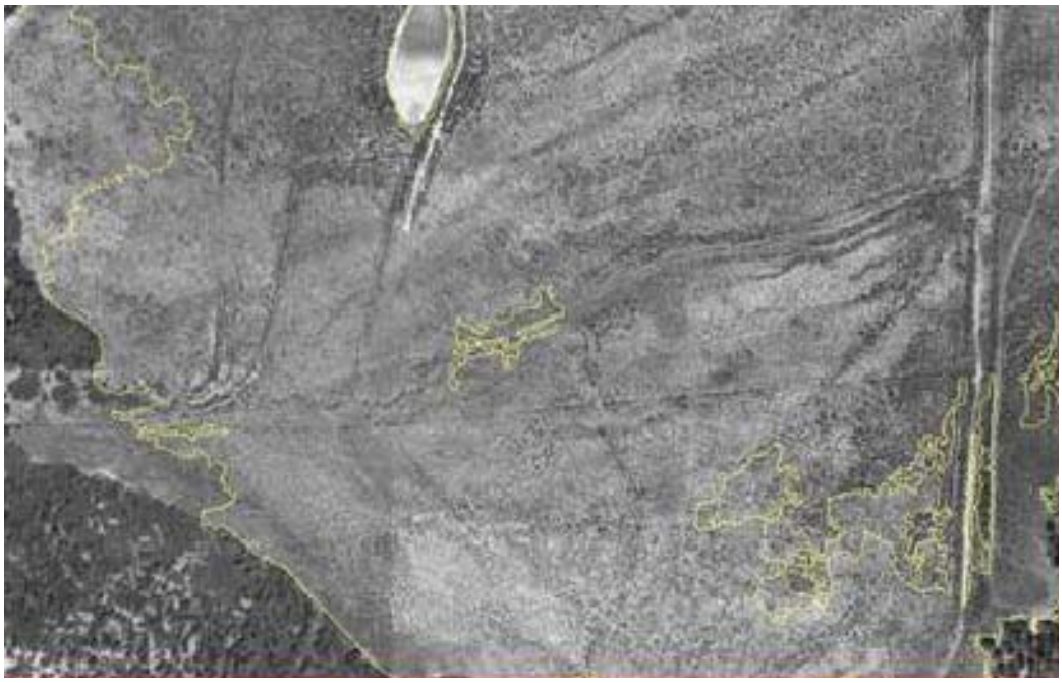


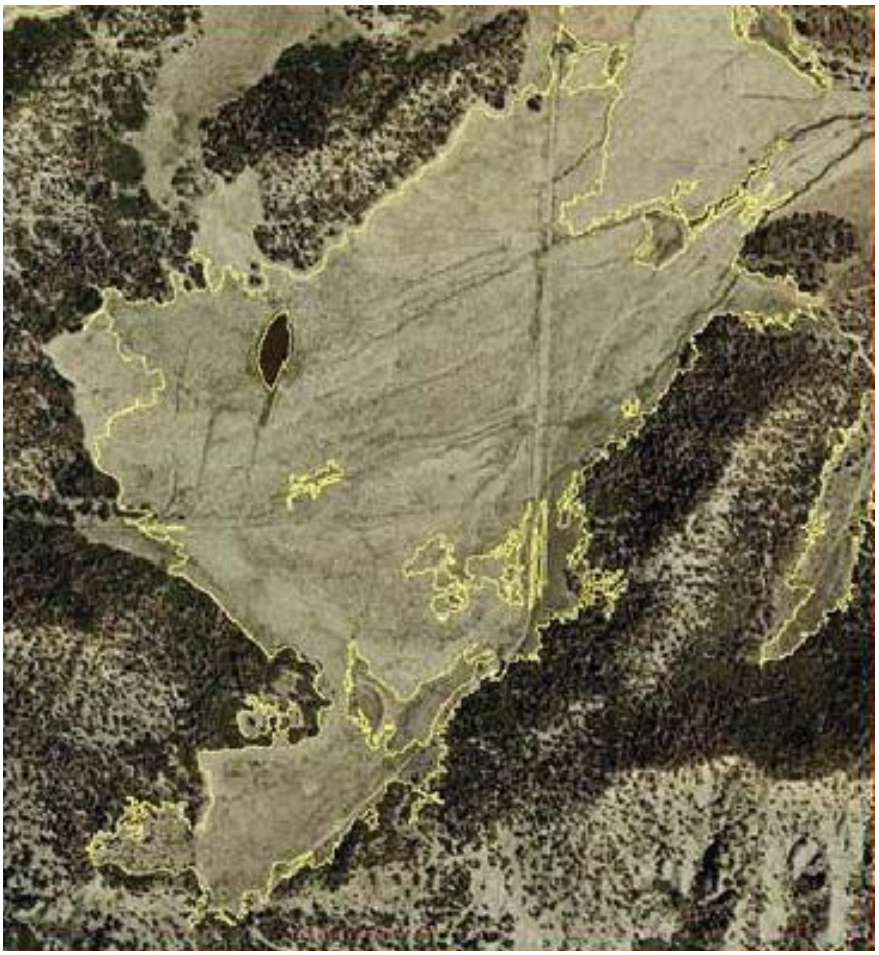
43 Rubber Rabbitbrush / Smooth Brome - (Western Wheatgrass) Shrub Herbaceous Vegetation

Plant communities included	*Ericameria nauseosa* / *Bromus inermis* (*Pascopyrum smithii*) Shrub Herbaceous
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Rabbitbrush Shrub Herbaceous Vegetation (1 of 4)
Total number of map units in project area	100
Number of map units in park	94
Number of total map units less than 0.5 ha	6 (0.1% of total map class area)
Total area	595.5 ha/1471.4 ac
Area in park	225.1 ha/556.2 ac
Proportion of land cover in park	1.0%
Proportion of map class in project environs	62.2%
Base map class accuracy	user 45.0 (28.4–62.8), producer 42.9 (26.9–60.4)
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 68.4 (55.2–79.2), producer 72.2 (58.7–82.6)
Documentation for base map class	0 2004 relevés, 0 1993 relevés, 22 AA observation sites

Location: There are occurrences of this vegetation class in the northern end of the park, both inside and outside the boundary. In the north, this type tends to occur in fallow agricultural fields. The wheatgrass was seeded in some fields and subsequently spread to other fields. In the cuesta areas of the park, this vegetation class occurs in open fields and lowlands.

Photosignature: This vegetation class often occurs in smooth open fields with a light tan color. There is stippling, indicating either sagebrush or rabbitbrush, but the tone is lighter than the photosignature of *Artemisia*. The lack of dark stippling indicates rabbitbrush.





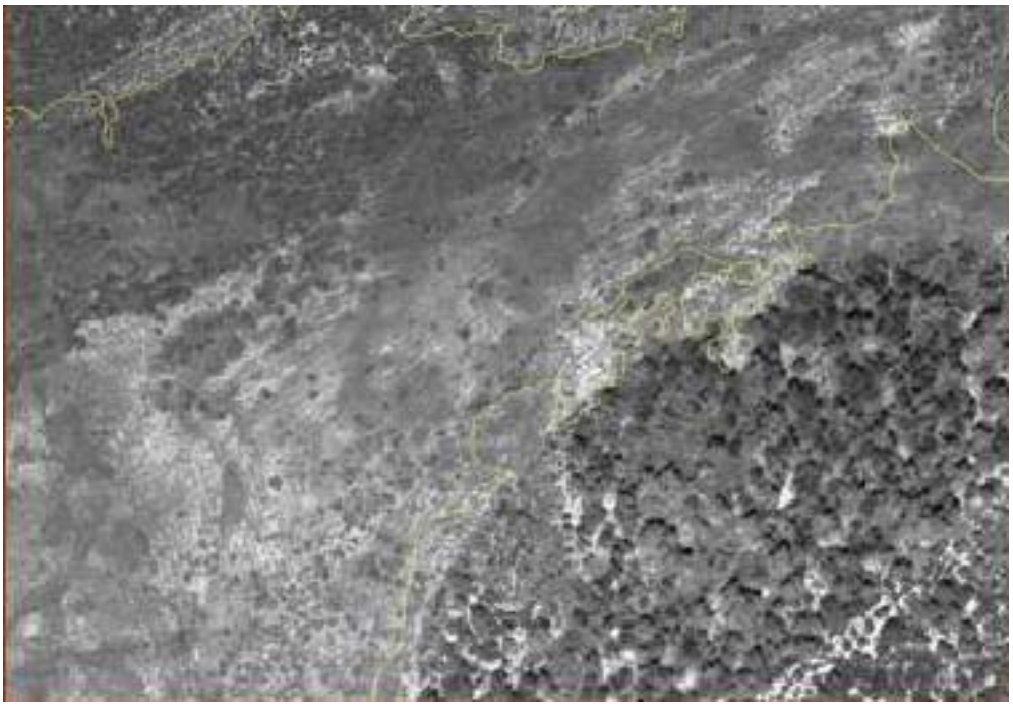


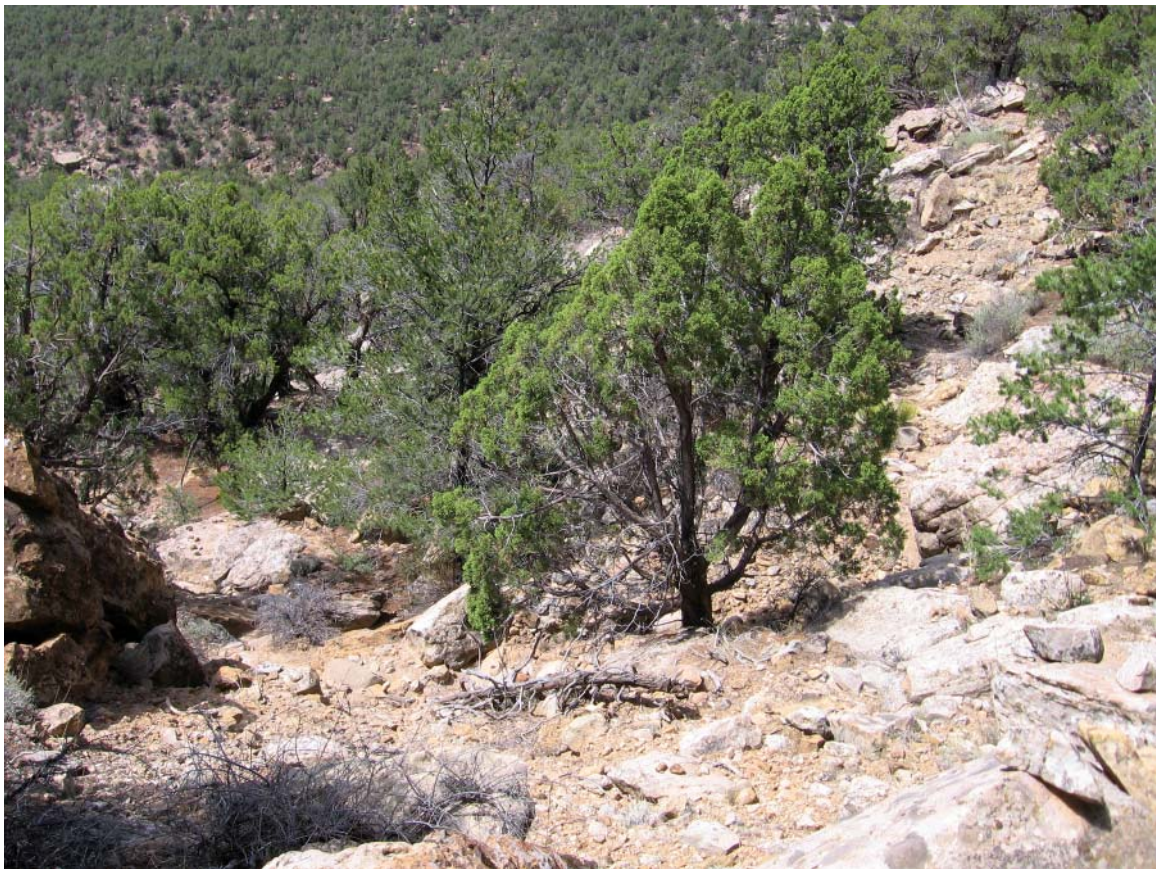
44 Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation

Plant communities included	*Bromus inermis* - (*Pascopyrum smithii*) Semi-natural Herbaceous Vegetation
Group map class included within	Inter-Mountain Basins Semi-Desert Grassland (1 of 7)
Management map class included within	Rabbitbrush Shrub Herbaceous Vegetation (1 of 4)
Total number of map units in project area	22
Number of map units in park	10
Number of total map units less than 0.5 ha	0 (0.0% of total map class area)
Total area	177 ha/436 ac
Area in park	50 ha/124 ac
Proportion of land cover in park	column title % Park land cover
Proportion of map class in project environs	Column occurrence in project environs
Base map class accuracy	user 30.0 (12.7–55.8), producer 37.5 (16.1–65.2)
Group map class accuracy	user 83.3 (74.5–89.5), producer 80.9 (71.9–87.5)
Management map class accuracy	user 68.4 (55.2–79.2), producer 72.2 (58.7–82.6)
Documentation for base map class	3 2004 relevés, 0 1993 relevés, 9 AA observation sites

Location: This herbaceous vegetation occurs in the northern area of the park near the park entrance, but may be anywhere in the park where meadowlands with low shrub density are present.

Photosignature: The photosignature often has a mottled tone and color with a smooth texture. Look for a low density of shrubs (small dark specks or blotches).



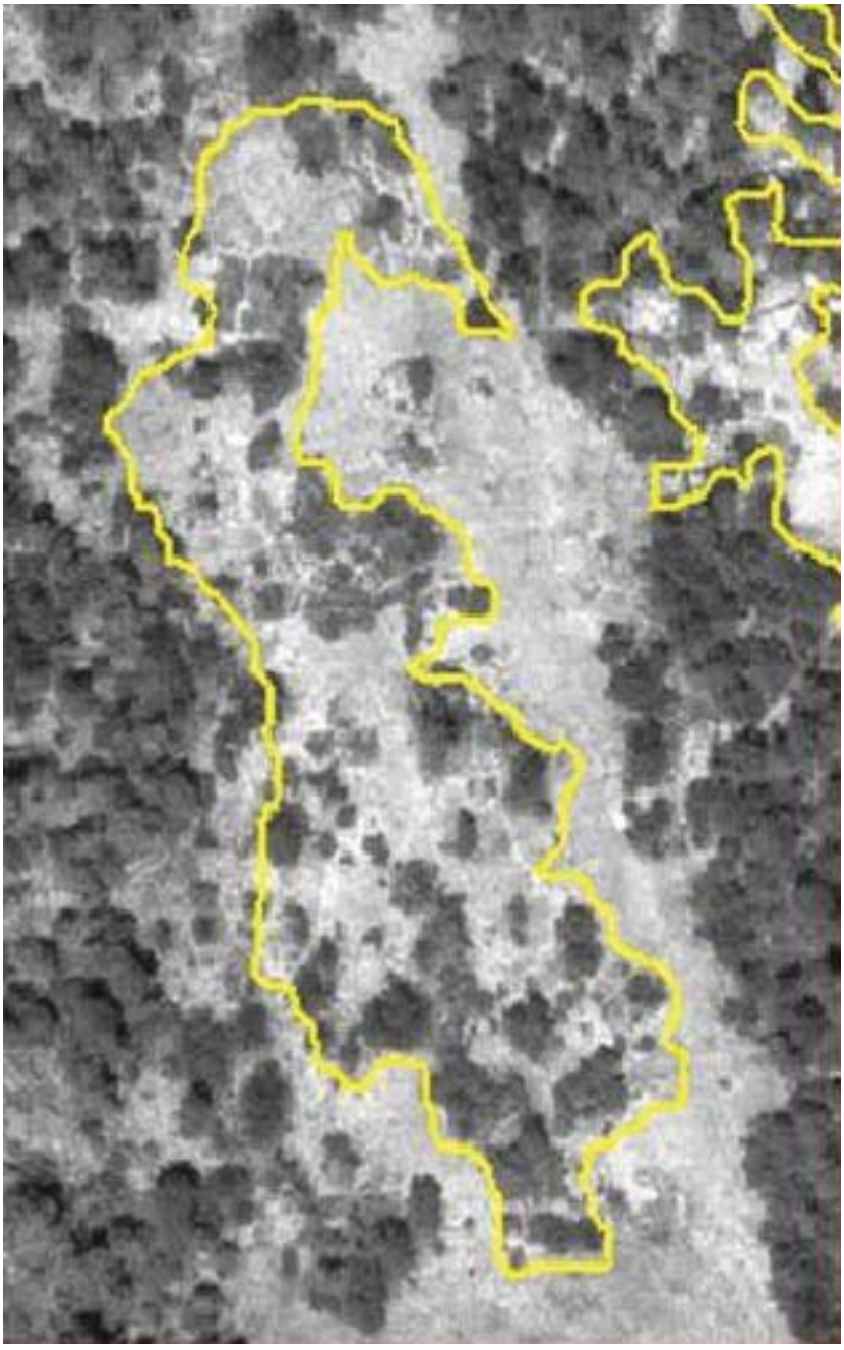


45 Colorado Piñon - Utah Juniper Sandstone Barrens

Plant communities included	Sandstone *Pinus edulis - Juniperus osteosperma* Barrens
Group map class included within	Colorado Plateau Piñon-Juniper Woodland (1 of 9)
Management map class included within	Colorado Piñon - Utah Juniper Sandstone Barrens (1 of 1)
Total number of map units in project area	168
Number of map units in park	150
Number of total map units less than 0.5 ha	156 (95.0% of total map class area)
Total area	14.6 ha/36.0 ac
Area in park	13.4 ha/33.2 ac
Proportion of land cover in park	0.1%
Proportion of map class in project environs	7.9%
Base map class accuracy	user 100.0 (27.0–100.0), producer 25.0 (5.8–64.4)
Group map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Management map class accuracy	user 100.0 (27.0–100.0), producer 25.0 (5.8–64.4)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 5 AA observation sites

Location: This vegetation class occurs mostly in the southern area of the park, but also on the escarpment slopes in the northern extent of the study area. The map class occurs on sandstone ledges at the edges of mesas.

Photosignature: A mosaic of bare sandstone and piñon or juniper trees is the basic photosignature for this vegetation class. The sandstone is a variation of gray tones and is blotchy like a watercolor painting. The trees are dark blotches scattered across the sandstone. Bare sandstone completely lacking trees is classified as Sandstone.



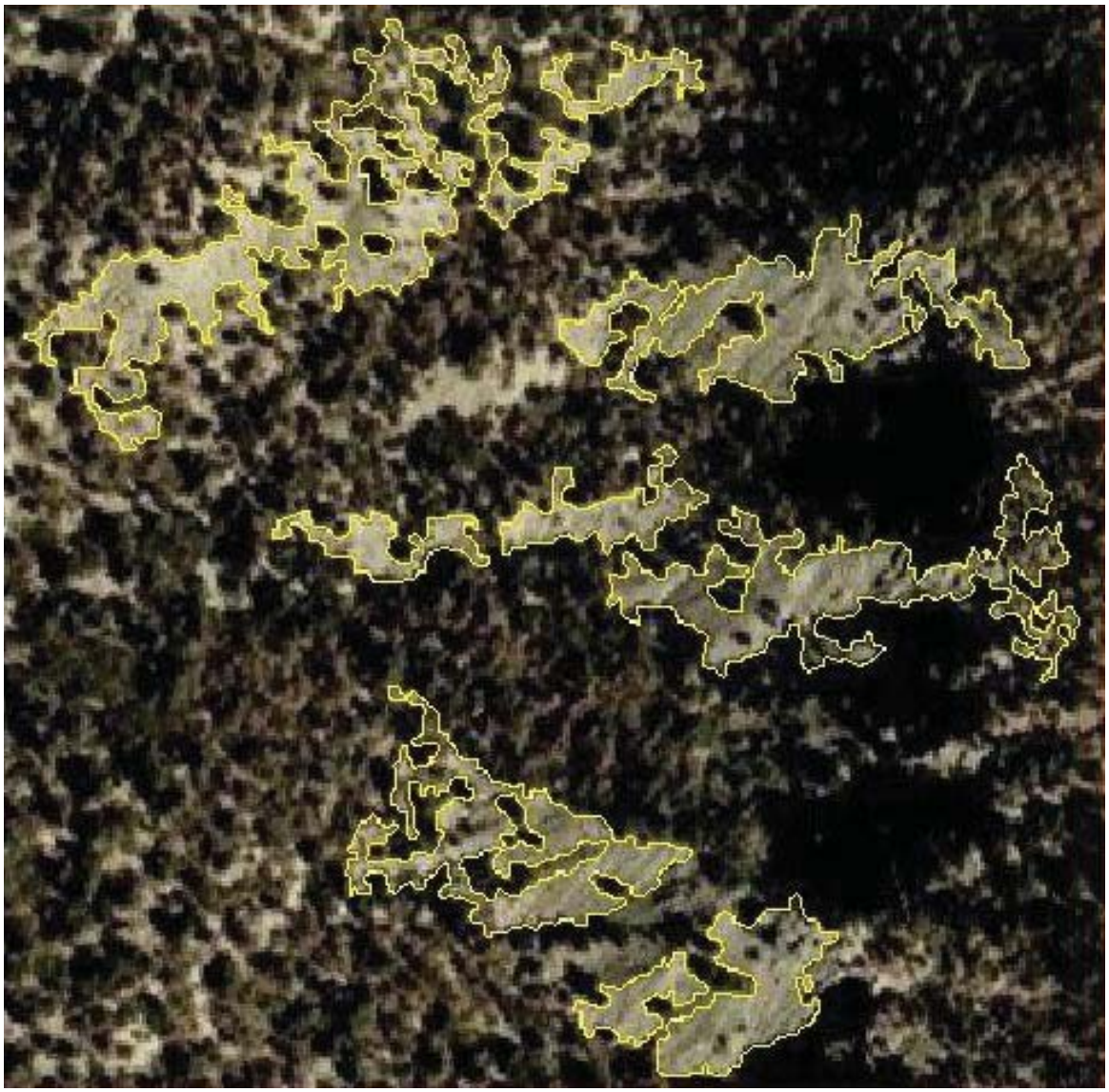


46 Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation

Plant communities included	*Eriogonum corymbosum* Badlands Sparse Vegetation
Group map class included within	Colorado Plateau Mixed Bedrock Canyon and Tableland (1 of 4)
Management map class included within	Mancos Shale Vegetation (1 of 4)
Total number of map units in project area	1,113
Number of map units in park	592
Number of total map units less than 0.5 ha	911 (14.8% of total map class area)
Total area	633.1 ha/1564.4 ac
Area in park	320.4 ha/791.8 ac
Proportion of land cover in park	1.5%
Proportion of map class in project environs	49.4%
Base map class accuracy	user 64.3 (42.6–81.4), producer 90.0 (65.2–97.7)
Group map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Management map class accuracy	user 63.6 (49.3–75.9), producer 87.5 (72.5–94.9)
Documentation for base map class	1 2004 relevés, 0 1993 relevés, 17 AA observation sites

Location: This vegetation class is located north of the escarpment and in the hills west of the Mancos River Valley.

Photosignature: Exposed areas of Mancos shale are bright white or gray on panchromatic and true-color photography. Shrubs are evident by the dark speckling, particularly on panchromatic imagery. The Mancos Shale Herbaceous Vegetation class lacks the shrub overstory, and the signature is smoother and brighter.



Appendix H
Accuracy Assessment Data

Appendix H consists of three contingency tables, also known as error matrices, showing the accuracy assessment for the base map classes (H.1), group map classes (H.2), and management map classes (H.3). Each table includes rows (Vegetation Map Database Map Class) representing the map classes for polygons in the vegetation map database, and columns (Field Assessment Map Class) representing the accuracy assessment made in the field for that polygon. A perfect correspondence between the map and the field is indicated by a tally in the matrix where the row and column intersect for the same map class. For example, in Table H.1, the intersection of row and column 31.001 shows a tally of five, indicating that in the field accuracy assessment, five of the polygons on the map were found to be the same map class in the field as that mapped. The contingency table also shows the source of error in the map. For row 31.001, the table shows that the field crew found the mapped polygon to actually be map class 31.002 in the field rather than what was mapped.

The number of correctly mapped polygons, as determined in the accuracy assessment, occur on the shaded diagonal of the contingency table. User and producer accuracy, 90% confidence intervals for each, overall accuracy, Kappa accuracy, and Kappa accuracy standard error are reported. The Kappa accuracy and standard error do not include vegetation map database map classes that were not field-assessed.

Each table is accompanied by a key code to map classes. In the example given above, 31.001 is Colorado Piñón - Utah Juniper / Shale Sparse Woodland.

For each table, the following notations are used:

NTF: None that fits; the assessment in the field did not match any existing map classes.

N/A: Not applicable; unable to compute confidence intervals because there were no polygons assessed as correct in the field.

N/S: Not sampled; unable to compute producer or user accuracy assessment since the polygons were not sampled.

Note: Due to their size, Tables H1 and H3 are spread across two pages, and should be read accordingly. The key for Table H1 appears on the page that follows it.

Table H1. Contingency table: Base map classes.

Vegetation map database map class: Map code	<>	11.001	31.001	31.002	31.003	31.004	42.001	42.002	42.003	42.004	42.005	43.001	43.002	51.001	51.004	52.002	53.001	53.002
Field assessment map class																		
11.001		0																
31.001			5	1														
31.002			4	9		1												
31.003					1													
31.004						0												
42.001							1		7									
42.002								0		1	1							
42.003									18		1							
42.004	2							1	2	9				1	2			1
42.005						1				5	3			1				
43.001										1		2	2					
43.002	1	1										1	1					
51.001	1							2		3	1			8		3		
51.004										1	1				1			
52.002											1					1		
53.001																	0	
53.002																		1
53.003	1																	
53.004									2									
53.005									2					1				
61.001			1											1		1		
61.002																		
61.003									1									
61.004																		
61.005			1															
61.006														1				
61.008																		
62.001																		
62.002																		
62.003										1								
63.003														1				
Sample number																		
	5	1	11	10	1	2	1	3	32	21	8	3	3	14	3	5	0	2
Producer accuracy/Omission error (% correct)																		
	NTF	0.0	45.5	90.0	100.0	0.0	100.0	0.0	56.3	42.9	37.5	66.7	33.3	57.1	33.3	20.0	N/S	50.0
90% confidence interval (-)																		
	NTF	N/A	24.2	65.2	27.0	N/A	27.0	N/A	41.9	26.9	16.1	25.3	7.8	36.0	7.8	4.6	N/S	12.1
90% confidence interval (+)																		
	NTF	N/A	68.5	97.7	100.0	N/A	100.0	N/A	69.6	60.4	65.2	92.2	74.6	75.9	74.6	56.5	N/S	87.9

OVERALL ACCURACY = 43.5% KAPPA INDEX*[1] = 43.8% STANDARD ERROR = 0.03

	53.003	53.004	53.005	61.001	61.002	61.003	61.004	61.005	61.006	61.008	62.001	62.002	62.003	63.003	Sample number	User accuracy/ commission error (% correct)	90% confidence Intervals	
																(% correct)	-	+
															0	N/S	N/S	N/S
			3	1					8						18	27.8	14.2	47.1
															14	64.3	42.6	81.4
															1	100.0	27.0	100.0
															0	N/S	N/S	N/S
		1													9	11.1	2.5	37.7
															2	0.0	N/A	N/A
															19	94.7	79.6	98.8
	1		1												20	45.0	28.4	62.8
															10	30.0	12.7	55.8
															5	40.0	14.3	72.8
															4	25.0	57.9	64.4
			1		1										20	40.0	24.2	58.1
			3												6	16.7	3.8	50.2
															2	50.0	12.1	87.9
			1												1	0.0	N/A	N/A
	2	1	1												5	20.0	4.6	56.5
	17		4	1			1								24	70.8	54.1	83.3
	17	3	6				1		1						30	10.0	4.1	22.6
	13		9												25	36.0	22.3	52.4
	1		1	4	1		4			2					16	25.0	11.8	45.5
			1		19				1						21	90.5	74.9	96.8
					1	0			1						3	0.0	N/A	N/A
	1		1	1	3		7		8						21	33.3	19.2	51.3
				3		1		0							5	0.0	N/A	N/A
			2	1	3		4		9	1					21	42.9	26.9	60.4
										1					1	100.0	27.0	100.0
											1				1	100.0	27.0	100.0
	2											6			8	75.0	46.0	91.3
													0		1	0.0	N/A	N/A
														1	2	50.0	12.1	87.9
	54	5	34	11	28	1	17	0	28	4	1	6	0	1				
	31.5	60.0	26.5	36.4	67.9	0.0	41.2	N/S	32.1	25.0	100.0	100.0	N/S	100.0				
	22.2	27.2	16.1	17.5	52.3	N/A	24.1	N/S	19.8	5.8	27	68.9	N/S	27				
	42.5	85.7	40.3	60.6	80.2	N/A	60.7	N/S	47.7	64.4	100.0	100.0	N/S	100.0				

Total sampling points: 315
Total correct: 137

Key to base map class codes in Table H1

11.001 Artificial Catchment

31.001 Colorado Piñon – Utah Juniper / Shale Sparse Woodland

31.002 Crispleaf Wild Buckwheat Mancos Shale Sparse Vegetation

31.003 Gray Aster Herbaceous Vegetation

31.004 Mancos Shale Herbaceous Vegetation

41.001 Blue Grama Herbaceous Vegetation

42.001 Cheatgrass Semi-natural Herbaceous Vegetation

42.002 Mixed Weedy Herbaceous Vegetation

42.003 Post-Fire Mixed Herbaceous Vegetation

42.004 Rubber Rabbitbrush / Smooth Brome (Western Wheatgrass) Shrub Herbaceous Vegetation

42.005 Western Wheatgrass - Smooth Brome Semi-natural Herbaceous Vegetation

43.001 Baltic Rush Herbaceous Vegetation

43.002 Mixed Wetland Herbaceous Vegetation

51.001 Big Sagebrush Shrubland

51.002 Big Sagebrush / James' Galleta Shrubland

51.003 Big Sagebrush / Western Wheatgrass Shrubland

51.004 Black Sagebrush Shrub Herbaceous Vegetation

52.001 Basin Wildrye Herbaceous Vegetation

52.002 Greasewood - Big Sagebrush Shrubland

53.001 Bitterbrush / Indian Ricegrass Shrubland

53.002 Choke Cherry Shrubland

53.003 Gambel Oak - Mixed Montane Shrubland

53.004 Gambel Oak Shrubland

53.005 Mixed Montane Shrubland

61.001 Colorado Piñon - Utah Juniper / Big Sagebrush Woodland

61.002 Colorado Piñon - (Utah Juniper) / Bitterbrush / Muttongrass Woodland

61.003 Colorado Piñon – (Utah Juniper) / Black Sagebrush Woodland

61.004 Colorado Piñon – (Utah Juniper) / Gambel Oak Woodland

61.005 Colorado Piñon – Utah Juniper / James' Galleta Woodland

61.006 Colorado Piñon – (Utah Juniper) / Mixed Montane Shrub Woodland

61.007 Colorado Piñon – (Utah Juniper) / Needle-and-Thread Woodland

61.008 Colorado Piñon – Utah Juniper Sandstone Barrens

61.009 Rocky Mountain Juniper / Smooth Brome (Western Wheatgrass) Woodland

62.001 Douglas-fir / Box elder Woodland

62.002 Douglas-fir / Gambel Oak Forest

62.003 Ponderosa Pine Woodland

63.001 Coyote Willow / Mesic Forb Shrubland

63.002 Lanceleaf Cottonwood Riparian Woodland

63.003 Narrowleaf Cottonwood - Rocky Mountain Juniper Woodland

Table H2. Contingency table: Group map classes.

Vegetation map database map class	Field assessment map class												Sample number	User accuracy/ Commission error (% correct)	90% confidence interval	
	Map code	<>	100	300	400	430	510	550	610	620	630	640			-	+
	100		0										0	N/S	N/S	N/S
	300			21									21	100.0	49.3	75.9
	400	1		1	55		2	7					66	83.3	74.5	89.5
	430	1	1		1	6							9	66.7	39.8	85.8
	510	1			7		12	1	1				22	54.5	37.6	70.5
	550	1			3		1	76	4				85	89.4	82.7	93.7
	610			2	1		3	7	75				88	85.2	77.9	90.4
	620							2		7			9	77.8	50.4	92.3
	630				1						0		1	0.0	N/A	N/A
	640						1					1	2	50.0	12.1	87.9
Sample number																
		4	1	24	68	6	19	93	80	7	0	1				
Producer accuracy/Omission error (% correct)																
		NTF	0.0	87.5	80.9	100.0	63.2	81.7	93.8	100.0	N/S	100.0				
90% confidence intervals (-)																
		NTF	N/A	72.5	71.9	68.9	44.4	71.6	76.9	72.1	N/S	27.0				
90% confidence intervals (+)																
		NTF	N/A	94.9	87.5	100.0	78.6	85.4	89.6	100.0	N/S	100.0				
OVERALL ACCURACY = 80.3% KAPPA INDEX = 76.6% STANDARD ERROR 0.028													Total samples = 315 Total correct = 253			

Key to group map class codes in Table H2

100 Agriculture
300 Colorado Plateau Mixed Bedrock Canyon and Tableland
400 Inter-Mountain Basins Semi-Desert Grassland
430 Rocky Mountain Alpine-Montane Wet Meadow
510 Inter-Mountain Basins Big Sagebrush Shrubland
550 Rocky Mountain Gambel Oak-Mixed Montane Shrubland
610 Colorado Plateau Pinyon-Juniper Woodland
620 Southern Rocky Mountain Montane Mixed Conifer Forest and Woodland
630 Southern Rocky Mountain Ponderosa Pine Woodland
640 Rocky Mountain Lower Montane Riparian Woodland and Shrubland

Table H3. Contingency table: Management map classes.

Field assessment map class

Vegetation map database map class: Map code	<>	31.005	42.006	42.007	43.002	51.001	53.005	61.002	61.008	61.010	61.011
31.005		21					3			8	1
42.006			26	1			1				
42.007	1	1	2	26		2	6				
43.002	1			1	7						
51.001	1			7		12	1	1			
53.005	1		3			1	76			3	1
61.002							1	19		1	
61.008									1		
61.01						1	4	6	1	28	2
61.011		2				2	2	1	2	4	7
61.013			1					1		1	
62.001											
62.002							2				
62.003				1		0					
63.004						1					
Sample number											
	4	24	32	36	7	19	96	28	4	45	11
Producer accuracy/Omission error (% correct)											
	NTF	87.5	81.3	72.2	100.0	63.2	79.2	67.9	25.0	62.2	63.6
90% confidence interval (-)											
	NTF	72.5	67.6	58.7	72.1	44.4	71.6	52.3	57.9	50.0	39.4
90% confidence interval (+)											
	NTF	94.9	90.0	82.6	100.0	78.6	85.1	80.2	64.4	73.1	82.5
OVERALL ACCURACY = 73.3% KAPPA INDEX *1 = 70.8% STANDARD ERROR 0.03											

*[1] The Kappa index and standard error are only based on map classes with sample data and corresponding reference data
NTF = None that fits, these points represent field data that does not match exsisting map classes
N/A = not applicable, unable to compute confidence intervals from map codes that were found to be incorrect (0% producer/user accuracy)
N/S = not sampled, unable to compute producer/user accuracy and confidence intervals from map codes that were not sampled by reference data or sample data

	61.013	62.001	62.002	62.003	63.004	Samples	User accuracy/ Commission error (% correct)	90% confidence intervals -	90% confidence intervals +
						33	63.6	49.3	75.9
						28	92.9	80.6	97.6
						38	68.4	55.2	79.2
						9	77.8	50.4	92.4
						22	54.5	37.6	70.5
						85	89.4	82.7	93.7
						21	90.5	74.9	96.8
						1	100.0	27.0	100.0
						42	66.7	54.0	77.3
	1					21	33.3	19.2	51.3
	0					3	0.0	N/A	N/A
		1				1	100.0	27.0	100.0
			6			8	75.0	46.0	91.3
				0		1	0.0	N/A	N/A
					1	2	50.0	12.1	87.9
	1	1	6	0	1				
	0.0	100.0	100.0	N/S	100.0				
	N/A	27.0	68.9	N/S	27.0				
	N/A	100.0	100.0	N/S	100.0				

Total sampling points = 315
Total correct = 231
Standard error = 0.03

Key to management map class codes in Table H3

31.005 Mancos Shale Vegetation
42.006 Disturbed Semi-natural Vegetation
42.007 Rabbitbrush Shrub Herbaceous Vegetation
43.002 Mixed Wetland Herbaceous Vegetation
51.001 Big Sagebrush Shrubland
53.005 Mixed Montane Shrubland
61.002 Colorado Piñon - Utah Juniper / Bitterbrush / Muttongrass Woodland
61.008 Colorado Piñon - Utah Juniper Sandstone Barrens
61.01 Colorado Piñon - Utah Juniper / Mixed Montane Shrubland
61.011 Colorado Piñon - Utah Juniper / Sagebrush Woodland
61.013 Colorado Piñon – Utah Juniper / Black Sagebrush Woodland
62.001 Douglas-fir / Box elder Woodland
62.002 Douglas-fir / Gambel Oak Forest
62.003 Ponderosa Pine Woodland
63.004 Mancos River Woodland and Shrubland

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 100020, May 2009

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525

www.nature.nps.gov