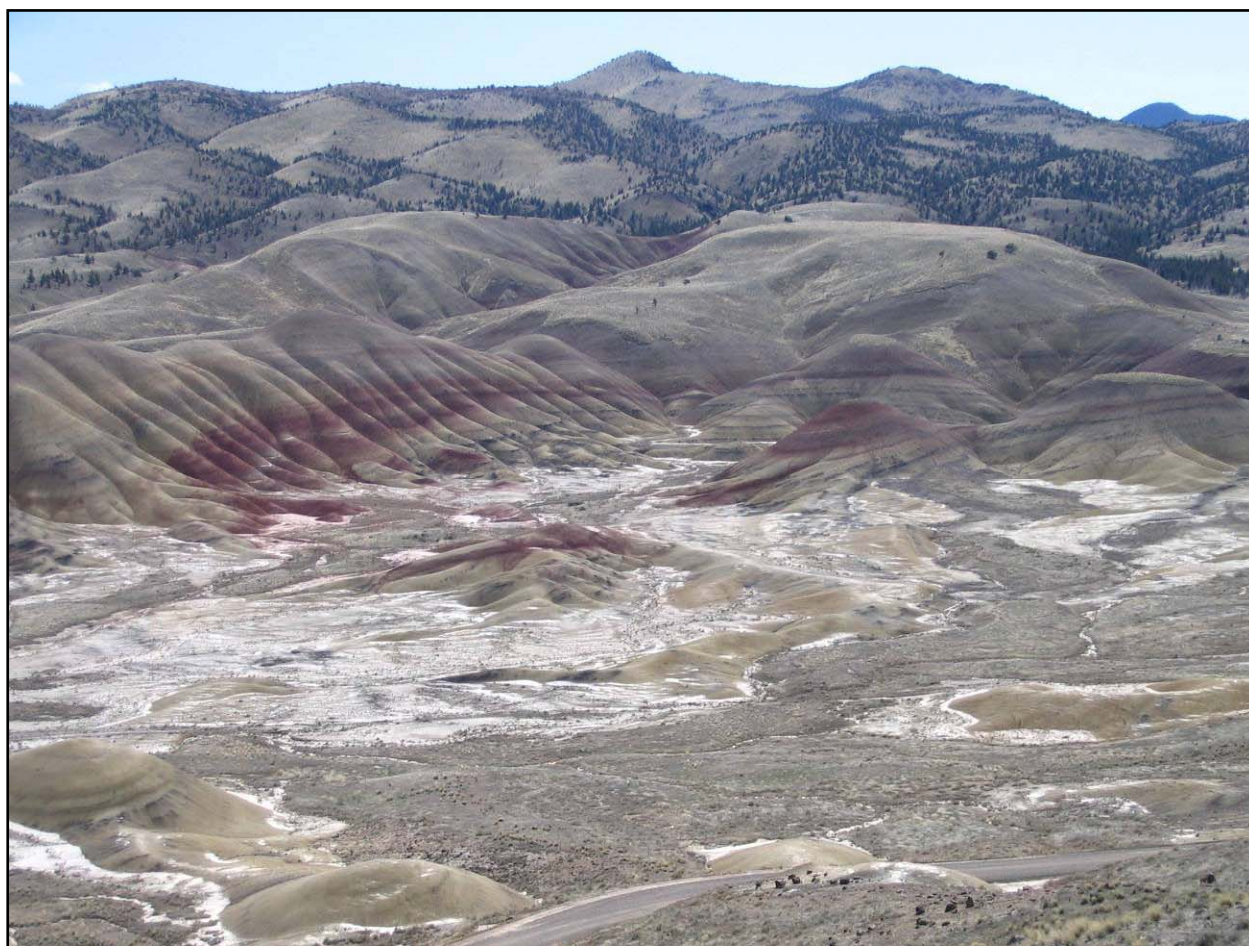




Vegetation Inventory Project

John Day Fossil Beds National Monument

Natural Resource Report NPS/UCBN/NRTR—2011/419



ON THE COVER

John Day Fossil Beds National Monument: Painted Hills Unit
Photograph by: Cogan Technology, Inc.

Vegetation Inventory Project

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Natural Resource Technical Report NPS/UCBN/NRTR—2011/419

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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.

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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 informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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We could not have asked for a better partner on this project than the resource staff at JODA. Shirley Hoh (Resource Manager) and her staff went out of their way to assist the field crews, answer questions and review all of the draft deliverables. They were always timely, professional and extremely helpful throughout the process.

Executive Summary

John Day Fossil Beds National Monument (JODA) encompasses approximately 14,014 acres (5,697 ha) in three management units containing eight parcels located in the John Day River Valley of southeastern Oregon. The Sheep Rock Unit (six parcels totaling 8,916 acres) is located six miles west of Dayville, OR. The Clarno Unit (1,969 acres) is located 20 miles west of Fossil, OR, and the Painted Hills Unit (3,129 acres) is located nine miles northwest of Mitchell, OR.

Collectively, these units managed by the National Park Service (NPS) include dramatic volcanic and sedimentary rock formations containing widespread fossil beds that are aged from 54 million to 6 million years ago (mya). On and around these exposed sedimentary and volcanic landscapes are 243 species of vascular plants including a mix of native and non-native plant communities common to badlands, basins, slopes, volcanic exposures, alluvial deposits, and riparian sites. To better understand the plant community distribution at JODA, the NPS Vegetation Inventory Program (NVIP) funded an effort, beginning in 2008, to inventory and document (map) the vegetation. The Upper Columbia Basin Inventory and Monitoring Network (UCBN) coordinated the JODA vegetation inventory effort as part of a network-wide project.

A three-year, four-phase program was initiated to complete the tasks of sampling, classifying, and mapping the vegetation types within JODA. Phase-one, directed by UCBN staff in conjunction with Northwest Management Incorporated (NMI) and the Oregon Natural Heritage Information Center (ORNHIC) resulted in the plant association and alliance classification using the National Vegetation Classification System (NVCS). Classification was based on new, 2008 sampling efforts resulting in 361 representative classification plots located within the three JODA units. Analysis of the classification plot data by ORNHIC ecologists occurred in late 2008. Through this process 52 distinct plant associations and 23 vegetation alliances were identified. Vegetation descriptions and a field key for each association are included as appendices to this report.

Phase-two, directed by NMI and Cogan Technology, Inc. (CTI) resulted in the digital vegetation map and geodatabase. Mapping was conducted primarily on 2009 National Aerial Imagery Program (NAIP) products supplemented by 2005 NAIP imagery. Interpreting the vegetation-specific signatures from the new imagery, CTI reliably discerned 41 vegetation, 21 land use/land cover, and four geology map units. The mapping process used primarily manual digitizing of the homogenous photo-signatures supported by on-site verification. All interpreted data were converted to Geographic Information System (GIS) databases using ArcGIS[®] software. The final map layer contains vegetation, land-use, and geologic exposure polygons with corresponding map class, NVC, and modifier attributes.

Draft maps were printed, field tested during April 2009, reviewed, and revised. Following verification by JODA staff, edits were applied to create the final vegetation map product for accuracy assessment (AA). In Phase-three the AA was conducted by NMI ecologists in 2010 by placing 407 random point locations throughout the study area based on frequency and abundance of the vegetation map units. AA locations were accessed by NMI field crews, the vegetation at the targets was keyed to the proper association, and representative photographs of each location

were acquired. The field data were compared to the electronic vegetation map and following the final assessment revealed an overall thematic accuracy of 87%.

Completion of the project in Phase-four included producing the standard project deliverables as described and presented in this report and the accompanying DVD. Deliverables include:

- The *Final Report* that includes keys to the vegetation types and imagery signatures, AA information, and a summary of all the methods and results;
- A *Spatial GIS Database* containing spatial data for the vegetation, plots, and AA points;
- *Digital Photos* from sample plots and miscellaneous park views;
- *Metadata* for all spatial data [Federal Geographic Data Committee (FGDC)-compliant];
- *Vegetation Descriptions and Photo Signature Key* to the map classes and associations/alliances.

A Summary of the projects statistics is included below:

Field Work:

- 2008 Plot Sampling = 361 Classification Plots:
2009 Observation Point Collection = 70 Observation Points
- 2010 Accuracy Assessment = 408 Points

Classification:

- 52 NVC Plant Associations and 23 NVC Vegetation Alliances

GIS Database:

- Project Size = 74,537 acres
 - John Day Fossil Beds National Monument =
 - 14,014 acres (Authorized Boundary)
 - 15,911 (Mapping Boundary includes in-holdings)
 - Environs = 58,627 acres
- Base Imagery =
 - NAIP 2009, True-color, 3-band, 1-meter, 1:12,000-scale ortho-image
 - NAIP 2005, True-color, 3-band, 1-meter, 1:12,000-scale ortho-image
- 48 Map Units = 32 Vegetated, 4 Geology, and 12 Land-use/Land-cover
- Minimum Mapping Unit = 1.24 acres were modified to ¼ acre for wetlands and riparian polygons
- Total Size = 9,662 Polygons
- Average Polygon Size = 8 acres
- Overall Thematic Accuracy = 87%

Introduction

Background

In 1994, the U.S. Geological Survey (USGS) and National Park Service (NPS) formed the USGS-NPS Vegetation Mapping Program to cooperatively inventory and map the vegetation in the system of National Parks. Presently managed as the National Vegetation Inventory Program (NVIP) by the NPS Natural Resource Program Center, Biological Resource Management Division, program goals are to provide baseline ecological data for park resource managers, obtain data that can be examined in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998).

Also in 1994, the NVIP adopted the U.S. National Vegetation Classification (USNVC; Grossman et al. 1998) as a basis for the *a priori* definition of vegetation units to be inventoried. The Federal Geographic Data Committee (FGDC) adopted a modified version of the upper (physiognomic) levels as a federal standard (FGDC-STD-005, FGDC 1997). This standard was hereafter termed the National Vegetation Classification Standard (NVCS). The NVCS established a federal standard for a complete taxonomic treatment of vegetation in the U.S. at eight physiognomic levels, they are: (1) Formation Class, (2) Formation Subclass, (3) Formation, (4) Division, (5) Macrogroup, (6) Group, (7) Alliance, and (8) Association, with the finest level being the plant association. Alliances are usually aggregations of associations that are physiognomically uniform and share one or more characteristic or diagnostic species. An association is defined as a plant community or type with a consistent species composition, uniform physiognomy, and homogenous habitat conditions (Flahault and Schroter 1910). The plant association or community type is determined by environmental patterns and disturbance processes.

The NVCS established conceptual taxonomic levels for the floristic units of alliance and association, largely following the USNVC, but did not offer a taxonomic treatment for the floristic levels because of the immense scope of establishing robust floristic units for the entire U.S. The FGDC standard requires that federally funded vegetation classification efforts collect data in a manner that enables crosswalking the data to the NVCS (i.e., the physiognomic levels) and sharing between agencies, but does not require use of that standard by agencies for internal mission needs. NatureServe (2010) maintains a treatment of floristic units (alliances and associations), which, though not a federal standard, are used as classification and mapping units by the NVIP whenever feasible. For purposes of this document, the federal standard (FGDC 1997) is denoted as the NVCS; the USNVC will refer exclusively to the NatureServe treatment for vegetation floristic units (alliances and associations only).

Use of the NVCS as the standard vegetation classification system is central to fulfilling the goals of the NVIP because it:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;

- identifies vegetation units based on both qualitative and quantitative data; and
- is appropriate for mapping at multiple scales.

The use of the NVCS and the NVIP vegetation inventory protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS and by other federal and state agencies. The vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs. In addition they can be used to provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental conditions and ecological processes across the landscape.

The NVCS has primarily been developed and implemented by The Nature Conservancy (TNC) and the network of State Natural Heritage Programs over the past forty years (TNC 1994a; Grossman et al. 1998). The NVCS is currently supported and endorsed by multiple federal agencies, the FGDC, NatureServe, State Heritage Programs, and the Ecological Society of America. Refinements to the classification occur in the process of application, which lead to ongoing revisions that are reviewed both locally and nationally. TNC and NatureServe have made available a two-volume publication presenting the standardized classification, providing a thorough introduction to the classification, its structure, and the list of vegetation types occurring within the U.S. as of April 1997 (Grossman et al. 1998). *Volume I: The National Vegetation Classification Standard* can be accessed electronically on the Internet at: <http://www.natureserve.org/publications/library.jsp>. NatureServe has since superseded *Volume II* of the publication (the classification listing), providing regular updates to ecological communities in the U.S. and Canada. This online database server, NatureServe Explorer®, can be accessed electronically on the Internet at: <http://www.natureserve.org/explorer>.

NPS-USGS Vegetation Inventory Program

The Director of the NPS approved the Natural Resource Challenge (NRC) in 1999 to encourage the NPS to focus on the preservation of the nation's natural heritage through science, natural resource inventories, and expanded resource monitoring (NPS 1999). The NRC provided funding for 12 baseline inventories to be completed in each of 270 parks with significant natural resources. The vegetation inventory and mapping is considered one of the 12 baseline inventories. Through the NRC, 270 units managed under the NPS were organized into 32 networks for the purpose of accomplishing natural resource inventory and monitoring projects.

The NVIP is a cooperative effort between the NPS and the USGS to classify, describe, and map vegetation communities in more than 270 national park units across the U.S. Vegetation species and communities can be unique from park-to-park. The inventory of vegetation resources helps park managers identify and conserve plant biodiversity; manage challenges including exotic species invasions, insect effects, and diseases; and understand resources and processes including wildlife habitat relationships and wildland fires.

The primary objective of the NVIP is to produce high-quality, standardized maps and associated data sets of vegetation and other land cover occurring within parks and selected adjacent environments (environs). This information fills data gaps and complements a wide variety of

resource assessments, park management, and conservation needs. For example, in Sequoia and Kings Canyon national parks, the 2007 vegetation map and digital database provided tools to better manage the foxtail pine (*Pinus balfouriana* ssp. *austrina*), an endemic species to the southern Sierra Nevada Mountains. Foxtail pine may live more than 1,000 years and their tree rings contain valuable information about past-to-present climate fluctuations. In Rocky Mountain National Park, vegetation map and inventory data aid in the study of American elk (*Cervus elaphus*) effects to quaking aspen (*Populus tremuloides*) reproduction and distribution and willow (*Salix* spp.) trees and shrubs comprising a portion of American elk winter habitat.

The NVIP uses well-established procedures that are compatible with other agencies and organizations including the NVCS, a system that is integrated with the major scientific efforts in the taxonomic classification of vegetation, and is a FGDC standard. In addition, stringent quality control procedures ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales.

A complete vegetation mapping project for an NPS unit includes the following products, at a minimum:

- Detailed vegetation report
- Digital vegetation map
- Vegetation plot data
- Accuracy assessment data & analysis
- Dichotomous vegetation key
- Photo-interpretation key

Maps are produced in Universal Transverse Mercator (UTM) coordinates (NAD 83) with a 1:24,000 scale and a minimum mapping unit of 1.24 acres. The vegetation maps must meet the National Map Accuracy Standards for positional accuracy, and the minimum class accuracy goal across all vegetation and land cover classes of 80 percent.

Upper Columbia Basin Network

The specific decision to classify and map the vegetation of JODA was made in response to guidelines set forth by the NPS Natural Resources Inventory and Monitoring Program and implemented by the Upper Columbia Basin Network (UCBN), which includes nine NPS units located in four states of the inland Northwest (Figure 1). The UCBN was organized to inventory and monitor status and trends for selected natural resources (network organization facilitates collaboration, information sharing, and economies of scale in natural resource monitoring). The inventory and monitoring information is used by NPS and park unit resource managers to guide management decisions, to inform scientific research, and to provide public education. One goal of the NPS servicewide monitoring program is to collect and serve data to better understand the dynamic nature and condition of park-managed ecosystems and to provide reference points for comparisons with other management types and possibly with altered environments. The development of a vegetation classification to the plant association level and associated GIS map and database for each park is viewed as a high priority in reaching this goal.

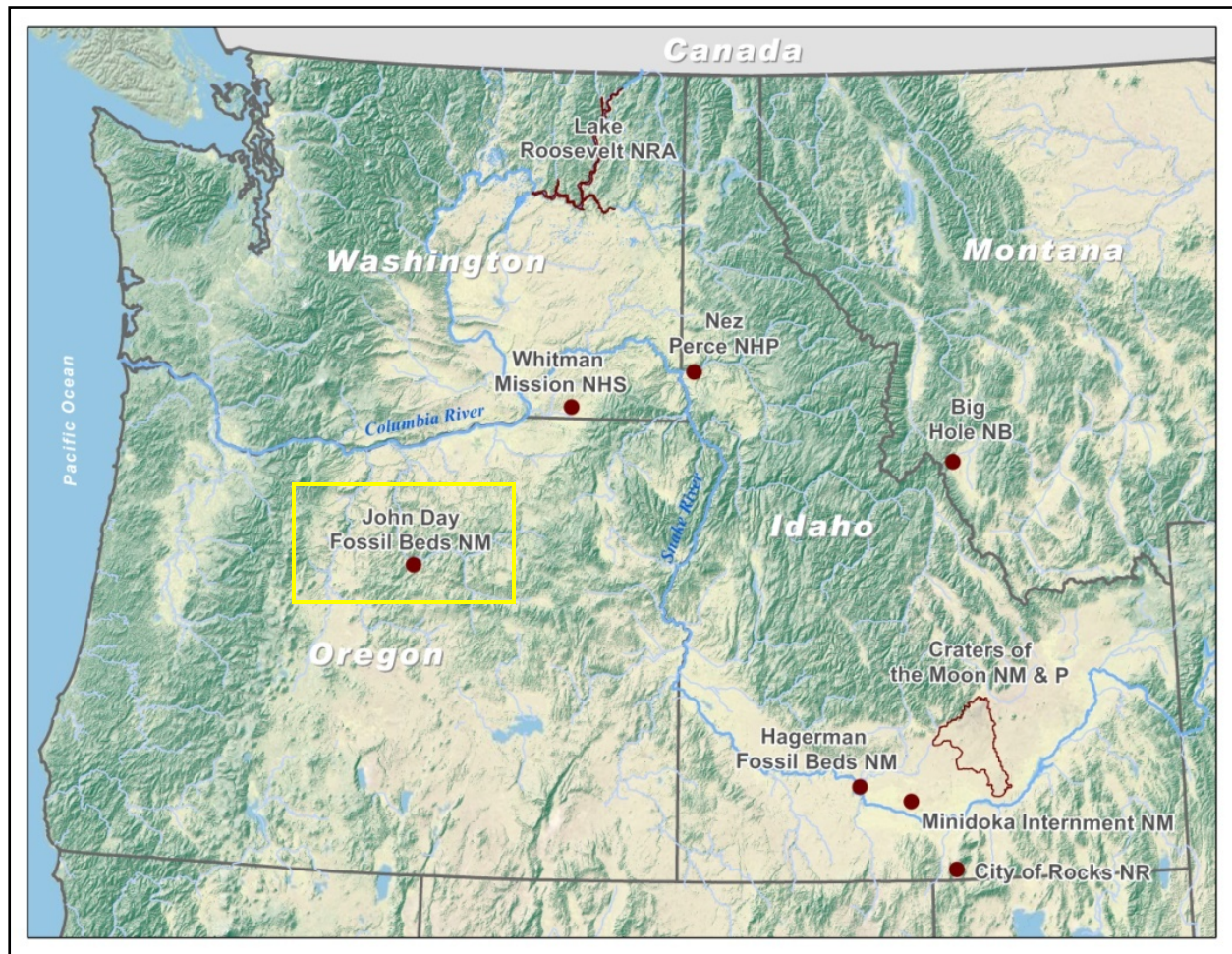


Figure 1. Map of UCBN showing the location of the park units in the network.

John Day Fossil Beds National Monument

On October 26, 1974, JODA was authorized by Congress (Public Law 94-486) and was formally established in 1975 under proclamation of President Gerald R. Ford (NPS-JODA 2008). The Monument occurs as eight individual land parcels within three managed units of northcentral Oregon, they are the: (1) Sheep Rock Unit, (2) Painted Hills Unit, and (3) Clarno Unit (Figure 2). JODA management units are located on the Upper Great Basin near the Columbia Plateau on the moderately broad John Day River Valley, which receives runoff from the Aldrich, Strawberry, Greenhorn, and Umatilla mountains in the vicinity of the Monument (NPS-JODA 2005a). JODA is located in Grant and Wheeler counties in northcentral Oregon; the nearest town to the Sheep Rock Unit is Dayville (6 miles east); the Painted Hills Unit is located 9 miles northwest of Mitchell; and the Clarno Unit occurs 20 miles west of the town of Fossil. The nearest cities are Bend (95 miles to the southwest) and The Dalles (120 miles to the northwest). JODA units are located on State Highway 26 and 19 (Sheep Rock), State Highway 26 (Painted Hills), and State Highway 218 (Clarno). The units are bordered by a combination of privately-owned and public-managed lands (Figure 3).

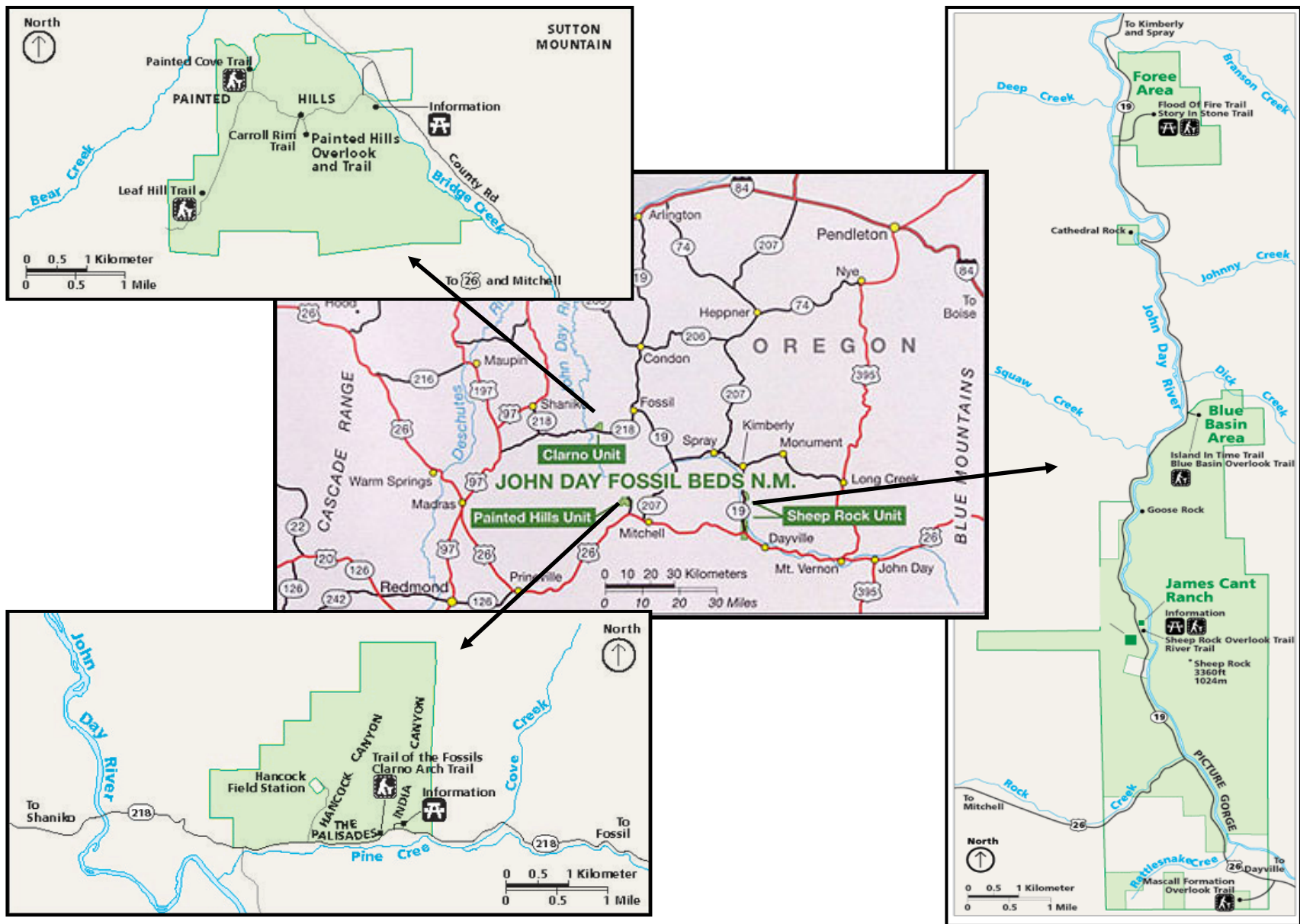


Figure 2. JODA Boundary Maps.

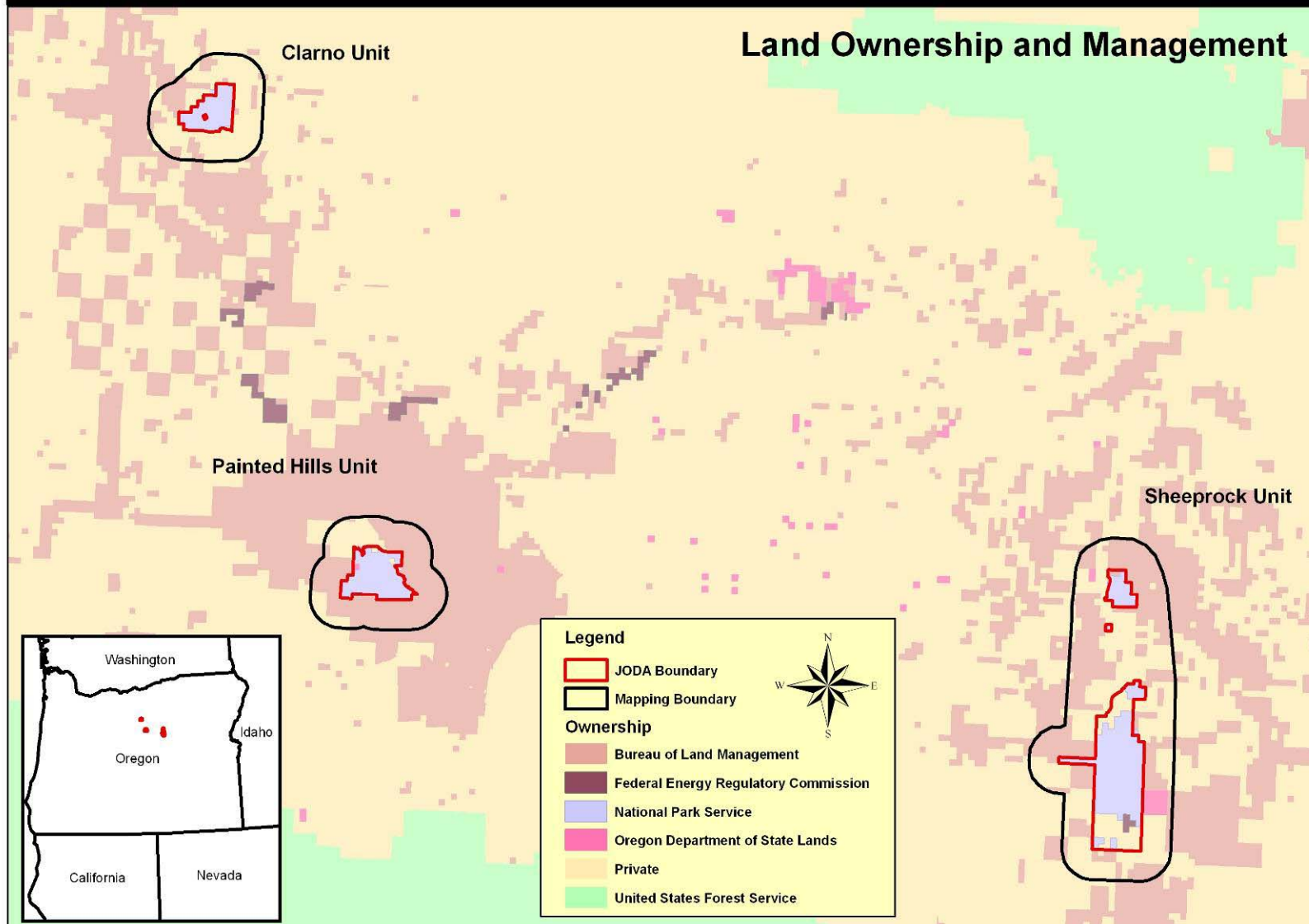


Figure 3. Map of JODA and surrounding land ownership

JODA was established primarily to preserve the most extensive fossil record of the Tertiary age (encompasses approximately 48-million years) in the U.S. The abundant fossil beds scattered across the three units have preserved vestiges of the actual soils, riverbeds, ponds, watering holes, mudslides, ashfalls, floodplains, middens, trackways, prairies, and forests in an unbroken sequence that is one of the longest known continuous geological records. Embedded in these layers are preserved fossil seeds, fruits, leaves, branches, and plant roots in addition to a plethora of animal fossils including early rhinoceros, tapirs, and feline predators (NPS-JODA 2007).

Natural and Developed Setting

JODA occurs in the John Day River Valley and Basin, a subunit of the Columbia Plateau physiographic region in northcentral Oregon (NPS-JODA 2008). This valley originates in the Blue and Ochoco mountains and delivers flows northward to the Columbia River. At 20,979 square kilometers (8,100 square miles), the John Day River is the fourth largest drainage basin in the State of Oregon, draining an area roughly the size of New Jersey. Consisting of a mainstem, North, Middle, and South forks the John Day River at over 451 kilometers (280 miles) is also one of the longest free-flowing rivers in the continental United States.

The landscape within all three units of JODA is heavily influenced by the John Day River, and its associated tributaries, canyons, and floodplains (Figure 4). It flows through the entirety of the Sheep Rock Unit from south to north and travels one-mile west of the Clarno Unit. Many tributaries also flow into the river in or near the Monument units; these include the Rattlesnake, Rock, Squaw, Dick, Johnny, Deep, Branson, Bridge, Bear, Cove, and Pine creeks. As one travels away from the river, large alluvial fans and flats gradually trend into hills, slopes, and ridges with impressive bedrock, basalt, sediment and badland exposures. Providing dramatic vistas, JODA landscape varies greatly resulting in an elevations ranging from approximately 1,300 to 1,500 ft on the John Day River to 4,578 ft at Windy Point (NPS-JODA 2005a).



Figure 4. Sheep Rock Unit - John Day River

From a broader physiographic perspective, JODA occurs within the John Day/ClarnoUplands of the Northwestern Forested Mountains (USEPA 2010) and occurs on a large interior plateau lying between the Cascade Range and the Blue Mountains (USFWS 2002). The plateau can be considered a broad upland plain formed by floods of molten basalt overlain with wind-deposited sediments. This is surrounded and intermixed with the older assemblages of sedimentary, volcanic, and metamorphic rock that was uplifted, tilted, and faulted to form rugged mountains and hills.

Through weathering and erosion many of these unique geologic formations are exposed in the John Day River Valley and a great concentration occurs within the boundary of JODA. In fact JODA was established to help preserve these world-class Tertiary Period fossil bed exposures and many can be found scattered across the six major geologic formations that occur here. From the oldest to youngest, the six main formations include: 1) Goose Rock Deposits, 2) Clarno Group, 3) John Day Group, 4) Picture Gorge Basalt Group, 5) Mascall Formation, and 6) Rattlesnake Group (Figure 5). Encompassing and often derived from these geologic exposures are talus slopes, gravel formations and a great variety of clayey soils. During a soil survey for JODA in 2000, 37 soil types and 84 soil map units were found at JODA (NRCS 2002). Most were clayey in texture and well drained. As expected soils found in the bottomlands were deep (40 to over 60 inches), but become variable, patchy, and shallow (10 to 40 inches) on the steep uplands and rocky bluffs. On most undisturbed areas, biological soil crusts composed of algae, lichens, mosses, microfungi, and bacteria were found.

Along with its terrain, JODA's weather also varies greatly and can be unpredictable. The area in and around the Monument is characterized by a semiarid plateau/continental interior climate, averaging approximately 14 inches of precipitation annually, including 15 inches of snow (WRCC 2010). Temperatures range from an average maximum of 91.2 °F in July to an average minimum of 21.6 °F in January. Hottest days average a maximum of 85 to 91 °F in June and July and do exceed 100 °F (WRCC 2011). The growing season for this region is approximately 120 days.

The proximity of available water coupled with a relatively mild climate has led to many human developments in the John Day River Basin. Most of the land in the basin is private, about 62%, with the rest comprised of 30% U.S. Forest Service (USFS), and 7% U.S. Bureau of Land Management (BLM) managed lands. The State of Oregon and NPS manage most of the rest totaling less than 1 percent. Predominant land uses in the basin include agriculture, timber production, and recreation. Over 95 percent of the basin is zoned for agriculture and forestry uses (Oregon Department of Fish and Wildlife 1990) and about 60,103 acres of land are actually irrigated in the basin (including small acreages in the JODA Sheep Rock Unit). Interestingly, most of the land within the John Day River Basin is ceded territory to the Confederated Tribes of the Warm Springs Reservation. Part of the North Fork John Day River subbasin is land ceded to the Confederated Tribes of the Umatilla Indian Reservation (Buchanan et al.1997).

The continual use and development of the John Day River has had many effects on the hydrology, ecology and vegetation common to this area over the years. From the late 1860s to

the present, livestock grazing and irrigated fields greatly impacted the native lowland vegetation by reducing the distribution and abundance of many native plant species (NPS 2005b). Livestock

John Day Fossil Beds

National Park Service
U.S. Department of the Interior

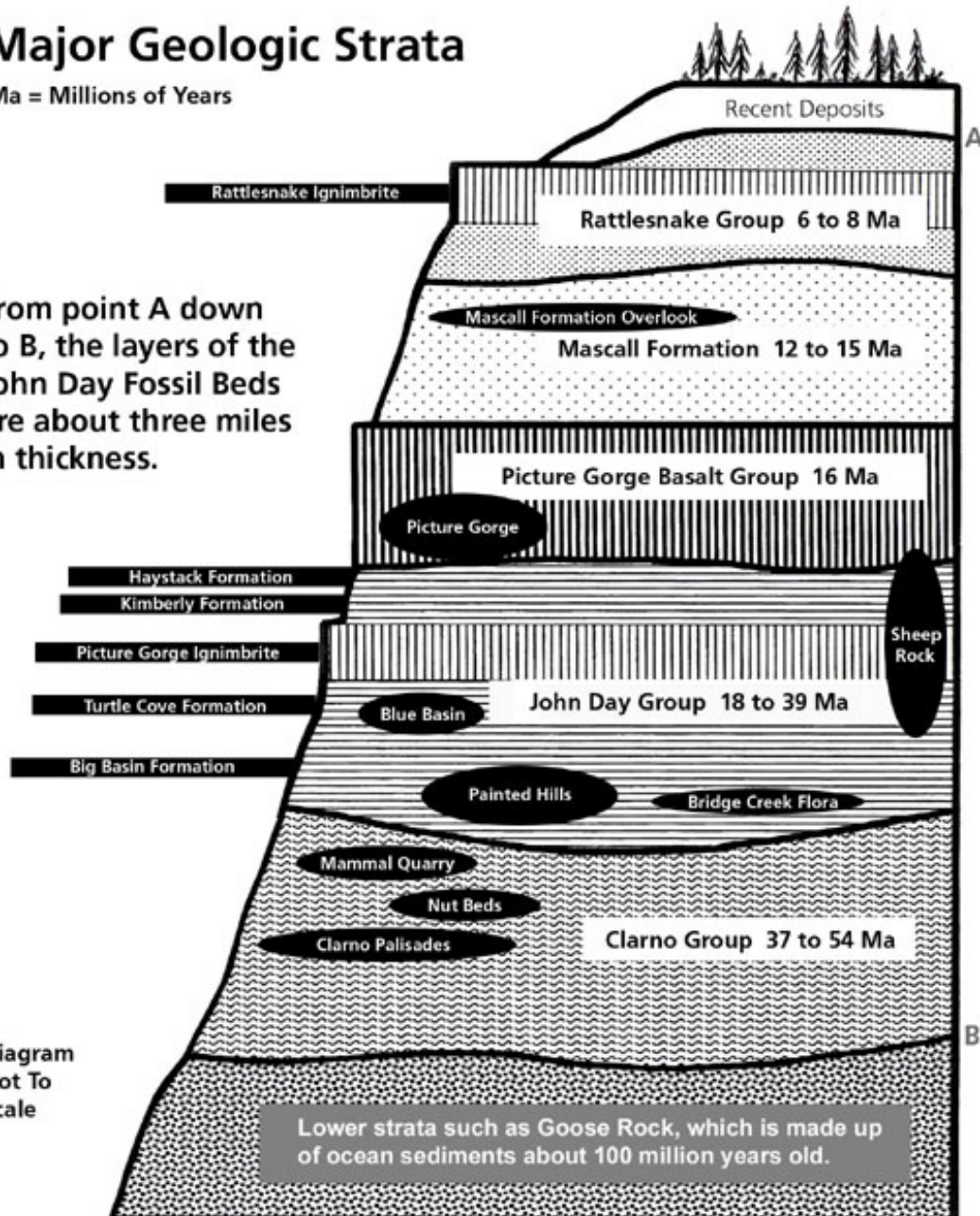
John Day Fossil Beds
National Monument



Major Geologic Strata

Ma = Millions of Years

From point A down to B, the layers of the John Day Fossil Beds are about three miles in thickness.



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Figure 5. Geologic formations diagram (obtained from NPS).

grazing and browsing was curtailed upon the establishment of the JODA units, but roughly 72 acres of irrigated river bottomlands continue to be maintained as historic alfalfa fields in the Sheep Rock Unit and a three-acre orchard remnant is maintained in the Sheep Rock Unit (NPS-JODA 2008). In addition to the obvious landscape changes many areas of JODA support, and will continue to support, high amounts of non-native grasses and weeds likely introduced during agricultural activities (NPS-JODA 2008). For example, in addition to serving as pastures for livestock, the floodplain of the John Day River and some adjacent alluvial fans were converted to dryland and irrigated hay fields likely seeded with non-native plants.

In addition to the historic and current agricultural influences, other anthropogenic disturbances also occur throughout the JODA units. In the Clarno Unit there are a total of 75,676 linear feet (24,212 meters) of inventoried human-created unofficial trails (social trails). Vegetation occurring along the social trails has been denuded, trampled, and crushed to varying degrees and this loss is most apparent along the more popular trails. Until recently, fire was excluded from JODA, but prior to Anglo-American settlement monument lands were estimated by NPS to burn every five to 15 years (NPS-JODA 2008), although Bell and Hinson (2010), reviewing scientific literature on sagebrush steppe fire regimes, determined that much longer fire return intervals were more likely, given the predominance of Wyoming big sagebrush (*Artemisia tridentata*). From the early 1900s until the recent prescribed burn program instituted by the park service, fire suppression was practiced in the region, which in combination with heavy livestock use, resulted in the proliferation of woody plants and non-native invasive annual grasses. Also, the encroachment of western juniper trees from scattered ridges and hollows down on to the slopes and alluvial fans in some portions of JODA has also been a result of the altered fire regime. Today, western juniper management in JODA uses prescribed fire and selective cutting with the goals of reducing tree density and reinvigorating shrublands and grasslands.

Vegetation

JODA habitats support a rich diversity of nearly 250 plant species occurring on butte, ridge, hill, slope, alluvial fan, valley, floodplain, and badlands landforms and exposures. The distribution of vegetation types and plant species conforms to the ecological drivers of geologic substrate, elevation, slope, slope aspect, soil development, and hydrology and to historic human land uses and present vegetation management by the NPS.

Excluding the Goose Rock deposits, JODA's vegetation is influenced mostly by the geographic features (Figure 6). It is fairly common to find many native and non-native grasses and Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) on the deep soils of the Clarno Group. On more gravelly slopes and on talus deposits western juniper (*Juniperus occidentalis*) and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) are common. The ash and tuff deposits in the John Day group are somewhat inhospitable to most vegetation but some sparse shadscale (*Atriplex confertifolia*) and other dwarf shrubs (e.g., *Salvia dorrii*) can be found throughout. The steep slopes of the Picture Gorge group are mostly unvegetated although some may support thin bands of mountain mahogany and junipers. Similar sites occurring in the Mascall Group are mostly unvegetated or contain sparse, dwarf shrubs. Unique drainages and alkaline soils at the base of the Mascall exposure support small stands of greasewood (*Sarcobatus vermiculatus*) and sagebrush. Finally the Rattlesnake Group has little associated

vegetation but the soils developed on top of this formation support thick stands of bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*) and dense sagebrush shrublands.

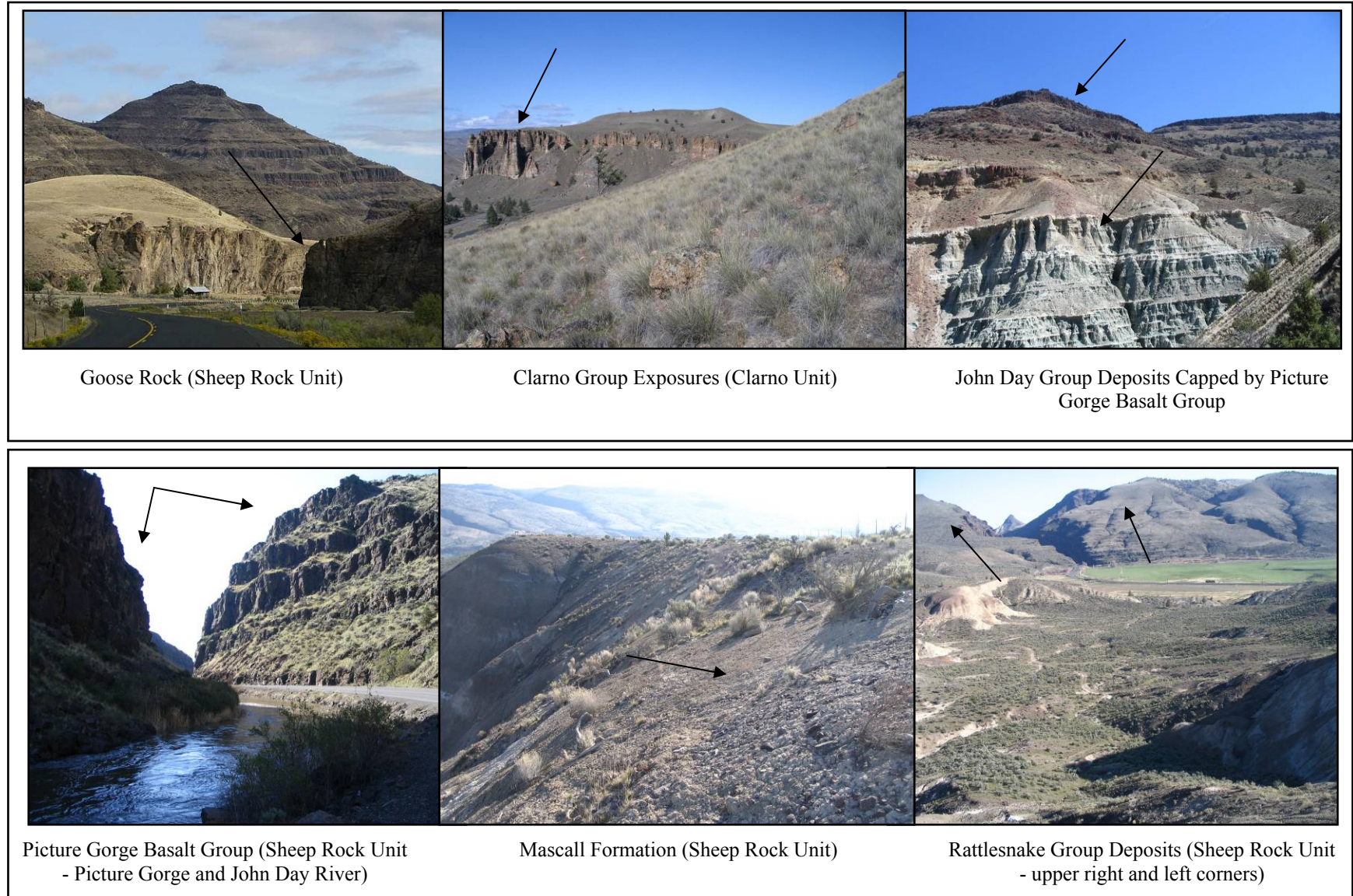


Figure 6. Examples of JODA's major geologic formations and associated vegetation.

Generally the vegetation at JODA trends from upland woodlands dominated by western juniper and curl-leaf mountain-mahogany with native grasses in the understory to expansive slopes and alluvial fans characterized by Wyoming big sagebrush, antelope bitterbrush (*Purshia tridentata*) and encroaching western juniper trees. Continuing downslope towards the floodplains, grasslands are comprised primarily of the native bluebunch wheatgrass, Idaho fescue, and Thurber's needlegrass (*Achnatherum thurberianum*). Scattered throughout the upland areas, on tuff/ash deposits and on badlands are shrubs and herbaceous vegetation characterized by shadscale, broom snakeweed (*Gutierrezia sarothae*), Blue Mountain wild buckwheat (*Eriogonum strictum*), curly bluegrass (*Poa secunda*), Nuttall's Sunflower (*Helianthus nuttallii*), Golden Spiderflower (*Cleome platycarpa*), and gray ball sage (*Salvia dorrii*). Unique stands of vegetation also dot the landscape including small patches of netleaf hackberry (*Celtis laevigata* var. *reticulata*) in the Clarno Unit and chokecherry (*Prunus virginiana*) in all three units.

The floodplains in JODA are heavily disturbed but some still contain stands of native basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), Great Basin wildrye (*Leymus cinereus*) and greasewood on alkali soils. The lowest areas of JODA support ribbons of riparian woodlands and shrublands containing black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), Russian-olive (*Elaeagnus angustifolia*), white alder (*Alnus rhombifolia*), chokecherry, coyote willow (*Salix exigua*), and Woods' rose (*Rosa woodsii*). Finally emergent wetland and mesic herbaceous species occur on the river and creek banks (in addition to also occurring in upland seeps and springs). Dominant native species include broad-leaved cattail (*Typha latifolia*), common reed (*Phragmites communis*), reed canarygrass (*Phalaris arundinacea*), Baltic rush (*Juncus balticus*), and meadow barley (*Hordeum brachyantherum*).

As evidenced from these and other inventories non-native exotic plants are unfortunate widespread contributors to the vegetation diversity at JODA. Non-native or exotic plant species number 91 within JODA and comprise 38% of the known plant species. Regionally they occur on sites ranging in size from less than an acre along parking lots and trails to thousands of acres covered by a mix of cheatgrass (*Bromus tectorum*), medusahead rye (*Taeniatherum caput-medusae*), crested wheatgrass (*Agropyron cristatum*), intermediate wheatgrass (*Thinopyrum intermedium*) and other non-native grasses.

Since the early to middle 1900s, 13 exotic plant species have become established within JODA that are of particular management concern, including cheatgrass, Dalmatian toadflax (*Linaria dalmatica*), Russian knapweed (*Acroptilon repens*), diffuse knapweed (*Centaurea diffusa*), spotted knapweed (*Centaurea maculosa*), whitetop (*Cardaria draba*), medusahead rye, musk thistle (*Carduus nutans*), poison hemlock (*Conium maculatum*), yellow star thistle (*Centaurea solstitialis*), scotch thistle (*Onopordum acanthium*), perennial pepperweed (*Lepidium latifolium*), and Russian-olive (NPS-JODA 2008). These invasive plant species are considered noxious by NPS staff and are of high management concern because of their adverse effects on native plant and animal communities and their high potential to spread throughout the monument. Many of the afore-mentioned nonnative plant species are also among the most established and most difficult to control; completely displacing native vegetation stands if control measures are not undertaken.



Western Juniper/Wyoming Big Sagebrush/Idaho Fescue



Curl-leaf Mountain Mahogany



Netleaf Hackberry and Cheatgrass



Wyoming Big Sagebrush/Bluebunch Wheatgrass



Broom Snakeweed



Shadscale

Figure 7. Examples of JODA's vegetation communities.



Ash Bed Sparse Vegetation



Western Juniper/Curly Blugreass/Bluebunch Wheatgrass



Slender Wheatgrass (Introduced)



Bluebunch Wheatgrass/Idaho Fescue



Medusahead Rye and Cheatgrass



Coyote Willow

Figure 7. Examples of JODA's vegetation communities (continued).

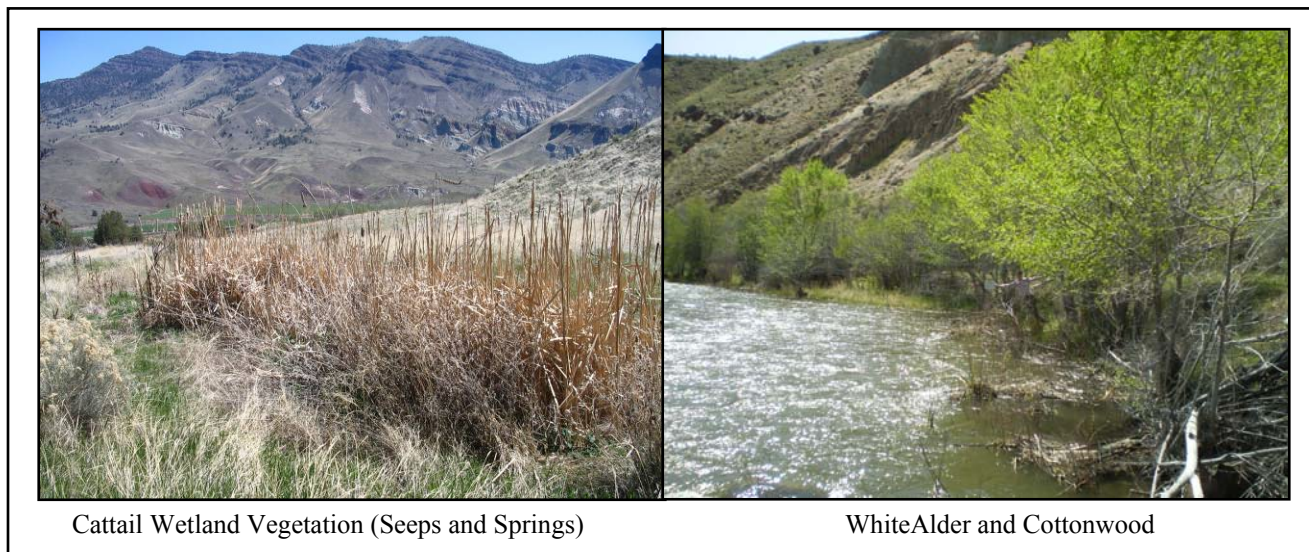


Figure 7. Examples of JODA's vegetation communities (continued).

The U.S. Fish and Wildlife Service has identified seven rare, native plant species of concern that may occur within the JODA region of Oregon; however they have not all been documented within the monument (NPS-JODA 2008). In the Painted Hills Unit, hedgehog cactus (*Pediocactus simpsonii*; Figure 8) and the endemic John Day chaenactis (*Chaenactis nevii*) are listed as rare by the Oregon Natural Heritage Program (ONHP). A 1991 survey (Wright 1992) for sensitive plant species within JODA identified *Chaenactis nevii* within all three Monument units but only considered common and widespread on clay outcrops in the Painted Hills Unit. Apparently healthy populations of hedgehog cactus occurred in the Painted Hills and Sheep Rock units. More recently in JODA plant surveys, Ordway (2005) identified the ONHP plant species of concern scapose catchfly (*Silene scaposa*; NPS-JODA 2008).



Figure 8. *Pediocactus simpsonii* in the Painted Hills Unit.

John Day Fossil Beds Vegetation Inventory Project

JODA is one of nine NPS units served by the UCBN Inventory & Monitoring Program. The UCBN initiated a vegetation mapping inventory for JODA in the winter of 2007 as part of a larger effort to complete vegetation inventory maps for the network. An initial multi-year work plan was developed for the UCBN by Cogan Technology, Inc. (CTI). This work plan provided recommendations for completing the plant community classification, digital database, and map products for each of the nine UCBN parks; it received approval from the Washington Area Service Office (WASO) Inventory Coordinator in May 2006.

Once approved, UCBN staff contracted with ORNHIC to complete vegetation plot field data collection during the spring/summer of 2008. The ORNHIC was retained to provide the preliminary and final vegetation classification as part of a cooperative agreement with the UCBN. In September 2007, the UCBN entered into a contract with NMI to provide all of the vegetation mapping services presented in the work plan and to administer and coordinate the UCBN vegetation mapping projects for the nine park units. Subsequently, CTI was retained by NMI as a sub-contractor to assist with mapping vegetation and land use for the JODA project.

The classification and mapping team objectives were to secure or create the following:

Spatial Data

- Aerial and ortho-photography
- Map classification based on JODA-specific requirements
- Map classification description and key
- Spatial database of vegetation communities of JODA vegetation
- Digital and hardcopy maps of vegetation communities
- Metadata for spatial databases
- Complete accuracy assessment of spatial data

Vegetation Information

- Vegetation classification
- Dichotomous field key of vegetation classes
- Formal description for each vegetation class
- Ground photos of vegetation classes
- Field data in database format

Scope of Work

Vegetation inventory for JODA occurred within an approximate 74,537 acre project area, encompassing the boundary of eight parcels comprising three Monument units (as provided by UCBN) and a general 2-km environ radius (Figure 9). The final project area determination was based on management needs, financial constraints, and time limitations. The 2-km environs area was used in this project for inventory and monitoring purposes and to capture various management considerations such as exotic weed dispersal. Also the size of the environs corresponded to the size proposed in the work plan and matches the other vegetation mapping protocols in the UCBN.

John Day Fossil Beds National Monument
Oregon

National Park Service
U.S. Department of the Interior

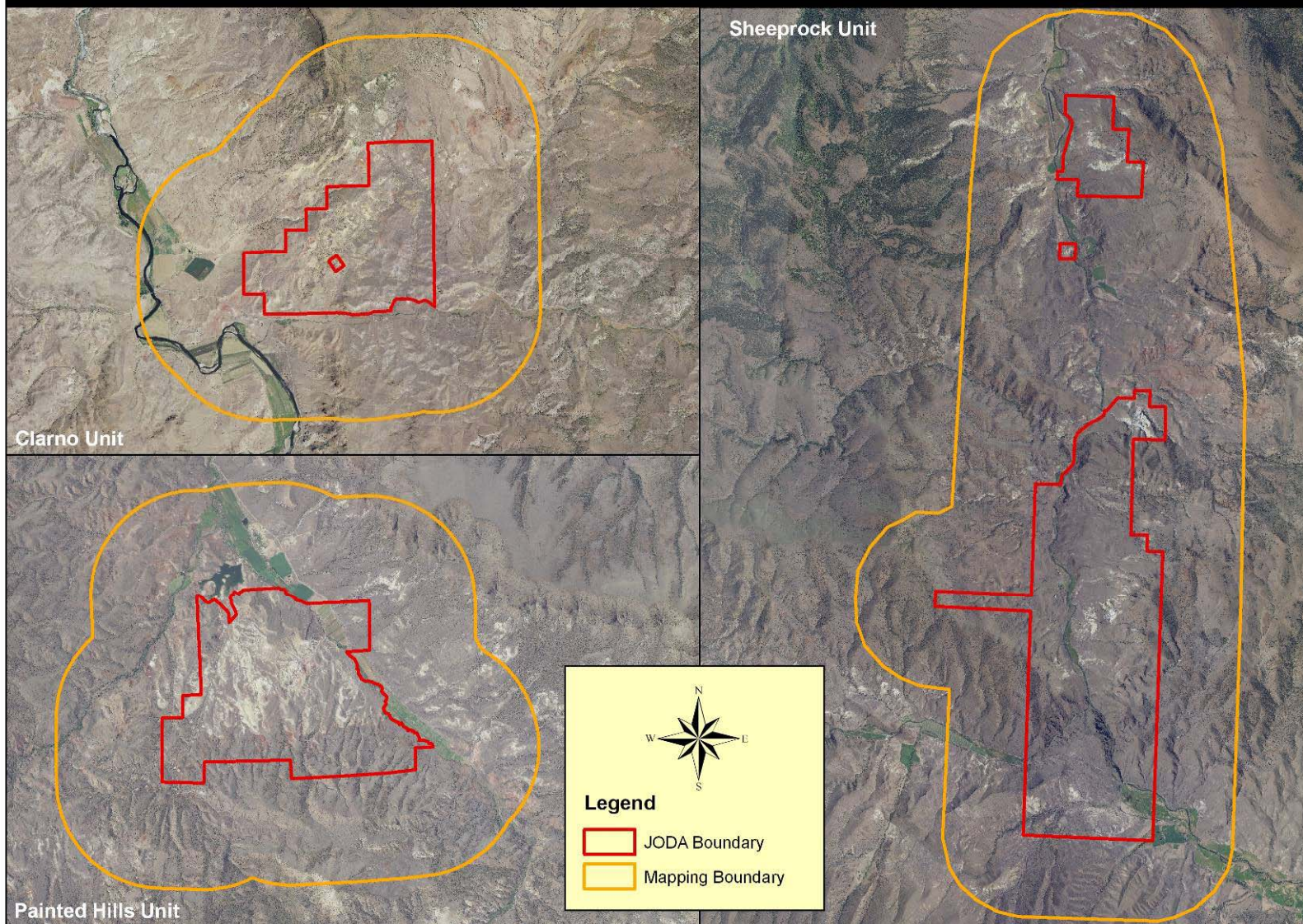


Figure 9. Project boundary for vegetation inventory at JODA.

Methods

The vegetation classification and mapping project for JODA was considered to be in the “small park” category based on the overall size of the project area (TNC 1994b). However, because the Monument is divided into three distinct units separated by many miles, the standard methodology to separate the park into the different subsets based on unit location (as is typically conducted on very large parks) was used. For JODA this breakdown included the western-most Clarno Unit, the central Painted Hills Unit and the eastern Sheep Rock Unit plus their surrounding environs. Based on this approach the assignment of project tasks and responsibilities was divided into five major steps following the flowchart of major steps produced for the national program by the USGS (Appendix A), they are:

1. Plan, gather data, and coordinate tasks;
2. Survey JODA to understand and sample the vegetation;
3. Classify the vegetation (using the field sample data) to NVCS standard associations and alliances and crosswalk to recognizable map units;
4. Acquire current digital imagery and interpret the vegetation and land use per the survey, classification results, and NVCS crosswalk;
5. Assess the accuracy of the final map product; and
6. Create the final project deliverables

All protocols for this project as summarized in the following sections were initially described by The Nature Conservancy and others (1994a, 1994b, and 1994c) for the USGS-NPS Vegetation Inventory Program and may be accessed at: <http://biology.usgs.gov/npsveg>.

Planning, Data Gathering and Coordination

Based on the work plan and the contract commitments by UCBN, a series of tele-conference calls were held in 2007 to provide project planning and guidance. This was followed by an official project planning and kick-off meeting held at U.S. Forest Service Office in John Day, Oregon in November of 2007. During this meeting representatives from the various contracted firms and federal agencies discussed the project and then visited the Sheeprock Unit for an overview of the vegetation. The goals of the planning meeting were to: (1) provide an overview of NVIP protocols, (2) learn about the JODA management issues and concerns, 3) discuss availability of existing data, 4) develop a schedule, 5) discuss procedural issues and data, (6) define potential cooperators, and 7) finalize the scope of the project.

Park specific items approved for mapping during the planning stage included delineating seeps and springs regardless of size. Resource managers were also interested in the distribution of cheatgrass, medusahead rye, and other exotic plant species and requested the various types of exposed geologic formations be delineated. A 2-km (1.2 mile) environs was approved as the project boundary around all three units and review of the existing vegetation data and imagery yielded the following datasets to review: (1) the entire Sheep Rock Unit had been mapped completely by hand in 1977 (Youtie and Winward 1997), (2) ORNHIC was in the second year of a weed and at-risk species mapping project on the Painted Hills Unit, (3) ORNHIC’s vegetation map for the Warm Springs Indian Reservation Pine Creek Ranch mitigation site, which included

all of the Clarno Unit, and (4) review of the available National Agricultural Imagery Program (NAIP) imagery. A reasonable schedule was set with the project completion scheduled for the end of 2010 (Table 1).

Table 1. Project Timeline for JODA Vegetation Inventory Project.

Task Description	2007	2008	2009	2010
Planning and Scoping	-----■-----	-----	-----	-----
Acquire Aerial Imagery	-----■-----	-----■-----	-----	-----
Field Data Collection	-----	-----■-----	-----	-----
Image Interpretation	-----	-----■-----	-----■-----	-----
Vegetation Classification	-----	-----■-----	-----	-----
Local & Global Descriptions	-----	-----	-----■-----	-----
Spatial Database	-----	-----■-----	-----■-----	-----■-----
Plant Association Field Key	-----	-----	-----■-----	-----
Accuracy Assessment	-----	-----	-----■-----	-----
Final Report and Products	-----	-----	-----	-----■-----

Specific task responsibilities were assigned as follows:

JODA-UCBN-NPS Responsibilities

- Provide oversight and project funding;
- Provide JODA plant list;
- Supply digital boundary files and ancillary data files;
- Assist with field work and logistical considerations;
- Work with Oregon Natural Heritage Information Center and NatureServe to develop the vegetation classification;
- Compile, review, and update drafts of the vegetation map, classification and report;
- Accept the final products and close the project.

NMI Responsibilities

- Provide project management,
- Coordinate the field work with JODA;
- Write descriptions of the vegetation types found at JODA;
- Collect accuracy assessment data;
- Provide a final report describing all aspects of the project; and
- Create a DVD with reports, metadata, guides, vegetation classification, plot data, spatial data, vegetation database (map), graphics, and ground photos.

Oregon Natural Heritage Information Center (ORNHIC) Responsibilities

- Collect representative classification plot data;
- Assist with fieldwork and logistical considerations;
- Develop the vegetation classification based on the NVCS using quantitative analysis and ecological interpretation of the field data; and

- Write a field key to the vegetation types classified within JODA.

NatureServe

- Work with ORNHIC staff to develop a vegetation classification for the study area;
- Provide guidance regarding the crosswalk of vegetation types to map units;
- Review the local vegetation descriptions and field key; and
- Review the final database containing the field data.

CTI Responsibilities

- Assist with overall project facilitation and coordination;
- Verify vegetation and land use/land cover signatures on the imagery;
- Develop map units linked to the NVCS;
- Provide field maps and GIS support to the field crews;
- Collect less detailed observations about the draft vegetation map;
- Interpret and delineate the final vegetation and land use types;
- Transfer and automate interpreted data to a digital spatial database;
- Produce spatial layers of plot and accuracy assessment site locations;
- Assist with the accuracy assessment by picking the stratified random target points, creating field maps and providing GIS support;
- Provide final report sections describing the mapping aspects of the project;
- Provide a visual guide to the photo signatures of each map unit;
- Document FGDC-compliant metadata for all vegetation data; and
- Assist in creating the project DVD.

Field Surveys

Field methods used in this project followed NVIP standards (e.g., TNC and ESRI 1994a, 1994b). Data gathered by ORNHIC during the 2008 field season to inform this project contributed to understanding vegetation relationships across broader landscapes beyond the Monument boundaries. The plot dataset was enhanced by CTI ecologists collecting observation point data during vegetation map verification in April 2009, whose primary purpose was to support digital image interpretation. Plot forms and individual data field descriptions appear in Appendix B.

The ORNHIC is part of the Oregon State University, Institute for Natural Resources and a constituent member of NatureServe. ORNHIC and NatureServe ecologists are tasked to expand and maintain vegetation classification and mapping information for the U.S., including the NVCS as part of the International Vegetation Classification System (IVC). NMI, via a contracting agreement provided funds to ORNHIC to assist in the development of the classification, construct a field key to plant communities and write descriptions of the vegetation types. Having ORNHIC involved insured that all new plant associations and alliances described would be incorporated into the NVCS. ORNHIC ecologists also assisted in training the NMI field staff to use the field key and identify the plant communities in the accuracy assessment data collection phase.

The sampling area included all eight parcels comprising the 14,014-acre Monument. Private lands in the environs and any private in-holdings were not visited. Because the project area was relatively small and divided into three units, access was not an issue and areas sampled were selected in the field by experienced ecologists from ORNHIC. ORNHIC was in the second year of a weed and at-risk species mapping project for the Painted Hills Unit and had sampled in the extant vegetation types. In addition, ORNHIC had completed a vegetation map for the Warm Springs Indian Reservation Pine Creek Ranch mitigation site, which included all of the Clarno Unit. The sampling design was based on accessing a majority of the Monument and using the existing land-cover map to inform the sampling per Lea (2006).

Field crews were composed of ORNHIC ecologists with plant community sampling experience in national parks and other landscapes. They received site-specific training and support from Eastern Oregon Stewardship Services whose staff had also performed considerable sampling in the JODA region. The list of ecological systems, vegetation alliances, and component plant associations prepared by NatureServe ecologists provided a starting point for naming the plant communities sampled in the field. The sampling goal was to collect between three and five classification plots in every plant association within the JODA project area. However, some common associations were sampled more often and some rare types were sampled less often. An effort was made to achieve a good spatial distribution of plots across the landscape and to capture the full range of variation of each association.

When a representative stand of vegetation was located, a Relevé macroplot was established to record stand characteristics; transitional areas such as ecotones were usually avoided unless they exceeded the project minimum mapping unit (MMU) of 1.24 acres. Highly disturbed areas were also avoided unless they supported a distinct plant community. Classification plots were generally located in stands exceeding the MMU, however a few plots were sampled in smaller patches if the vegetation was rare and distinctive. Plot size and shape requirements were consistent with NVIP guidelines (TNC and ESRI 1994a) and were determined by the physiognomy of the community being sampled (Table 2). Measuring tapes were used to establish the circular sampling area and the plot shape was adjusted as needed to sample linear bands of vegetation in drainage bottoms, on seeps and springs, or other confined sites. Plot size and shape were recorded for all plots.

Table 2. Plot Sizes Used for Classification Sampling at JODA.

Vegetation Class	Area (m²)	Radius (m)
Forest and Woodland	400	22.6
Shrubland	400	22.6
Herbaceous	100	11.3

Following the establishment of each plot, environmental data were recorded, including: elevation, slope, aspect, landform, topographic position, soil texture and drainage, hydrologic (flooding) regime, and evidence of disturbance or wildlife use. The unvegetated surface was

estimated and recorded as percent cover of: bedrock, litter and duff, wood, bare soil, large rocks (>10 cm), small rocks (0.2-10 cm), sand (0.1-2 mm), lichens, and mosses.

Next the vegetation was visually divided into strata, with the height and canopy cover of the dominant vegetation estimated for each stratum. Physiognomic class, leaf phenology, and type of dominant stratum were recorded. The species for each stratum were listed and percent canopy cover estimated using a twelve-point cover scale (e.g. <1%, 1-5%, >5-15% ...; Daubenmire 1959). Additional species within the vegetation unit that occurred outside of sampled plots were listed separately to assist with creation of local descriptions. No attempt was made to identify individual non-vascular plant species. Species that were not identifiable in the field were collected for later identification and specimens were typically destroyed in analysis. Species were recorded by scientific epithet familiar to researchers and a provisional vegetation type was assigned to the plot.

Field crews documented the vegetation plots as follows: 1) a species list was developed and recorded; 2) UTM coordinates, field note headers (Identifiers/Locators), environmental descriptions and a plot map were recorded; 3) UTM NAD83 X-Y coordinates and elevation were recorded both manually on the plot forms and stored as waypoints in the GPS receiver; 4) the UTM coordinates of the southeast corner of the plot was documented using another GPS receiver; and 5) four representative digital photographs were acquired facing the four cardinal directions (N, E, S, and W) from the edge of the polygon facing plot center.

In addition to vegetation classification plots (361), CTI field crews collected vegetation and environmental data at 70 observation points (sometimes called rapid assessment points) during draft vegetation map verification. Data recorded at observation points reflected the vegetation of an approximately 1.24 acre area around the point rather than a measured plot, and were less detailed (Appendix B). Overall conditions at each observation point were documented by one or more digital photographs. These data were intended primarily to support modeling and interpretation of the base imagery, but were also used to help describe plant associations when local descriptions were prepared. Specifically, observation point data was collected when:

- The vegetation was homogenous, representative, and seral classification plots had been sampled,
- They were sampling the environs outside the JODA boundary,
- The vegetation was highly disturbed, ecotonal, or otherwise anomalous and therefore unlikely to be classified under the NVC,
- Project photointerpreters requested documentation of a specific photo-signature or area,
- They wished to document special features as requested by JODA staff including seeps, springs and invasive plant stands, and/or
- They wanted to document a vegetation type that consistently occurred in stands smaller than the 1.24 acre MMU.

The classification data collection was conducted between May and September, 2008. Vegetation sampling included 361 classification plots (Figure 10) and 70 observation points (Figure 11),

which were sampled in April 2009 during vegetation map verification to support the photo-interpretation task.

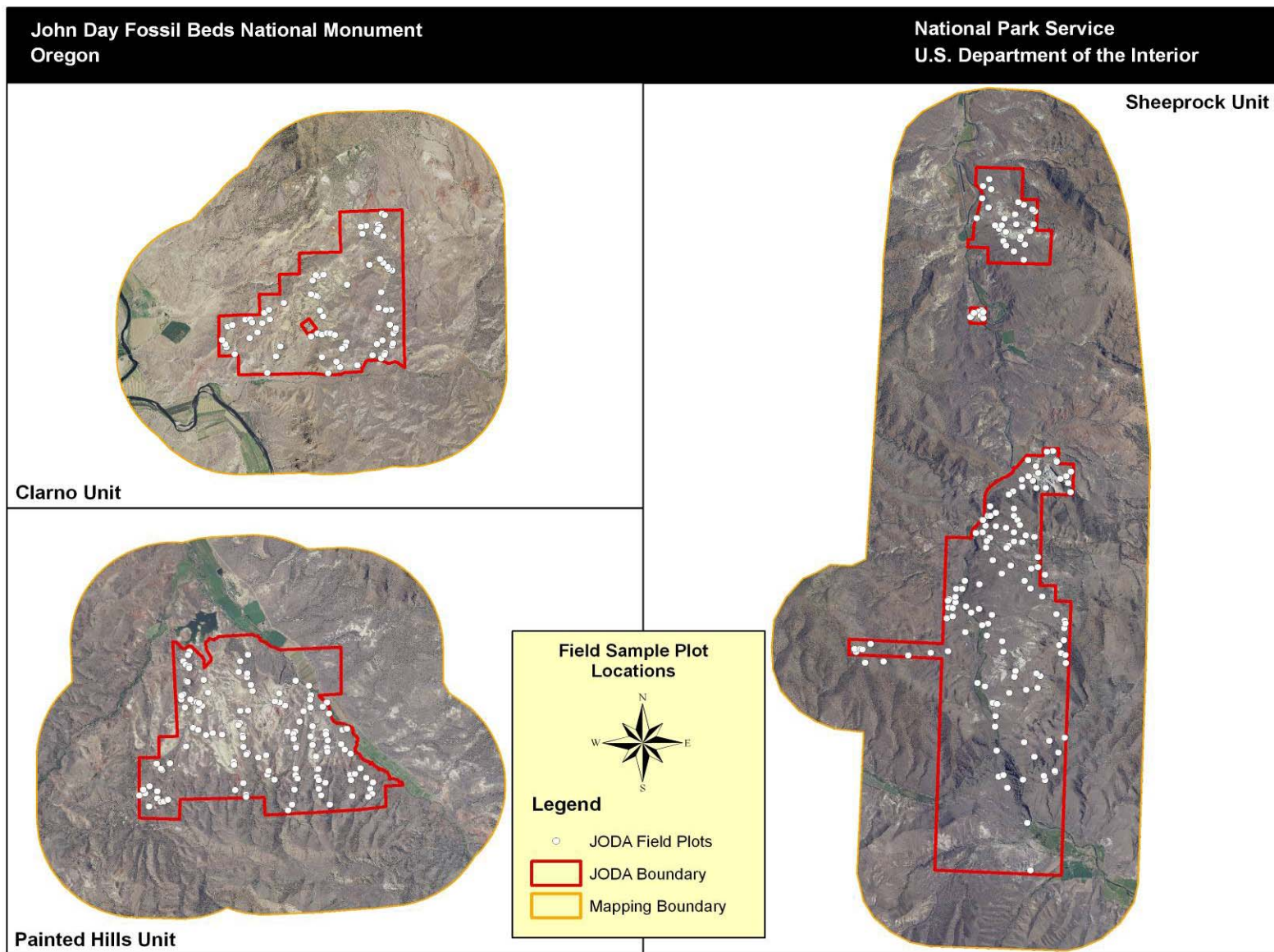


Figure 10. Vegetaton plot locations at JODA.

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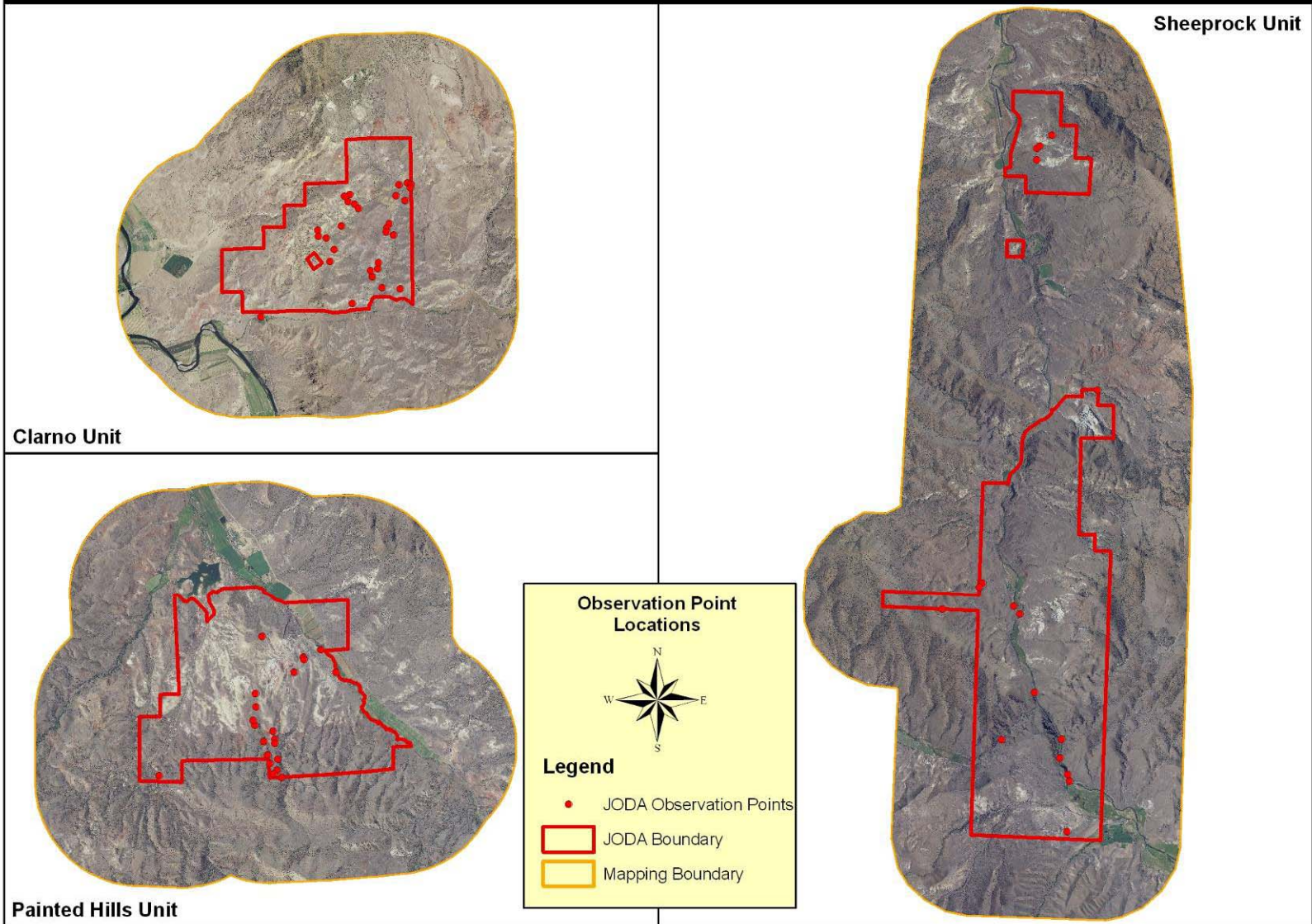


Figure 11. Observation point locations at JODA.

Vegetation Classification

A draft vegetation classification was provided to NMI by ORNHIC in February 2008; the initial report, titled “John Day Fossil Beds National Monument Initial Plant Association List”, included a list of all of the plant associations and alliances documented from the three units of JODA. It also included a list of all plant associations and alliances that were documented from areas adjacent to the JODA boundaries or expected to occur. The initial report included links to online descriptions of each of the alliances and plant associations listed, mostly available at the NatureServe Explorer (<http://www.natureserve.org/explorer/> web site. Listed in this report were one barren type, one grassland type, 19 shrubland types, and eight forest types from JODA. It also included two grassland types, three shrubland types, and two woodland types which might be present (Kagan and NatureServe 2009).

Classification plot data were sampled using GPS receivers to determine location and to store data. All data from GPS receivers were transferred to and managed in a Microsoft Access database. For ease of use the MS Access database mirrored the standard field form with fields and tables that matched all of the data recored on the field forms. Scientific names were updated according to the vascular plant list provided to the crews (Appendix E).

Following data entry, quality assurance checking was performed to minimize errors associated with duplicate entries or erroneously selected plant or association names. Unknown species identification, especially those with high cover were resolved, as were other taxonomic issues including grouping subspecies and varieties judged to be ecologically similar. Data were regularly compiled and at the completion of the field work the final database was used by ORNHIC for quantitative analysis. A GIS data layer was also developed at this time to document classification plot locations.

Quantitative analysis of the vegetation included preparing the JODA data for use in analytical programs by conducting the following steps: (1) standardize strata for certain taxa, for example cacti may sometimes be listed as shrubs and sometimes listed as herbaceous; (2) create “pseudospecies” for each taxon by appending the stratum in which it was found in each plot to a code for the taxon; (3) update the species lists to include changes in the scientific names; and (4) removing of plots that were outliers, incomplete or had missing data.

Analytical methods were employed in a manner consistent with the objective of identifying natural associations of existing vegetation (The Nature Conservancy and Environmental Systems Research Institute 1994b; Tart et al. 2005; Jennings et al. 2006). Multivariate statistical analyses were conducted using PC-ORD (McCune and Mefford 2006). Initial plant community groups were identified using hierarchical cluster analysis. Plant community groups were successively partitioned to optimize within-group homogeneity, between-group difference, and the number of groups. These three factors were evaluated using statistics generated by indicator species analysis (the mean p-value and number of significant [$p < 0.05$] indicator species) and multi-response permutation procedures (T, a measure of separation between groups; the chance-corrected within-group agreement [A], a measure of within-group homogeneity; and the compositional similarity of samples within a group [as measured by average relative Sorensen distance]). Environmental relations, within-group homogeneity, and between-group difference

were evaluated graphically through detrended correspondence analysis (McCune and Grace 2002). Final decisions regarding the naming of plant associations were informed by cross-walking candidate community groupings to the NVCS (NatureServe 2009). Classification and regression tree analysis (recursive partitioning) was employed in the development of dichotomous keys and the evaluation of classification results.

Plant nomenclature of the Integrated Taxonomic Information System (ITIS) as reflected by the PLANTS Database (USDA, NRCS 2008) was employed in the naming of plant associations. These databases represent the NVIP Standard and are necessary to discriminate differences among associations currently reported within the NVCS. JODA plant associations were named for the indicator (dominant or diagnostic) species of the vegetative strata present. The indicator species of the upper strata was listed first, followed by successively lower strata. Species that occurred in the same strata (or were the same lifeform) were separated by a hyphen (-). Indicator species that occurred in different strata (or are a different lifeform) were separated by a slash (/). Alliance names were concluded with the word “Alliance” to differentiate them from association names. Plant association names incorporated the physiognomic class in which the association was classified (e.g., Forest, Woodland, or Herbaceous).

The final products of the classification stage were the creation of a field key and local plant association descriptions. The dichotomous field key to the JODA plant associations and vegetation alliances was developed to assist users in identifying vegetation associations in the field, particularly during the vegetation map accuracy assessment (Appendix C). ORNHIC ecologists collaborated with NatureServe, NPS staff, and NMI to prepare the field key to allow determination of a vegetation association in the field through a structured decision-making process. Each plant association was crosswalked to a single vegetation alliance, so both alliances and associations can be generated from field data. The first draft of the field key was provided to NMI and NPS staff for review during February 2009, and updated keys were provided during March 2009 for field testing; the final field key was provided in May 2009. The local descriptions were based on the field data and provide JODA characteristics for each association (Appendix D).

Digital Imagery and Interpretation

Since JODA represented a small site, existing sources of imagery were evaluated and the National Aerial Imagery Program (NAIP) products were found to be adequate. Based on the currentness of the 2009 product, this true-color, 1-meter pixel was accepted as the base imagery. The 2005 true-color, 1-meter pixel product was also used as ancillary data (Figure 12).

Mapping and interpretation of JODA involved a five step process including: (1) field reconnaissance, (2) map class development, (3) image processing and interpretation, (4) draft map validation, and (5) spatial database development. Field reconnaissance was initiated by CTI and NMI staff in 2008 to quickly familiarize the mappers with the vegetation patterns and distribution at JODA. As the classification plot data were acquired later in 2008, feedback on the dominant and characteristic plant species was solicited from ORNHIC ecologists.



Figure 12. Examples of the 2005 and 2009 imagery for JODA.

All of the ground information obtained in 2008 was documented and summarized to apply to the NAIP ortho-imagery and the final list of NVC associations for JODA in 2008 and 2009. CTI created preliminary map classes based on the ORNHIC preliminary list of plant associations developed from previous projects and all developed areas, roads, streams, badlands exposures, and other obvious features were manually digitized and incorporated with the project boundary into a draft GIS layer.

In the winter of 2008-2009, CTI compared the initial map classes to the 2005 NAIP imagery and the draft of the JODA vegetation classification. Emphasis was placed on the ability to accurately delineate homogenous polygons from the base ortho-imagery. In general, the level of detail possible in a vegetation map is limited by the imagery, the skill and experience of the interpreter and mapper, and the availability of supporting information. The relationships between the map classes and plant associations were complex. In most cases, the JODA map classes were derived on a one association or alliance to one map class basis. However due to the limitations of the imagery some of the associations could not be recognized consistently. This issue was addressed by either scaling up the NVCS to the alliance level or combining similar associations/alliances into complexes. Complexes were used when associations/alliances could not be discerned from each other.

All of the resulting map classes were reviewed by UCBN and JODA staff. Based on their recommendations some additional park-specific or “Park Specials” were defined. These included:

- Wetlands and riparian stands below the minimum mapping unit (MMU; e.g. white alder, black cottonwood, Woods’ rose, coyote willow, etc)
- Western juniper stands below the MMU
- All non-native species stands
- Geologic exposures

In some cases, NVCS alliances were later matched to these new units, such as matching the cheatgrass mapping unit to the cheatgrass NVC alliance. To round-out the mapping convention, map classes were created for land use types based on a mapping system developed by Anderson et al. (1976, updated 2002). Land use types were areas not covered by the NVC, including roads, facilities, open water, agricultural fields, etc.

Mapping began in late 2008 by re-sampling the 2005 NAIP imagery to a 3-meter pixel resolution and then segmenting it using eCognition software. Initial segments were created to delineate obvious landforms (e.g. open water, fields, and geologic exposures) and physiognomic features (e.g. grasslands versus woodlands). The objective of the segmentation was to create a system of lines with as coarse a scale as possible without omitting most of the small, important and obvious land cover patches. By incrementally increasing segmentation size within the program, small image objects (i.e. preliminary polygons) were continuously merged into larger ones. Completion of the segmentation was based on visual judgment of the analyst when obvious, distinct features were lost. At this point in the process, the previous segmentation was adopted as the final treatment.

Following segmentation, the lines were exported as ArcInfo shapefiles and converted to ArcInfo coverages. The resulting coverages were run through a series of smoothing routines until no obvious artificial or relict breaks in the lines were visible. Following smoothing, the line-work was manually cleaned to remove extraneous lines, small polygons, and polygons that obviously split a homogenous stand of vegetation.

The cleaned segmented lines were then supplemented with manual linework, digitized directly off the 2005 NAIP imagery. This included such obvious features as roads, field boundaries, rivers/streams, and facilities. At this stage in 2009, the mapping switched from the 2005 NAIP imagery to the more current 2009 NAIP image. All existing lines were updated and by using the plot data, field notes and ancillary GIS data, polygons were edited, split, and merged through on-screen digitizing to create consistent, homogenous polygons that matched the JODA mapping convention.

When the interpretation effort was considered complete, topology for the final polygon layer was built, attributed, and then imported into a spatial database (geodatabase). Each polygon was attributed with its own appropriate map unit name, code, and modifier. Polygon specific modifiers included additional data on the height, density, and patterns of the dominant and characteristic vegetation. Additionally map class data including the NVCS crosswalk, land-use classes, and comments were added in the final stage (Table 3).

In April 2009, a draft vegetation map verification trip was conducted by CTI to examine polygon boundary placement and labeling. Field notes were made directly on vegetation map copies and an additional 70 observation points were sampled to support the notations. Confusing sites were visited including the Picture Gorge area where shadows on the NAIP imagery prevented viewing the distribution of vegetation types. Ground data and ground photographs were collected to insure consistent mapping of confusing sites. Upon return to the office, minor updates of the draft vegetation map were completed prior to the AA task.

Table 3. JODA polygon attribute items, modifiers, and descriptions.

<u>ATTRIBUTE</u>	<u>DESCRIPTION</u>
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
CRMO_VEG#*	Unique code for each polygon
CRMO_VEG-ID*	Unique identification code for each polygon
VEG_CODE	Final Map Unit Codes – Numeric (Project specific)
MAP_CODE	Final Map Unit Codes – Text (Project specific)
MAP_DESC	Map Unit Common Description Name – (Project specific)
DENS_MOD	Modifier - Percent cover of the upper stratum layer in the polygon Percent cover classes: Sparse = 10 - 25% , Open = 25 - 60% , Discontinuous - Closed = > 60%
PTRN_MOD	Modifier - Vegetation pattern within the polygon Vegetation pattern classes: Evenly Dispersed = Homogeneous Grouped Stands of Vegetation = Bunched / Clumped , String of Vegetation = Linear
HT_MOD	Modifier - Height range of the dominant vegetation layer Height classes: < 1, 1-5, 5-15, and 15-30 Meters
CES_CODE	Ecological Systems Code – NVCS derived (NatureServe)
CES_NAME	Ecological Systems Name – NVCS derived (NatureServe)
NVC_ELCODE	Corresponding Association Code – NVCS derived (NatureServe) Association = Community Element Global Code – Elcode link to the NVCS
KEY_CODE	Association Code used in the Field Key – (Project Specific)
ASSN_NAME	Project Association (Community) Name - NVCS Association(s)
ASSN_CNAME	Project Common Association (Community) Name - Association(s) synonym name
ALL_CODE	Alliance Name Code – NVCS derived (NatureServe) Alliance = Alliance Global Code – Alliance Link to the NVCS
ALL_NAME	Project Alliance Name = NVCS Alliance(s)
ALL_CNAME	Project Common Alliance Name = NVCS Alliance(s)
NVCS_CODE	NVCS Code - to NVCS Formation Level
FORMATION	NVCS Formation = Formation name NVCS Code – Formation name
SUBGROUP	NVCS Formation Subgroup = NVCS Code – Subgroup name
GROUP	NVCS Formation Group = NVCS Code – Group name
SUBCLASS	NVCS Formation Subclass = NVCS Code – Subclass name
CLASS	Formation Class = NVCS Code – Class name
LUC_II_GEN	General Land Use and Land Cover Classification System Name Project specific based on Level I or II of Anderson et al. (1976)
LUC_II	Specific Land Use and Land Cover Classification System Name Project specific Level II or Level III of Anderson et al. (1976)
COMMENTS	Additional Comments about the Vegetation in Individual Polygons” Presence of Cheatgrass, Dead Junipers, Dead Sagebrush, or Fire Evidence Dominance of <i>Cleome platycarpa</i>, <i>Ericameria sp.</i> <i>Gutierrezia sarothrae</i>, <i>Salvia dorrii</i>, or <i>Sporobolus cryptandrus</i> (where known) Sparse/Geologic Units = Talus or Red Ash/Tuff
ACRES	Surface area of the polygon in acres
(*ArcInfo® default items)	

Accuracy Assessment

Once the JODA mapping was complete and finalized the accuracy assessment (AA) was conducted. AA is a statistical test of how well the vegetation map represents vegetation on the ground. The AA compares preselected stratified random field observations with the map class assignment. Errors occur when mapped polygon labels differ from field observations. Results of the AA allow users to evaluate the utility of the vegetation mapping data for particular applications. Accuracy assessment results come in two forms (Hop et al. 2005): “producer’s accuracy” (the probability that an AA point was mapped correctly, also referred to as “errors of omission”), and “user’s accuracy” (the probability that the map represents what was found on the ground, also referred to as “errors of commission”). High producer’s accuracy combined with low user’s accuracy indicates that the map class is under-mapped (i.e. polygons of this type were not mapped). Conversely, low producer’s accuracy combined with high user’s accuracy indicates that a type is over-mapped (i.e. more of this type was mapped than actually occurs on the ground).

The thematic accuracy of the vegetation map was assessed using the methodology following the standards provided by the NVIP Accuracy Assessment Procedures manual (TNC 1994c). This methodology included a four-step process consisting of a sample design, sample site selection, data collection, and data analysis. The design of the AA process incorporated the five possible scenarios provided in the field manual with stratified random targets placed in each map class based on their respective frequency and abundance. The AA included most vegetation map classes and was limited to NPS-managed lands within the JODA boundary; private, state, and federal lands outside of the Monument were not included in the accuracy evaluation. Sample sizes for each evaluated map class were selected using the NVIP guidelines (TNC 1994). The design of the AA process followed the five possible scenarios provided in the guidelines with stratified random points placed in each map class based on their respective frequency and abundance (Table 4).

AA parameters were loaded into a custom GIS program along with the vegetation layer and the program picked the random point locations, buffered them ten meters away from any polygon boundary, and 50 meters away from any other point. Being able to choose minimum distance to polygon boundaries helped to minimize confusion and accounts for most of the horizontal error typically encountered in common GPS receivers (± 5 m). The resulting AA point locations were restricted within the boundaries of JODA due to private land access constraints. Fifteen land-use and geologic map classes were excluded from analysis because they were essentially unvegetated or occurred exclusively outside of the Monument boundary.

Once the target locations were selected, ecologists were provided with draft field maps, overview maps, map unit definitions, the field key to the associations (Appendix C), and digital GPS receiver files containing the location of the AA targets. The ecologists hiked to the AA target sites and determined the plant association/vegetation alliance using the field key. At each AA point they recorded the primary and any additional secondary or tertiary associations that occurred within a roughly 50-meter radius. They also recorded height and cover of vegetation strata, environmental data, and percent canopy cover of the major species (Appendix B). Other nearby vegetation types outside the 50-meter radius and any recent disturbance were also

Table 4. NVIP Sampling protocol for AA points.

Scenario	Description	# Polygons	Area (ac)	Recommended # of Samples
A	The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, the recommended sample size is 30.	> 30	> 125	30
B	The class is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size for this type of class is that sample sites are more difficult to find because of the lower frequency of the class.	< 30	> 125	20
C	The class is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, the recommended sample size is 20. The rationale for reducing the sample size is that the class occupies a small area. At the same time, however, the class consists of a considerable number of distinct polygons that are possibly widely distributed. The number of samples therefore remains relatively high because of the high frequency of the class.	> 30	< 125	20
D	The class is rare. It has more than five but fewer than 30 polygons and covers less than 50 hectares of the area. In this case, the recommended number of samples is five. The rationale for reducing the sample size is that the class consists of small polygons and the frequency of the polygons is low. Specifying more than five sample sites will therefore probably result in multiple sample sites within the same (small) polygon. Collecting five sample sites will allow an accuracy estimate to be computed, although it will not be very precise.	5-30	< 125	5
E	The class is very rare. It has fewer than five polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that the existence of the class be confirmed by a visit to each sample site. The rationale for the recommendation is that with fewer than five sample sites (assuming one site per polygon) no estimate of level of confidence can be established for the sample (the existence of the class can only be confirmed through field checking).	< 5	< 125	Visit all and confirm

recorded. To better assist the analysis, four digital ground photographs were acquired to characterize each AA point, in the sequence of cardinal directions, N-E-S-W.

Data from 407AA points were entered into the MS Access database and imported from the database into a GIS layer (Figure 13) where they were visually compared in two stages to the vegetation map coverage. The first stage was to compare the AA points to the original target locations to check for erroneous points and remove them from further analysis. General errors in the data were recorded at this time, including documenting points that had GPS receiver and UTM coordinate errors. The most common GPS receiver error included transposing two UTM coordinate numbers. Location errors involved having the final AA point occur in the wrong target polygon either due to bad GPS satellite positioning or the point occurred too close to a polygon boundary. Nomenclature standards and other data management procedures were the same as described for the classification plot data.

The second review step involved deciding between the primary and secondary call for the plant association as recorded by the field crew. In larger vegetation mapping projects such as Rocky Mountain National Park (Salas et al. 2004), AA analysis has involved fuzzy logic which assigns different levels of accuracy based on the primary, secondary, and tertiary calls. However due to the confusion that fuzzy logic can cause, a simple binary assessment was conducted wherein CTI GIS specialists assigned a final map unit for every point by choosing between the primary and secondary calls. Point assignment was accomplished by first adding a new attribute to the point layer labeled “Final_Code” and then by comparing the assigned field names of the point with its corresponding location on the digital imagery. In most cases the primary name assigned by the field crew was used. However some points were assigned their secondary field call based on one of the following reasons: 1) it appeared that the second call was the better choice due to the overhead perspective (e.g. a stand judged to be sparse woodland on the imagery vs. herbaceous vegetation in the field), 2) the data were actually recorded in a stand that was too small for analysis (i.e. inclusion), or 3) the second call better matched the ecological context (e.g. riparian woodland located next to a stream vs. upland woodland located next to a stream).

Once the field data were reviewed and overlain on the mapped polygons the accuracy analysis was conducted. The JODA process was streamlined using methods developed from previous studies at Rocky Mountain National Park (Salas et al. 2004) and Wupatki National Monument (Hansen et al. 2004). Specifically, many of the in-house GIS programs developed for these projects were used to compare the AA data, generate confidence intervals, Kappa statistics, and error matrices (contingency tables). Through this automated process, the final map units in the AA layer were compared to the map unit designations for their corresponding polygons. All of the statistics and calculations used to analyze these data are described at length in the program manuals (TNC 1994c) and are summarized in Table 5. Final assessments for each point were recorded using an error matrix (i.e. contingency table).

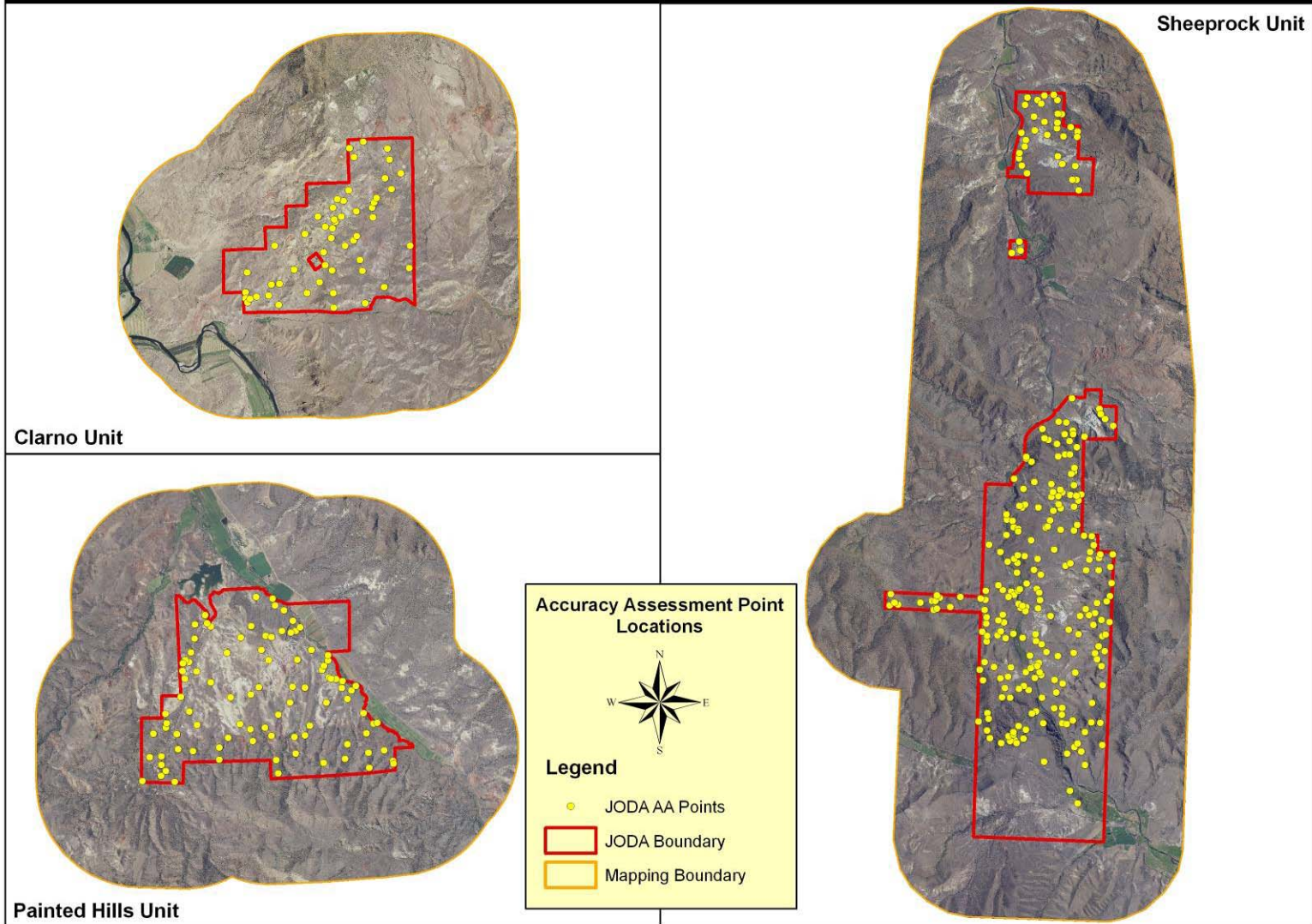


Figure 13. Location of the accuracy assessment (AA) points at JODA.

Table 5. Statistics used in AA analysis.

Statistic	Formula	Description
User's - accuracy:	$\frac{n_{ii}}{n_{i+}}$	Where i is the land cover type, n_{ii} is the number of matches between map and reference data and n_{i+} is the total number of samples of i in the map. This formula is the number of "correct" observations divided by the sum of the row.
Producer's accuracy	$\frac{n_{ii}}{n_{+i}}$	Where n_{+i} = total number of sample of i in the reference data. This formula is the number of "correct" observations divided by the sum of the column.
Confidence Interval	$\hat{p} \pm \left\{ z_{\alpha} \sqrt{\frac{\hat{p}(1 - \hat{p})}{n} + \frac{1}{(2n)}} \right\}$	Where $z_{\alpha} = 1.645$ (this comes from a table of the z-distribution at the significance level for a two-sided limit with a 90% confidence interval). The term $1/(2n)$ is the correction for continuity. The correction should be applied to account for the fact the binomial distribution describes discrete populations $\hat{p}$ = the sample accuracy (0 -1.0), n = the number of sites sampled.
Kappa Index	$k = \frac{N \sum_{i=1}^r x_{ii} - \sum_{i=1}^r (x_{i+} \times x_{+i})}{N^2 - \sum_{i=1}^r (x_{i+} \times x_{+i})}$	Where N is the total number of sites in the matrix, r is the number of rows in the matrix, x_{ij} is the number in row i and column j , x_{+i} is the total for row i , and x_{i+} is the total for column i .

Results

Vegetation Classification

The known flora of JODA is comprised of 243 plant species and many were documented during the course of the field data collection (Appendix E). Based on the dominant species and other classification factors the vegetation was classified into 52 plant associations which represented 23 vegetation alliances (Kagan and Natureserv 2009; Table 6). The numbers of plant associations that occur within each unit include 27 in Clarno, 40 in Painted Hills, and 52 in Sheep Rock.

Twenty-four of the communities were shrubland types, including 19 upland shrubland associations, and five riparian shrubland types. Six communities were classified as forests and woodlands (four riparian), three as wooded herbaceous types, six sparse types, and 15 as herbaceous or shrub herbaceous vegetation types (one wetland). Table 6 lists all associations classified by scientific name, common name, code, and number of plots/association. They are ordered by physiognomy: forests and woodlands, shrublands, herbaceous, and sparse vegetation.

Seventy percent of the plant communities sampled at JODA fit into existing NVC association concepts. The remaining plant communities were considered significant enough to create new NVC associations by Kagan and NatureServe (2009). New vegetation types that had not been mapped or described prior to this project included the Indian Ricegrass Herbaceous Vegetation, Golden Spiderflower Ash Bed Sparse Vegetation, Rubber Rabbitbrush Sparse Shrubland, Nuttall's Sunflower Ash Bed, and Antelope Bitterbrush Ash Bed.

Table 6. List of plant associations for JODA.

Scientific Name	Common Name	Code	Elcode	N
Forest and Woodland				
<i>Alnus rhombifolia</i> / <i>Philadelphus lewisii</i> Forest	White Alder / Lewis' Mock Orange Forest	ALRH/PHLE	CEGL000634	2
<i>Alnus rhombifolia</i> / <i>Rosa woodsii</i> Forest	White Alder / Woods' Rose Forest	ALRH/ROWO	CEGL000636	3
<i>Celtis laevigata</i> var. <i>reticulata</i> / <i>Pseudoroegneria spicata</i> Woodland	Netleaf Hackberry / Bluebunch Wheatgrass Woodland	CELAR/PSSP	CEGL001085	3
<i>Juniperus occidentalis</i> / <i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Woodland	Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass Woodland	JUOC/CELE/PSSP	CEGL000725	2
<i>Juniperus occidentalis</i> / <i>Artemisia rigida</i> / <i>Poa secunda</i> Wooded Herbaceous Vegetation	Western Juniper / Scabland Sagebrush / Curly Bluegrass Wooded Herbaceous Vegetation	JUOC/ARRI/POSE	CEGL001718	2
<i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> – <i>Purshia tridentata</i> Wooded Herbaceous Vegetation	Western Juniper / Big Sagebrush – Antelope Bitterbrush Wooded Herbaceous Vegetation	JUOC/ARTR/PRTR	CEGL001722	13
<i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> <i>Pseudoroegneria spicata</i> Wooded Herbaceous Vegetation	Western Juniper / Big Sagebrush / Bluebunch Wheatgrass Wooded Herbaceous Vegetation	JUOC/ARTR/PSSP	CEGL001721	19
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Alnus incana</i> Forest	Black Cottonwood / Gray Alder Forest	POBAT/ALIN	CEGL000667	0
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Salix exigua</i> Forest	Black Cottonwood / Coyote Willow Forest	POBAT	CEGL000676	2
Shrubland				
<i>Artemisia tridentata</i> ssp. <i>tridentata</i> / <i>Leymus cinereus</i> Shrubland	Basin Big Sagebrush / Great Basin Wildrye Shrubland	ARTR/LECI	CEGL001016	1
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Atriplex confertifolia</i> – <i>Sarcobatus vermiculatus</i> Shrubland	Wyoming Big Sagebrush – Shadscale – Greasewood Shrubland	ARTR/ATCO/SAVE	CEGL001040	10

Scientific Name	Common Name	Code	Elcode	N
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Bromus tectorum</i> Shrubland	Wyoming Big Sagebrush / Cheatgrass Shrubland	ARTRW/BRTE	CEGL0010xx	2
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Poa secunda</i> Shrubland	Wyoming Big Sagebrush / Curly Bluegrass Shrubland	ARTRW/POSE	CEGL001049	10
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Purshia tridentata</i> / <i>Pseudoroegneria spicata</i> Shrubland	Wyoming Big Sagebrush – Antelope Bitterbrush / Bluebunch Wheatgrass Shrubland	ARTRW-PUTR/PSSP	CEGL001050	9
<i>Atriplex confertifolia</i> / <i>Bromus tectorum</i> Shrubland	Shadscale / Cheatgrass Shrubland	ATCO/BRTE	CEGL0013xx	2
<i>Atriplex confertifolia</i> / <i>Elymus elymoides</i> Shrubland	Shadscale / Squirreltail Shrubland	ATCO/ELEL	CEGL001302	19
<i>Atriplex confertifolia</i> / <i>Pseudoroegneria spicata</i> Shrubland	Shadscale / Bluebunch Wheatgrass Shrubland	ATCO/PSSP	CEGL001312	8
<i>Atriplex confertifolia</i> Sparse Shrubland	Shadscale Sparse Shrubland	ATCO/Sparse Shrubland	CEGL003830	4
<i>Cercocarpus ledifolius</i> – <i>Artemisia tridentata</i> Shrubland	Curl-leaf Mountain-mahogany – Big Sagebrush Shrubland	CELE/ARTR	CEGL000960	3
<i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Shrubland	Curl-leaf Mountain-mahogany – Bluebunch Wheatgrass Shrubland	CELE/PSSP	CEGL000967	2
<i>Chrysothamnus viscidiflorus</i> / <i>Bromus tectorum</i> Shrubland	Green Rabbitbrush / Cheatgrass Shrubland	CHVI/BRTE	CEGL00xxxx	7
<i>Gutierrezia sarothrae</i> / <i>Bromus tectorum</i> Shrubland	Broom Snakeweed / Cheatgrass Shrubland	GUSA/BRTE	CEGL00xxxx	6
<i>Gutierrezia sarothrae</i> / <i>Taeniatherum caput-medusae</i> Shrubland	Broom Snakeweed / Medusahead Rye Shrubland	GUSA/TACA	CEGL00xxxx	1
<i>Gutierrezia sarothrae</i> / <i>Poa bulbosa</i> Shrubland	Broom Snakeweed / Bulbous Bluegrass Shrubland	GUSA/POBU	CEGL00xxxx	5
<i>Prunus virginiana</i> – (<i>Prunus americana</i>) Shrubland	Chokecherry – (American Plum) Shrubland	PRVI/PRAM	CEGL001108	1
<i>Rosa woodsii</i> Shrubland	Woods' Rose Shrubland	ROWO	CEGL001126	1

Scientific Name	Common Name	Code	Elcode	N
<i>Salix exigua</i> Barren Shrubland	Coyote Willow Barren Shrubland	SAEX	CEGL001200	0
<i>Salix exigua</i> – <i>Rosa woodsii</i> Shrubland	Coyote Willow – Woods' Rose Shrubland	SAEX/ROWO	CEGL00xxxx	4
<i>Salix exigua</i> / <i>Eleocharis palustris</i> – <i>Schoenoplectus americanus</i> Shrubland	Coyote Willow Mesic Graminoid Shrubland	SAEX/ELPA-SCAM	CEGL001203	0
<i>Salvia dorrii</i> / <i>Pseudoroegneria spicata</i> Dwarf-shrubland	Gray Ball Sage / Bluebunch Wheatgrass	SADO/PSSP	CEGL001453	8
<i>Sarcobatus vermiculatus</i> / <i>Leymus cinereus</i> Shrubland	Greasewood / Great Basin Wildrye Shrubland	SAVE/LECI	CEGL001366	5
<i>Sarcobatus vermiculatus</i> / <i>Bromus tectorum</i> Shrubland	Greasewood / Cheatgrass Shrubland	SAVE/BRTR	CEGL0013xx	5
<i>Tetradymia canescens</i> / <i>Poa secunda</i> Shrubland	Gray Horsebrush / Curly Bluegrass Shrubland	TECA/POSE	CEGL00xxxx	4
Herbaceous Vegetation				
<i>Achnatherum thurberianum</i> – <i>Pseudoeegneria spicata</i> Herbaceous Vegetation	Thurber's Needlegrass – Bluebunch Wheatgrass Herbaceous Vegetation	ACTH7-PSSP	CEGL00xxxx	10
<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation	Dwarf Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	ARARA/PSSP	CEGL001412	7
<i>Artemisia rigida</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation	Scabland Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	ARRI/PSSP	CEGL001529	2
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Achnatherum thurberianum</i> – <i>Pseudoroegneria spicata</i> Steppe	Wyoming Big Sagebrush / Thurber's Needlegrass – Bluebunch Wheatgrass Steppe	ARTRW/ACTH/PSSP	CEGL00xxxx	8
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Festuca idahoensis</i> Steppe	Wyoming Big Sagebrush / Idaho Fescue Steppe	ARTRW/FEID	CEGL00xxxx	10
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation	Wyoming Big Sagebrush / Bluebunch Wheatgrass Shrub Herbaceous Vegetation	ARTRW/PSSP	CEGL001535	22

Scientific Name	Common Name	Code	Elcode	N
<i>Eriogonum strictum</i> / <i>Poa secunda</i> Dwarf-shrub Herbaceous Vegetation	Blue Mountain Wild Buckwheat / Curly Bluegrass Dwarf-shrub Herbaceous Vegetation	ERST/POSE	CEGL001788	2
<i>Juniperus occidentalis</i> / <i>Achnatherum</i> <i>thurberianum</i> Wooded Herbaceous Vegetation	Western Juniper / Thurber's Needlegrass Wooded Herbaceous Vegetation	JUOC/ACTH	CEGL002635	18
<i>Juniperus occidentalis</i> / <i>Festuca idahoensis</i> Wooded Herbaceous Vegetation	Western Juniper / Idaho Fescue Wooded Herbaceous Vegetation	JUOC/FEID	CEGL001724	7
<i>Juniperus occidentalis</i> / <i>Pseudoroegneria spicata</i> Wooded Herbaceous Vegetation	Western Juniper / Bluebunch Wheatgrass Wooded Herbaceous Vegetation	JUOC/PSSP	CEGL001728	10
<i>Leymus cinereus</i> Bottomland Herbaceous Vegetation	Great Basin Wildrye Bottomland Herbaceous Vegetation	LECI/Bottomland	CEGL001480	1
<i>Pseudoroegneria spicata</i> – <i>Balsamorhiza</i> <i>sagittata</i> – <i>Poa secunda</i> Herbaceous Vegetation	Bluebunch Wheatgrass – Arrowleaf Balsamroot – Curly Bluegrass Herbaceous Vegetation	PSSP/BASA/POSE	CEGL001662	34
<i>Pseudoroegneria spicata</i> – <i>Festuca idahoensis</i> Canyon Herbaceous Vegetation	Bluebunch Wheatgrass – Idaho Fescue Canyon Herbaceous Vegetation	PSSP/FEID	CEGL001669	17
<i>Sporobolus cryptandrus</i> – <i>Poa secunda</i> Herbaceous Vegetation	Sand Dropseed – Curly Bluegrass Herbaceous Vegetation	SPCR/POSE	CEGL001516	12
<i>Typha (latifolia, angustifolia)</i> Western Herbaceous Vegetation	(Broadleaf Cattail, Narrowleaf Cattail Western Herbaceous Vegetation	TYLA/TYAN	CEGL002010	2
Sparse Vegetation				
<i>Cleome platycarpa</i> Ash Bed Sparse Vegetation	Golden Spiderflower Ash Bed Sparse Vegetation	CLPL	CEGL00xxxx	0
<i>Ericameria nauseosa</i> Sparse Shrubland	Rubber Rabbitbrush Sparse Shrubland	ERNA	CEGL003961	0
<i>Helianthus nuttallii</i> Ash Bed	Nuttall's Sunflower Ash Bed	HENU	CEGL00xxxx	3
<i>Purshia tridentata</i> Ash Bed	Antelope Bitterbrush Ash Bed	PUTR/Ash Bed	CEGL00xxxx	3

Source: Kagan and NatureServe 2009.

Forest and Woodland Associations

Forest assemblages were rare in JODA and restricted to white alder and black cottonwood trees on the banks of Rock Creek and the John Day River. Woodland stands characterized by western juniper, curl-leaf mountain-mahogany, and netleaf hackberry occurred at the highest elevations, on canyon slopes, ignimbrite outcrops, and on steep, rocky slopes of many exposures. Juniper stands were common on the south- and east-facing slopes of the Painted Hills Unit and on the higher slopes in the Sheep Rock Unit. In both areas western juniper were commonly associated with Idaho fescue, bluebunch wheatgrass, Wyoming big sagebrush, and curl-leaf mountain-mahogany. Many of the western juniper stands would be classified wooded shrublands or wooded herbaceous types due to low cover, at or below 15% tree cover. Some stands of western juniper were dead due to fire, cutting, or disease. Curl-leaf mountain-mahogany trees and tall shrubs have become established on and around ignimbrite bedrock outcrops, particularly in the Sheep Rock and Clarno units. Netleaf hackberry small trees were limited to small patches near bedrock exposures in the Clarno Unit.

Shrubland Associations

Shrublands were the most extensive and diverse community types within the mapping area. Some wild buckwheat and shadscale communities established on ash beds and paleosol exposures were sparse, while Wyoming big sagebrush and antelope bitterbrush stands established on deeper soils were moderately dense in terms of cover. Broom snakeweed dwarf-shrubs have become established on exposed ridges and some alluvial fans. At higher elevations on ignimbrite exposures, extensive stands of curl-leaf mountain-mahogany shrubs have become established within all three JODA units. The toes of alluvial fans on the edge of the Bridge Creek floodplain in the Painted Hills Unit support greasewood and shadscale.

Herbaceous Associations

Grass and forb associations were common in the Clarno Unit but more restricted in distribution in the other two units. Grasslands have become established on slopes, ridges, alluvial fans, and flats and were characterized by bluebunch wheatgrass, Idaho fescue, curly bluegrass, and Thurber's needlegrass. Small-to-moderate-sized patches and stands of the invasive annuals medusahead rye and cheatgrass are common likely following grazing and fire disturbance. Slender wheatgrass and alfalfa primarily, along with crested and intermediate wheatgrass was introduced along Bridge Creek and in other areas outside of JODA, probably as a hay crop, and persists in the floodplain. Forb-dominated types consisting of Nuttall's sunflower and golden spiderflower occurred on sparsely vegetated slopes and alkaline flats.

Riparian and Wetland Shrubland Associations

Mesic riparian shrub communities were limited in distribution to the banks of the John Day River and Rock, Bridge, and Dick creeks within JODA boundaries. Linear stands (typically 1-5 meters wide) of coyote willow, Woods' rose, and chokecherry provided dense cover. Some stands of white alder tall shrubs were interspersed with the above-mentioned streambank dominants.

Riparian and Wetland Herbaceous Associations

Mesic riparian and wetland herbaceous associations occurring within JODA were uncommon, limited in distribution, and were characterized by broadleaf cattail, spikerush, reed canarygrass, common reed, Baltic rush, and basin wildrye. All stands have become established on sites with water at, or near the surface along the John Day River and Rock, Bridge, and Dick creeks and scattered small seeps and springs. Diversity can be high in these mesic herbaceous types, but most stands occurred in patches smaller than the minimum mapping unit.

Ecological Systems

During classification, most plant associations were placed into an ecological system to provide a broader and more comprehensive landscape perspective. The ecological system classification addresses natural landscapes at a coarser scale than the association and alliance. In total, twenty-one ecological systems occurred within the JODA vegetation mapping project area (Kagan and NatureServe 2009; Table 7).

Table 7. List of ecological systems classified within JODA.

Ecological System	NVC Code
Columbia Basin Foothill Riparian Woodland and Shrubland	CES304.768
Columbia Plateau Western Juniper Woodland and Savanna	CES304.082
Columbia Basin Foothill Riparian Woodland and Shrubland	CES304.768
Inter-Mountain Basins Big Sagebrush Shrubland	CES304.777
Inter-Mountain Basins Big Sagebrush Steppe	CES304.778
Columbia Plateau Ash and Tuff Badland	CES304.081
Inter-Mountain Basins Mixed Salt Desert Scrub	CES304.784
Inter-Mountain Basins Big Sagebrush Shrubland	CES304.777
Great Basin Xeric Mixed Sagebrush Shrubland	CES304.774
Inter-Mountain Basins Curl-leaf Mountain-mahogany Woodland/Shrubland	CES304.772
Inter-Mountain Basins Mixed Salt Desert Scrub	CES304.784
Inter-Mountain Basins Shale Badland	CES304.789
Northern Rocky Mountain Lower Montane Mesic Deciduous Shrubland	CES306.994
Rocky Mountain Lower Montane-Foothill Riparian Woodland/Shrubland	CES306.821
Inter-Mountain Basins Greasewood Flat	CES304.780
Columbia Basin Palouse Prairie	CES304.792
Columbia Basin Foothill and Canyon Dry Grassland	CES304.993
Inter-Mountain Basins Semi-Desert Grassland	CES304.787
North American Arid West Emergent Marsh	CES300.729
Columbia Plateau Low Sagebrush Steppe	CES304.080
Columbia Plateau Scabland Shrubland	CES304.770

Source: Kagan and NatureServe (2009).

Plant Association Rarity and Imperilment

NatureServe and its network of state natural heritage programs indicate the rarity and degree of imperilment of plant associations by assigning state and global conservation status ranks. The rank scale ranges from 1 to 5. A rank of 1 indicates critical imperilment due to rarity, endemism, and/or threats while a rank of 5 indicates little or no risk of extirpation of the plant community. Four JODA plant associations are considered critically imperiled (G1) and seven are considered imperiled (G2; Kagan and NatureServe 2009). The G1 plant associations include:

- 1) *Alnus rhombifolia* / *Philadelphus lewisii* Forest;
- 2) *Alnus rhombifolia* / *Rosa woodsii* Forest;
- 3) *Populus balsamifera* ssp. *trichocarpa* / *Salix exigua* Forest;
- 4) *Leymus cinereus* Bottomland Herbaceous Vegetation.

The G2 plant associations include:

- 1) *Juniperus occidentalis* / *Artemisia rigida* / *Poa secunda* Wooded Herbaceous Vegetation;
- 2) *Celtis laevigata* var. *reticulata* / *Pseudoroegneria spicata* Woodland;
- 3) *Artemisia tridentata* ssp. *tridentata* / *Leymus cinereus* Shrubland;
- 4) *Pseudoroegneria spicata* – *Balsamorhiza sagittata* – *Poa secunda* Herbaceous Vegetation;
- 5) *Sporobolus cryptandrus* – *Poa secunda* Herbaceous Vegetation;
- 6) *Juniperus occidentalis* / *Achnatherum thurberianum* Wooded Herbaceous Vegetation;
- 7) *Juniperus occidentalis* / *Festuca idahoensis* Wooded Herbaceous Vegetation.

The remaining plant associations classified during this project are ranked vulnerable to secure (G3, G4, and G5) or have yet to be accepted into the NVC. Those plant associations potentially new to the NVC include:

- 1) *Artemisia tridentata* ssp. *wyomingensis* / *Bromus tectorum* Shrubland;
- 2) *Tetradymia canescens* / *Poa secunda* Shrubland;
- 3) *Atriplex confertifolia* / *Bromus tectorum* Shrubland;
- 4) *Salix exigua* – *Rosa woodsii* Shrubland; (
- 5) *Sarcobatus vermiculatus* / *Bromus tectorum* Shrubland;
- 6) *Chrysothamnus viscidiflorus* / *Bromus tectorum* Shrubland;
- 7) *Gutierrezia sarothrae* / *Bromus tectorum* Shrubland;
- 8) *Gutierrezia sarothrae* / *Taeniatherum caput-medusa* Shrubland;
- 9) *Gutierrezia sarothrae* / *Poa bulbosa* Shrubland;
- 10) *Achnatherum thurberianum* – *Pseudoroegneria spicata* Herbaceous Vegetation;
- 11) *Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum thurberianum* – *Pseudoroegneria spicata* Steppe;
- 12) *Artemisia tridentata* ssp. *wyomingensis* / *Festuca idahoensis* Shrub Herbaceous Vegetation;
- 13) *Purshia tridentata* Ash Bed;
- 14) *Helianthus nuttallii* Ash Bed;
- 15) *Cleome platycarpa* Ash Bed.

Digital Imagery and Interpretation

For JODA, 49 original map units (33 vegetated, four geology, and 12 land-use/land-cover) were developed. Based on low accuracy assessment values and recommendations from JODA staff one of the shadscale/cheatgrass shrubland type was combined with the shadscale alliance yielding a total of 48 map units. (Note: All of the information related to the original map class was retained for these polygons in the comments field -“*Bromus tectorum* present”).

The final list of map classes/units was directly cross-walked or matched to corresponding plant associations and land use classes (Table 8). JODA map classes represent a compromise between the detail of the NVCS, the needs for Monument management, and the limitations of the imagery. As a result, the mapping legend does not exactly match the NVCS. When the NVCS link was not feasible, descriptive local map units were created. In some cases non-native map units outside of the NVC were subsequently matched to NVC alliances. Since this cross-walking was done after the formal classification, these alliances do not have descriptions and did not make it into the JODA field key; they include:

Elaeagnus angustifolia Semi-natural Woodland Alliance;
Bromus tectorum Semi-natural Herbaceous Alliance;
Thinopyrum intermedium Semi-natural Herbaceous Alliance;
Agropyron cristatum Semi-natural Herbaceous Alliance.

The following types represent the possible map scenarios that were encountered in the JODA project:

1. **One-to-one relationship** = When a plant association or vegetation alliance had a unique photo signature and could be readily delineated on the imagery, the map unit adopted the plant association/alliance name or similar synonym.
2. **One-to-many relationship** = When related plant associations shared the same signature and could not be distinguished on the imagery, several plant associations were combined into a single complex.
3. **Park Specials** = When unique stands of vegetation did not have a corresponding NVCS plant association or vegetation alliance.
4. **Land Use – Land Cover** = Non-vegetated areas and vegetation types not recognized by the NVCS received Anderson et al. (1976, updated 2002) map unit designations.

Please reference Appendix F for detailed descriptions and representative photographs for all vegetation map units.

Table 8. Assignment of map classes and relationships to plant associations and other maps units.

Map Code	Map Class Name	Description of Associations/Alliances Assigned to Map Class	Relationship
JUOC/ARTR	<i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> Woodland Complex	<i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> / <i>Pseudoroegneria spicata</i> Wooded Herbaceous Vegetation <i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> – <i>Purshia tridentata</i> Wooded Herbaceous Vegetation	1 : many
JUOC/CELE	<i>Juniperus occidentalis</i> / <i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Woodland	<i>Juniperus occidentalis</i> / <i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Woodland	1 : 1
JUOC/HERB	<i>Juniperus occidentalis</i> Wooded Herbaceous Alliance	<i>Juniperus occidentalis</i> / <i>Achnatherum thurberiana</i> Wooded Herbaceous Vegetation <i>Juniperus occidentalis</i> / <i>Festuca idahoensis</i> Wooded Herbaceous Vegetation <i>Juniperus occidentalis</i> / <i>Pseudoroegneria spicata</i> Wooded Herbaceous Vegetation	1 : many
JUOC/ASH	<i>Juniperus occidentalis</i> Sparse Ash Bed Woodland	<i>Juniperus occidentalis</i> / <i>Artemisia rigida</i> / <i>Poa secunda</i> Wooded Herbaceous Vegetation	1 : 1
JUOC/BRTE	<i>Juniperus occidentalis</i> / <i>Bromus tectorum</i> Woodland	(No Association)	Park Special
CELA	<i>Celtis laevigata</i> var. <i>reticulata</i> / <i>Pseudoroegneria spicata</i> Woodland	<i>Celtis laevigata</i> var. <i>reticulata</i> / <i>Pseudoroegneria spicata</i> Woodland	1 : 1
ALRH	<i>Alnus rhombifolia</i> Temporarily Flooded Forest Alliance	<i>Alnus rhombifolia</i> / <i>Philadelphus lewisii</i> Forest <i>Alnus rhombifolia</i> / <i>Rosa woodsii</i> Forest	1 : many
POBA	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> Temporarily Flooded Forest Alliance	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Alnus incana</i> Forest <i>Populus balsamifera</i> ssp. <i>trichocarpa</i> / <i>Salix exigua</i> Forest	1 : many
ELAN	<i>Elaeagnus angustifolia</i> Semi-natural Woodland Alliance	<i>Elaeagnus angustifolia</i> Semi-natural Woodland Alliance	1 : 1
CELE	<i>Cercocarpus ledifolius</i> Shrubland Alliance	<i>Cercocarpus ledifolius</i> – <i>Artemisia tridentata</i> Shrubland <i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Shrubland	1 : many
ARAR	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> - (<i>Artemisia rigida</i>) Shrub Herbaceous Complex	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation <i>Artemisia rigida</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation	1 : many
ARTR/SAVE	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> - (<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>) - <i>Sarcobatus vermiculatus</i> Shrubland Complex	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> - <i>Atriplex confertifolia</i> - <i>Sarcobatus vermiculatus</i> Shrubland <i>Artemisia tridentata</i> ssp. <i>tridentata</i> / <i>Leymus cinereus</i> Shrubland	1 : many

Map Code	Map Class Name	Description of Associations/Alliances Assigned to Map Class	Relationship
ARTRW	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Complex	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Achnatherum thurberiana</i> - <i>Pseudoroegneria spicata</i> Steppe <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Atriplex confertifolia</i> – <i>Sarcobatus vermiculatus</i> Shrubland <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Festuca idahoensis</i> Shrub Herbaceous Vegetation <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Poa secunda</i> Shrubland <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Pseudoroegneria spicata</i> Shrub Herbaceous Vegetation <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Purshia tridentata</i> / <i>Pseudoroegneria spicata</i> Shrubland	1 : many
ARTRW/BRTE	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Bromus tectorum</i> Shrubland	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Bromus tectorum</i> Shrubland	1 : 1
ATCO	<i>Atriplex confertifolia</i> Shrubland Alliance	<i>Atriplex confertifolia</i> Sparse Shrubland <i>Atriplex confertifolia</i> / <i>Elymus elymoides</i> Shrubland <i>Atriplex confertifolia</i> / <i>Pseudoroegneria spicata</i> Shrubland <i>Atriplex confertifolia</i> / <i>Bromus tectorum</i> Shrubland	1 : many
CHVI/BRTE	<i>Chrysothamnus viscidiflorus</i> / <i>Bromus tectorum</i> Shrubland	<i>Chrysothamnus viscidiflorus</i> / <i>Bromus tectorum</i> Shrubland	1 : 1
TECA	<i>Tetradymia canescens</i> / <i>Poa secunda</i> Shrubland	<i>Tetradymia canescens</i> / <i>Poa secunda</i> Shrubland	1 : 1
SAVE	<i>Sarcobatus vermiculatus</i> Intermittently Flooded Shrubland Alliance	<i>Sarcobatus vermiculatus</i> / <i>Bromus tectorum</i> Shrubland <i>Sarcobatus vermiculatus</i> / <i>Leymus cinereus</i> Shrubland	1 : many
SALX	<i>Salix exigua</i> - (<i>Rosa woodsii</i>) Temporarily Flooded Shrubland Complex	<i>Rosa woodsii</i> Shrubland <i>Salix exigua</i> / Barren Shrubland <i>Salix exigua</i> / <i>Eleocharis palustris</i> – <i>Schoenoplectus americanus</i> Shrubland <i>Salix exigua</i> – <i>Rosa woodsii</i> Shrubland	1 : many
PRVI	<i>Prunus virginiana</i> – (<i>Prunus americana</i>) Shrubland	<i>Prunus virginiana</i> – (<i>Prunus americana</i>) Shrubland	1 : 1
FEID	<i>Pseudoroegneria spicata</i> - <i>Festuca idahoensis</i> Canyon Herbaceous Vegetation	<i>Pseudoroegneria spicata</i> – <i>Festuca idahoensis</i> Canyon Herbaceous Vegetation	1 : 1
PSSP	<i>Pseudoroegneria spicata</i> - (<i>Sporobolus cryptandrus</i> - <i>Poa secunda</i>) Herbaceous Vegetation Complex	<i>Pseudoroegneria spicata</i> – <i>Balsamorhiza sagittata</i> – <i>Poa secunda</i> Herbaceous Vegetation <i>Sporobolus cryptandrus</i> - <i>Poa secunda</i> Herbaceous Vegetation	1 : many

Map Code	Map Class Name	Description of Associations/Alliances Assigned to Map Class	Relationship
ACTH	<i>Achnatherum thurberianum</i> - <i>Pseudoroegneria spicata</i> Herbaceous Vegetation	<i>Achnatherum thurberianum</i> - <i>Pseudoroegneria spicata</i> Herbaceous Vegetation	1 : 1
BRTE	<i>Bromus tectorum</i> – (<i>Taeniatherum caput-medusae</i> – <i>Poa bulbosa</i>) Semi-natural Herbaceous Vegetation Complex	<i>Bromus tectorum</i> Semi-natural Herbaceous Alliance	1 : 1
THIN	<i>Thinopyrum intermedium</i> - (<i>Agropyron</i> sp.) Semi-natural Herbaceous Vegetation Complex	<i>Thinopyrum intermedium</i> Semi-natural Herbaceous Alliance <i>Agropyron cristatum</i> Semi-natural Herbaceous Alliance	1 : 1
TYPHA	<i>Typha (angustifolia, latifolia)</i> – (<i>Leymus cinereus</i>) Herbaceous Vegetation Complex	<i>Typha (angustifolia, latifolia)</i> Western Herbaceous Vegetation <i>Leymus cinereus</i> Bottomland Herbaceous Vegetation	1 : many
WEED	Annual Forbs Mixed Weedy Herbaceous Vegetation	(No Association)	Park Special
PUTR	<i>Purshia tridentata</i> Ash Bed	<i>Purshia tridentata</i> Ash Bed	1 : 1
ERNA	<i>Ericameria nauseosa</i> Sparse Shrubland	<i>Ericameria nauseosa</i> Sparse Shrubland	1 : 1
GUSA	<i>Gutierrezia sarathae</i> Semi-Natural Dwarf-shrubland Alliance	<i>Gutierrezia sarothrae</i> / <i>Bromus tectorum</i> Dwarf-shrubland <i>Gutierrezia sarothrae</i> / <i>Poa bulbosa</i> Dwarf-shrubland <i>Gutierrezia sarothrae</i> / <i>Taeniatherum caput-medusae</i> Dwarf-shrubland	1 : many
ASH/SHRB	Ash Beds - Mixed Shrubland Complex	<i>Eriogonum strictum</i> / <i>Poa secunda</i> Dwarf-shrub Herbaceous Vegetation <i>Salvia dorrii</i> / <i>Pseudoroegneria spicata</i> Dwarf-shrubland	1 : many
ASH/HERB	Ash Beds - Mixed Herbaceous Vegetation Complex	<i>Cleome platycarpa</i> Ash Bed <i>Helianthus nuttallii</i> Ash Bed	1 : many
BANK	Barren Streambank	Unvegetated banks, point bars, and islands of the John Day River, etc.	N/A
CHNL	Unvegetated Channel	Unvegetated runoff channels and dry creekbeds	N/A
CNYN	Canyon Cliffs, Scree, and Rock Outcrops	Barren bedrock exposures	N/A
ASH	Ash and Tuff Badland Bare Ground	Barren badland and shale deposits/exposures	N/A
STRM	Stream / River	Natural linear drainage features with flowing water	N/A
CANL	Canal / Ditch	Man-made linear water conveyance systems with standing water	N/A
POND	Lake / Pond	Natural and small human-made water impoundments	N/A
RESV	Reservoir	Large impoundments for water storage	N/A
RESD	Residential	Single-family housing	N/A
AGRI	Agricultural Business	Ranch/Farm facilities	N/A
ROAD	Transportation	Paved and earthen roads	N/A

Map Code	Map Class Name	Description of Associations/Alliances Assigned to Map Class	Relationship
TRANS	Transitional	Disturbed sites along roads, parking lots, etc. with little plant growth	N/A
MINE	Quarries / Strip Mines / Gravel Pits	Sites disturbed to extract or store sand, gravel, rock or other minerals	N/A
ORCH	Orchards, Groves, Vineyards, Nurseries, and Horticultural Areas	Irrigated planted trees, fruit orchards, etc.	
FILD	Planted / Cultivated	Tilled, cropped, or fallow agricultural fields	
NPS	NPS Facilities	Paleontology Center, etc.	N/A

Vegetation Map

The JODA vegetation map consisted of 9,662 polygons totaling 74,537 acres; average polygon size was eight acres (Table 9). Lands managed by the NPS consisted of 14,014 acres and 15,911 acres where mapped within the supplied boundary (includes in-holdings), representing about 21% of the total project area. The remaining mapping in the environs consisted of a mixture of private, state and BLM lands totaling 58,627 acres or 79% of the total mapping area. Of the total 9,662 polygons, 87% or 68,467 acres represented natural or semi-natural vegetation map classes. Map classes representing non-vegetated geology formations, outcrops and stream deposits totaled 910 polygons or 2,174 acres (3%) and developed areas account for the remaining 316 polygons (3,897 acres) or 5% of the project area. [It should be noted that the polygon count is skewed on the high side since it does include adjacent polygons that have the same map code but different density or height attributes.] The most common map class in the entire project area was *Juniperus occidentalis* / *Artemisia tridentata* Woodland Complex and the most common within JODA was the *Pseudoroegneria spicata* - (*Sporobolus cryptandrus* - *Poa secunda*) Herbaceous Vegetation Complex.

Normally the standard minimum mapping unit for NPS vegetation inventory projects is defined as 1.24 acres. However, this is a nominal unit and due to the resolution of the imagery, it was reduced to ¼ acre for riparian, wetland, and other rare classes. This MMU allowed for more detail in the mapping and better delineation of sites deemed important for JODA management. This ability to recognize small patches of vegetation is reflected in the high number of polygons created and the average size of the polygons for some of the rarer vegetation types.

The JODA vegetation map should more appropriately be considered a spatial database that also contains many additional polygon attributes not presented in the preceding table (i.e. density, height, and pattern in particular). The extensive data are difficult to convey in a table or on a two-dimensional map, but it should be understood that the different attributes can be combined in many ways and at different scales and resolutions to produce additional products better representing the full spectrum of the vegetative diversity. Figure 14 is an example of a fine scale (1:12,000) JODA vegetation map centered on the visitors center created from the GIS spatial database with the 2009 NAIP imagery as the background.

Table 9. Summary statistics for the JODA map class polygons.

Map Code	Map Unit Description	NPS Lands			Total Project Area		
		# of Polygons	Acres	Hectares	# of Polygons	Acres	Hectares
JUOC/ARTR	<i>Juniperus occidentalis</i> / <i>Artemisia tridentata</i> Woodland Complex	182	920	373	829	8,739	3,539
JUOC/CELE	<i>Juniperus occidentalis</i> / <i>Cercocarpus ledifolius</i> / <i>Pseudoroegneria spicata</i> Woodland	33	171	69	142	1694	686
JUOC/HERB	<i>Juniperus occidentalis</i> Wooded Herbaceous Alliance	223	1,505	610	935	15,016	6,082
JUOC/ASH	<i>Juniperus occidentalis</i> Sparse Ash Bed Woodland	35	100	40	134	531	215
JUOC/BRTE	<i>Juniperus occidentalis</i> / <i>Bromus tectorum</i> Woodland	24	145	59	100	713	289
CELA	<i>Celtis laevigata</i> var. <i>reticulata</i> / <i>Pseudoroegneria spicata</i> Woodland	1	1	0.3	1	1	0.3
ALRH	<i>Alnus rhombifolia</i> Temporarily Flooded Forest Alliance	19	26	10	36	64	26
POBA	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> Temporarily Flooded Forest Alliance	35	21	8	203	206	83
ELAN	<i>Elaeagnus angustifolia</i> Semi-natural Woodland Alliance	16	2	1	40	18	7
CELE	<i>Cercocarpus ledifolius</i> Shrubland Alliance	64	600	243	165	1,811	733
ARAR	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> - (<i>Artemisia rigida</i>) Shrub Herbaceous Complex	2	11	4	2	22	9
ATTR/SAVE	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> - (<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>) - <i>Sarcobatus vermiculatus</i> Shrubland Complex	45	107	43	141	345	140
ARTRW	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Complex	186	1,742	705	663	7,171	2,904
ARTRW/BRTE	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> / <i>Bromus tectorum</i> Shrubland	181	970	393	568	,137	2,080
ATCO	<i>Atriplex confertifolia</i> Shrubland Alliance	194	782	317	342	1,358	550
CHVI/BRTE	<i>Chrysothamnus viscidiflorus</i> / <i>Bromus tectorum</i> Shrubland	6	9	4	21	50	20
TECA	<i>Tetradymia canescens</i> / <i>Poa secunda</i> Shrubland	2	72	29	2	72	29
SAVE	<i>Sarcobatus vermiculatus</i> Intermittently Flooded Shrubland Alliance	56	261	106	145	524	212
SALX	<i>Salix exigua</i> - (<i>Rosa woodsii</i>) Temporarily Flooded Shrubland Complex	55	88	36	149	270	109
PRVI	<i>Prunus virginiana</i> – (<i>Prunus americana</i>) Shrubland	3	3	1	18	20	8
FEID	<i>Pseudoroegneria spicata</i> - <i>Festuca idahoensis</i> Canyon Herbaceous Vegetation	139	899	364	641	4,330	1,753
PSSP	<i>Pseudoroegneria spicata</i> - (<i>Sporobolus cryptandrus</i> - <i>Poa secunda</i>) Herbaceous Vegetation Complex	232	2,665	1,079	825	8,557	3,466
ACTH	<i>Achnatherum thurberianum</i> - <i>Pseudoroegneria spicata</i> Herbaceous Vegetation	19	159	64	57	627	254

Map Code	Map Unit Description	NPS Lands			Total Project Area		
		# of Polygons	Acres	Hectares	# of Polygons	Acres	Hectares
BRTE	<i>Bromus tectorum</i> – (<i>Taeniatherum caput-medusae</i> – <i>Poa bulbosa</i>) Semi-natural Herbaceous Vegetation Complex	215	1,718	696	691	6,632	2,686
THIN	<i>Thinopyrum intermedium</i> - (<i>Agropyron</i> sp.) Semi-natural Herbaceous Vegetation Complex	5	18	7	9	29	12
TYPHA	<i>Typha (angustifolia, latifolia)</i> – (<i>Leymus cinereus</i>) Herbaceous Vegetation Complex	49	38	15	165	165	67
WEED	Annual Forbs Mixed Weedy Herbaceous Vegetation	14	34	14	92	213	86
PUTR	<i>Purshia tridentata</i> Ash Bed	3	9	4	43	208	84
ERNA	<i>Ericameria nauseosa</i> Sparse Shrubland	6	61	25	13	83	34
GUSA	<i>Gutierrezia sarathae</i> Semi-Natural Dwarf-shrubland Alliance	75	408	165	141	841	340
ASH/SHRB	Ash Beds - Mixed Shrubland Complex	171	348	141	474	1,245	504
ASH/HERB	Ash Beds - Mixed Herbaceous Vegetation Complex	181	336	136	649	1,774	718
BANK	Barren Streambank	16	9	4	64	48	19
CHNL	Unvegetated Channel	9	12	5	30	76	31
CNYN	Canyon Cliffs, Scree, and Rock Outcrops	98	245	99	352	715	290
ASH	Ash and Tuff Badland Bare Ground	195	819	332	468	1,342	544
STRM	Stream / River	19	67	27	17	299	121
CANL	Canal / Ditch	5	9	4	7	10	4
POND	Lake / Pond	6	2	1	34	25	10
RESV	Reservoir	0	0	0	1	57	23
RESD	Residential	1	1	1	8	7	3
AGRI	Agricultural Business	13	23	9	77	138	56
ROAD	Transportation	23	119	48	15	514	208
TRANS	Transitional	12	17	7	20	63	26
MINE	Quarries / Strip Mines / Gravel Pits	0	0	0	2	5	2
ORCH	Orchards, Groves, Vineyards, Nurseries, and Horticultural Areas	2	3	1	2	3	1
FILD	Planted / Cultivated	25	346	140	113	2,754	1,115
NPS	NPS Facilities	16	15	6	18	15	6
	Total Natural Vegetation	2,471	14,224	5,761	8,436	68,464	27,728
	Total Barren Geology	318	1,085	439	914	2,181	883
	Total Land use / Land Cover	122	602	244	314	3,892	1,576
	Totals	2,911	15,911	6,444	9,664	74,537	30,188



Map Code	Map Unit Description
JUOC/ARTR	Juniperus occidentalis / Artemisia tridentata Woodland Complex
JUOC/CELE	Juniperus occidentalis / Cercocarpus ledifolius / Pseudoroegneria spicata Woodland
JUOC/HERB	Juniperus occidentalis Wooded Herbaceous Alliance
JUOC/ASH	Juniperus occidentalis Sparse Ash Bed Woodland
JUOC/B RTE	Juniperus occidentalis / Bromus tectorum Woodland
CELA	Celtis laevigata var. reticulata / Pseudoroegneria spicata Woodland
ALRH	Alnus rhombifolia Temporarily Flooded Forest Alliance
POBA	Populus balsamifera ssp. trichocarpa Temporarily Flooded Forest Alliance
ELAN	Elaeagnus angustifolia Semi-natural Woodland Alliance
CELE	Cercocarpus ledifolius Shrubland Alliance
ARAR	Artemisia arbuscula ssp. arbuscula - (Artemisia rigida) Shrub Herbaceous Complex
ARTR/SAVE	Artemisia tridentata ssp. tridentata - (Artemisia tridentata ssp. wyomingensis) - Sarcobatus vermiculatus Shrubland Complex
ARTRW	Artemisia tridentata ssp. wyomingensis Shrubland Complex
ARTRW/B RTE	Artemisia tridentata ssp. wyomingensis / Bromus tectorum Shrubland
ATCO	Atriplex confertifolia Shrubland Alliance
CHV/B RTE	Chrysothamnus viscidiflorus / Bromus tectorum Shrubland
TECA	Tetradymia canescens / Poa secunda Shrubland
SAVE	Sarcobatus vermiculatus Intermittently Flooded Shrubland Alliance
SALX	Salix exigua - (Rosa woodsii) Temporarily Flooded Shrubland Complex
PRVI	Prunus virginiana - (Prunus americana) Shrubland
FEID	Pseudoroegneria spicata - Festuca idahoensis Canyon Herbaceous Vegetation
PSSP	Pseudoroegneria spicata - (Sporobolus cryptandrus - Poa secunda) Herbaceous Vegetation Complex
ACTH	Achnatherum thurberianum - Pseudoroegneria spicata Herbaceous Vegetation
B RTE	Bromus tectorum - (Taeniatherum caput-medusae - Poa bulbosa) Semi-natural Herbaceous Vegetation Complex
THIN	Thinopyrum intermedium - (Agropyron spp.) Semi-natural Herbaceous Vegetation Complex
TYPHA	Typha (angustifolia, latifolia) - (Leymus cinereus) Herbaceous Vegetation Complex
WEED	Annual Forbs Mixed Weedy Herbaceous Vegetation
PUTR	Purshia tridentata Ash Bed
ERNA	Ericameria nauseosa Sparse Shrubland
GUSA	Gutierrezia sarathae Semi-Natural Dwarf-shrubland Alliance
ASH/SHRB	Ash Beds - Mixed Shrubland Complex
ASH/HERB	Ash Beds - Mixed Herbaceous Vegetation Complex
BANK	Barren Streambank
CHNL	Unvegetated Channel
CNYN	Canyon Cliffs, Scree, and Rock Outcrops
ASH	Ash and Tuff Badland Bare Ground
STRM	Stream / River
CANL	Canal / Ditch
POND	Lake / Pond
RESD	Residential
RESV	Reservoir
AGRI	Agricultural Business
ROAD	Transportation
TRANS	Transitional
MINE	Quarries / Strip Mines / Gravel Pits
ORCH	Orchards, Groves, Vineyards, Nurseries, and Horticultural Areas
FILED	Planted / Cultivated
NPS	NPS Facilities

Example of Vegetation Map Classes

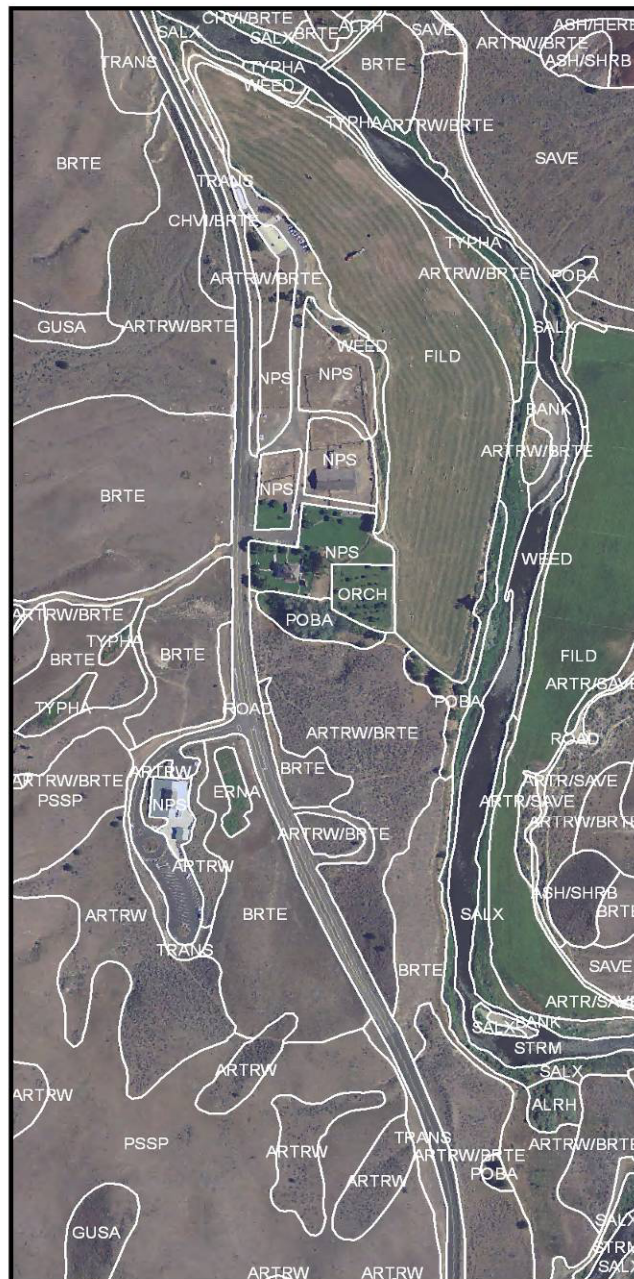


Figure 14. Example of the JODA vegetation map layer.

Accuracy Assessment

The 2009 accuracy assessment effort yielded 408 points distributed throughout the JODA units and parcels. Initial analysis revealed one point that was obviously sampled in the wrong location based on accuracy point description (Barren Rocky Slope). This point was subsequently removed from further analysis. In addition to using the AA points in the map analysis, many of the points were also used to update the classification and to revise the local descriptions. These data helped strengthen the classification for JODA and added to the global perspective of the individual types.

Analysis of the AA points involved a point-by-point review in two stages. During stage one, an AA GIS point file was created from the AA point coordinates recorded in the field. These sites were digitally overlaid on the vegetation map and a comparison of the final AA field call versus the vegetation polygon label was conducted by CTI staff. Stage one review resulted in a preliminary error matrix that was reviewed by NMI and CTI. Adjustments were made to the field calls at this time based on the actual cover values recorded and taking into account possible errors in the field key. Following incorporation of changes, results were presented to UCBN and JODA staffs and recommendations were made to improve the accuracy of the map. The recommendations included combining the two original shadescale map units (Shadescale Shrubland Alliance and Shadescale / Cheatgrass Shrubland) into one Shadescale Shrubland Alliance type. However the cheatgrass information was retained in the comments field of the GIS layer.

Stage two of the analysis involved incorporating the NPS recommendations by combining similar classes and re-running the accuracy assessment. Following vegetation map update, a final error matrix was calculated (Table 10) and included any correct alternate second or third field calls. In most cases, the correct second and third calls were very closely related to the incorrect primary call. The final assessment revealed an overall accuracy of 87%.

Examination of the final error matrix showed concentrations of user's error among the different sparsely vegetated classes occurring on ash and tuff soils (Map Units JUOC/ASH, GUSA, ASH/SHRB, and ASH/HERB). These low accuracy values were accepted by the park since the types represent important management considerations. Explanation of these errors likely involves the high reflectance of the ash soils masking the species signature and the overlap in species between these and other non-ash types such as bluebunch wheatgrass (PSSP) and Western juniper with grass understory (JUOC/HERB).

Other trends in the accuracy assessment involved the difficulty in separating types with cheatgrass in the understory. For example the ARTTW/BRTE Map Unit was confused twice with the ARTTW map unit. This reflects the difficulty in accurately interpreting when cheatgrass is the dominant under tree and shrub canopies and when it occurs in high enough cover compared to associated native grasses. Finally, the differences between the woodland and shrubland types confused with the grassland types can probably be explained by the difficulty in resolving the difference in scale and perspective between viewing the vegetation on the imagery and assessing it on the ground. For example, sampling could have occurred in inclusions or canopy openings that were actually a part of a larger woodland/shrubland polygon.

Table 10. Final Contingency Table for JODA

		Observed AA Point (Reference AA Ground Data)																																															
Map Class		JUOC / ARTR	JUOC / CELE	JUOC / HERB	JUOC / ASH	JUOC / BRTE	CELA	ALRH	POBA	CELE	ARAR	ARTR/ SAVE	ARTTW	BRTE	ATCO	CHVI BRTE	TECA	SAVE	SALX	PRVI	FEID	PSSP	ACTH	BRTE	THIN	TYPHA	WEED	ERHA	GUSA	ASH SHRB	ASH HERB	Total	Users Accuracy	90% Conf. Interval															
P r e d i c t e d	JUOC/ARTR	17	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	85%	69%	100%														
	JUOC/CELE	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	86%	57%	100%														
	JUOC/HERB	2	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	48	88%	79%	96%														
	JUOC/ASH	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0%	0	17%														
	JUOC/BRTE	1	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	88%	62%	100%														
	CELA	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%														
	ALRH	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	100%	92%	100%														
	POBA	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%														
	CELE	1	1	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	28	89%	78%	100%													
	ARAR	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%													
M a p	ATTR/SAVE	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9	89%	66%	100%													
	ARTTW	2	0	0	0	0	0	0	0	0	0	0	15	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	19	79%	61%	97%														
	ARTRW/BRTE	0	0	0	0	0	0	0	0	0	0	0	2	7	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	12	58%	31%	86%														
	ATCO	0	0	0	0	0	0	0	0	0	0	0	1	0	25	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	28	89%	82%	96%														
	CHVI/BRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%														
	TECA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%														
	SAVE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	18	100%	97%	100%														
	SALX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	17	100%	97%	100%														
	PRVI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	100%	50%	100%														
	FEID	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	2	1	1	0	0	0	0	0	0	0	26	81%	66%	95%													
C l a s s	PSSP	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	54	1	0	0	0	0	0	1	0	0	57	95%	89%	100%														
	ACTH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	100%	83%	100%														
	BRTE	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	3	1	45	0	0	0	0	0	0	0	51	88%	80%	97%														
	THIN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	100%	75%	100%														
	TYPHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	100%	75%	100%														
	WEED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	100%	75%	100%														
	ERHA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	100%	83%	100%															
	GUSA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	14	0	0	19	74%	54%	93%														
	ASH/SHRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	8	75%	44%	100%														
	ASH/HERB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	2	5	40%	0	86%															
Total		25	8	47	0	7	1	6	1	25	1	8	19	8	29	2	1	18	17	1	22	71	7	49	2	2	2	3	17	6	2	87% Overall Accuracy																	
Producers Accuracy		68%	75%	89%	0%	100%	100%	100%	100%	100%	100%	79%	88%	86%	50%	100%	100%	100%	100%	100%	95%	75%	43%	92%	100%	100%	100%	100%	82%	100%	100%	407 Total Points	86%		88%														
90% Conf. - Level +		51%	44%	81%	0	93%	50%	92%	50%	98%	50%	94%	61%	62%	77%	0	50%	97%	97%	50%	86%	65%	5%	84%	75%	75%	75%	83%	64%	92%	75%	353 Correct Points	Overall 90% Conf. Intervals																
		85%	100%	98%	0	100%	100%	100%	100%	100%	100%	97%	100%	95%	100%	100%	100%	100%	100%	100%	84%	81%	99%	100%	100%	100%	100%	100%	100%	100%	85% Kappa Index																		

Instructions on Using the Accuracy Assessment Contingency Table:

The contingency table or error matrix found above presents an array of numbers set out in rows and columns corresponding to a particular vegetation map unit relative to the actual vegetation type as verified on the ground. The column headings represent the vegetation classification as determined in the field and the row headings represent the vegetation classification taken from the vegetation map. The highlighted diagonal indicates the number of points assessed in the field that agree with the map label. Conversely, the inaccuracies of each map unit are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors). By reading across this table (i.e., rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled when compared to the field data. By reading down the table (i.e., columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were: 1) over-mapped - commission errors on the right - more of this type was mapped than occurs at the site or 2) under-mapped - omission errors on the bottom - some of this type was mapped as other map units.

Discussion

John Day Fossil Beds National Monument combines a unique mix of volcanic and sedimentary geology, fossil bed exposures, hydrology, native plant communities, sites converted to irrigated fields, and sites supporting exotic grasses due to historical agricultural activity. Several plant associations and vegetation alliances typical of the Columbia Basin and Plateau and including native and non-native dominants have become established on the varied and rugged landscape. Combined, the multiple geologic exposures, soil development patterns, and varied land use resulted in many challenges to the classification and mapping effort. These included demanding logistical considerations for field work due to working on exposed ash/tuff beds, cliff faces, steep slopes, and negotiating across the John Day River. The geologic exposures and river corridors within JODA also created challenges for mapping due to the shadows they produced on the aerial imagery. Even though the accuracy is high, there are still some areas where improvements can be made. These areas are summarized below.

Approaches that worked well: Field data and local descriptions of the associations provided by project ecologists were extremely helpful in the delineation of the different map classes. High-quality plot, observation point, and legacy data, in addition to focused local plant association descriptions provided information for direct image interpretation. JODA had a high density of vegetation classification plots, equal to or higher than any other small-to-medium Monument/park in the UCBN. Additional data collected by the project photointerpreter during field reconnaissance, further informed JODA interpretation and mapping. For mapping, the 2009 NAIP imagery was truly a boon to this project as it provided a timelier, high resolution base product that made the final map much more up-to-date and likely increased the overall accuracy.

Areas for Improvement: Inherent to all vegetation mapping projects is the need to produce both a consistent vegetation classification and a comprehensive set of map units. Typically, the systems are very similar, but when using a national classification such as the NVCS there is usually not a strict 1:1 correspondence. Nonconformity is due to the remote sensing nature of the interpretation and its ability to delineate map units based only on photo signatures. Subtle vegetation characteristics that can be seen on the ground are not necessarily the same as those apparent on the imagery. Canopy closure, shadows, soil reflections and the timing of the imagery acquisition can all impact the vegetation signatures. In the future if a more detailed map or classification is needed, especially for the complex ash and tuff deposits, more field-based classification and mapping work could be concentrated just in these units. Similarly, if more precision is needed for the delineation of the non-native vs. native grass types new imagery could be acquired at specific times to capture the highest degree of contrast between these types (i.e. cheatgrass' orange/yellow phase).

Field Survey

The vegetation classification data presented in this project should be used as the baseline from which to begin future vegetation studies. New survey work in a judicious timeframe would improve both the classification (plant association descriptions) and mapping (refined linework) efforts. Using the accuracy assessment as a guide, map classes with lower accuracy could be further surveyed and boundaries delineated in the field to create more accurate delineations/coverages. While it may appear that there are a large number of plant associations

and vegetation alliances described for this relatively small study area, some were minimally sampled either due to access or time allotted for sampling. Also, there is an active fire program to reduce tree and shrub cover at some locations and new types and concepts may be developed in future classifications. It is recommended that these types and locations receive additional field survey to further define classification and species composition.

Classification

In addition to private and tribal lands access adjacent to JODA, another principle classification challenge is documenting changes to site ecology caused by drought, wildfire, water and wind erosion of geologic features, prescribed burns, grazing recovery, and other anthropogenic disturbance. Changes can include increase or reduction of tree and shrub cover, physical removal of woody vegetation, erosion due to overbank flooding, and spread of invasive plant species. Periodically and immediately following events causing vegetation change, new data should be collected and analyzed. New vegetation map layers should be prepared as the base map becomes out-dated over time. Overall more specialized and targeted data collection in affected areas would help to document any changes and would greatly increase the understanding of the JODA landscape.

Digital Imagery and Interpretation

The vegetation map for JODA was based primarily on the 2009 NAIP ortho-imagery. Therefore, all of the resulting mapping products correspond to the summer of 2009 timing of the image acquisition (i.e. snapshot in time). As the data are used, please remember that fires, hand-cutting trees, or landscape altering events since 2009 are not included. In the future it would be beneficial to update the map based on newer imagery or from GPS coordinates (e.g. fire perimeters).

Accuracy Assessment

An important and necessary aspect of this project is the accuracy assessment; collecting independent ground data determines the usefulness of the vegetation map. As such, users of this product should remember that the GIS mapping and the classification portions of this project were conducted separately from both the plot and AA field data collection. Employing divisions in completing tasks created some challenges related to communication among the teams, including: 1) adequately conveying changes to the vegetation classification based on finding potentially new vegetation types during the field portion of the AA, 2) thoroughly testing and adjusting the field key to remove confusing splits among similar types, 3) insuring that adequate sample sizes are collected for rare and infrequent types, and 4) avoiding having to collect more than the estimated 30 data points for common types.

Actual errors in the mapping likely stemmed from the limitations of the ortho-photography as previously described, natural changes in the vegetation between sampling and the acquisition date of the imagery, errors in the field key, or the difficulty in establishing an overhead perspective to exactly match the ground view. Although the accuracy for JODA appears moderate to high, improvements can be made and users should fully explore and understand the sources of error as presented in the error matrix.

It is also important for users to remember that since the mapping portion of this project is primarily a remotely sensed exercise and the field work was conducted on site, all resulting products are scale dependent. In general the mapping portions should be viewed as a broader overview and the field data as more site specific. Although one can zoom in further than 1:12,000-scale using GIS software, the actual mapping was conducted at this scale. As such, any work performed with this product at a finer scale could lead to some uncertainty. In contrast, the field work was conducted at individual locations at one specific time and any extrapolation from these locations to out-lying areas or using them to determine what is there at different times is less reliable. Future users should fully appreciate these scale limitations and balance their efforts accordingly.

Future Recommendations

This project represents the best efforts put forth by a multi-disciplinary team over a short time period. In order to create the best possible “long-term” vegetation classification for JODA and the most accurate and detailed GIS layer, this project should be viewed as a place to start rather than an end product. In other words, present and future NPS staff should be encouraged to scrutinize this project, building from its strengths and bolstering its weaknesses. One way would be to periodically perform field checking by examining the map in the field by qualified park or contract staff, documenting any changes, and incorporating these into newer versions. By keeping in mind that this project represents a snapshot in time, future efforts can help complete understanding of the vegetation in and around JODA and how it changes over time. It is the hope of the producers that the products presented here will help focus and direct future efforts, as follows:

1. The diversity of plant species and dynamic nature of the Monument with respect to grazing, erosion, outside influences, and fire warrants periodic **field surveys** by experienced ecologists. Further, the inaccessibility of the private lands in the environs should be addressed by seeking permission to sample and verify the vegetation. In this way new plant associations could be discovered, existing types could be updated, and integrated pest management strategies could be expanded.
2. Remote sensing does not replace on-the-ground knowledge provided by GPS-linked plots, observations, photographs, and ground verification. Time, topographic features, and funding limitations curtailed the amount of map **ground-truthing** performed. As opportunities arise, maps should be examined in the field by experienced crews. Also GPS receiver data and other GIS layers should be used to improve and update the spatial data. This map product should not be viewed as static but should be updated with more current and accurate information.
3. To better understand the limitations of the map, the **accuracy assessment** data presented in Table 10 should be thoroughly reviewed by Monument staff. Map classes with low accuracy should be examined to see if they could be improved with future studies using ground-truthing or other remote-sensing formats (i.e. fine-scale imagery, hyperspectral, etc). Also, landscape modeling may help to tease out the location of specific types based on specific habitat information. Finally for some applications it may make sense to combine map classes into higher units, such as alliances or ecological systems to improve their accuracy.

4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects. New aerial photos or NAIP imagery acquired every year or as they are re-acquired, could be used in regular intervals to capture change. Specifically this new imagery could be used to create up-to-date vegetation layers that could be used to compare changes from the base map in both individual vegetation stands and across all Monument units.
5. In the future, resource management personnel could link the habitat for **species of concern** to specific associations and map units. These map units could then be used to help locate potential sites of rare, endangered, or threatened species and communities in the field or identify areas for non-native plant removal or treatment. Known populations and individual species of concern can be overlain using point or small polygon coverages.
6. Since this project was primarily a vascular plant inventory, **lichens and mosses** received only cursory review. Further research using this product and other imagery could help create new monitoring GIS layers showing the distribution and density of moss and lichen cover, cover by cryptobiotic soils, and how they relate to air quality and soil development.

Research Opportunities

Having an accurate and current vegetation classification and map presents many new and exciting research opportunities. Research could include expanding or linking the GIS layer to derive other information including fire models, habitat monitoring locations, guides for rare plant surveys, wildlife habitat structural analyses, and inventorying areas that likely contain exotic or invasive species. The map could also be enhanced by overlaying other existing GIS layers including geology, hydrology, elevation, and soils. In this manner complex interactions between these layers could be examined and yield important information about growth rates, regeneration after disturbance, biomass distribution, and stream morphology. Finally, through innovative analyses the vegetation layer could possibly be used as a springboard for other ecological studies including examining how the vegetation interacts with soil chemistry, pollution, paleontologic sites, weather patterns, etc.

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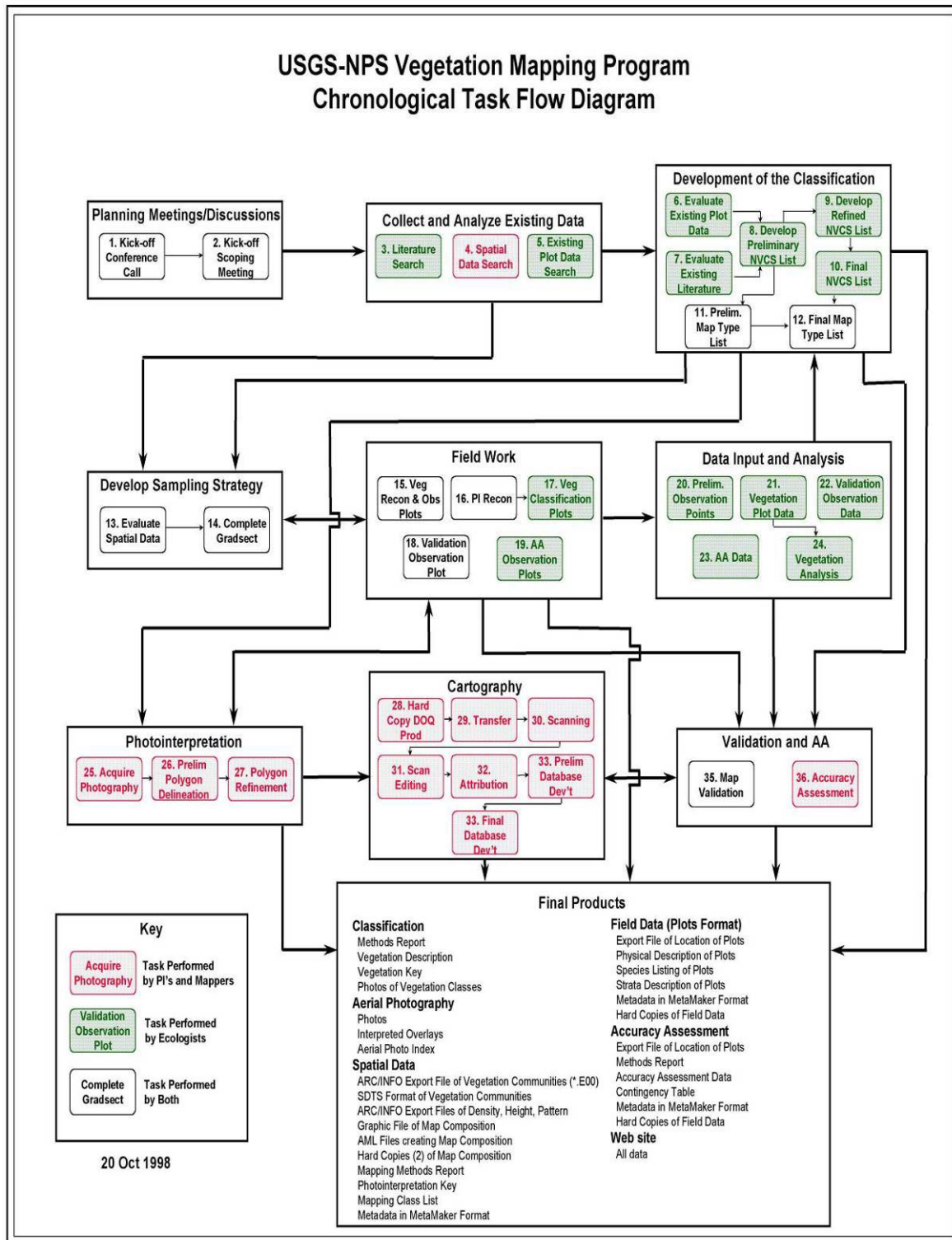
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List of Abbreviations and Acronyms

AA	Accuracy Assessment
Ac	Acres
BPU	Biophysical Unit
CDC	Conservation Data Center, Idaho Department of Game and Fish
CEGL	Community Element Code
COM	Craters of the Moon Lava Flow
CRMO	Craters of the Moon National Monument and Preserve
CTI	Cogan Technology, Incorporated
DBH	Diameter at Breast Height (4.5 feet)
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
e²M	engineering-environmental Management, Incorporated
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
ft	Feet
GIS	Geographic Information System
GPS	Global Positioning System (Receiver)
ha	Hectare
I&M	Inventory and Monitoring Program
ICDC	Idaho Conservation Data Center
in	Inch
ITIS	Integrated Taxonomic Information System
LC/LU	Land Cover/Land Use
MMU	Minimum Mapping Unit
NAD	North American Datum
NAIP	National Agriculture Imagery Program
NBII	National Biological Information Infrastructure Program
NMI	Northwest Management, Incorporated
NPS	National Park Service
NPS FirePro	National Park Service Fire Program
NRCS	Natural Resources Conservation Service
NRTR	Natural Resources Technical Report
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
QA/QC	Quality Assurance/Quality Control
SCS	Soil Conservation Service
TNC	The Nature Conservancy
TSN	Taxonomic Serial Number
UCBN	Upper Columbia Basin Network
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WRCC	Western Region Climate Center

Appendix A – Components and Flow Diagram of the Vegetation Classification and Mapping Program



Appendix B – Field Data Forms and Instructions

General instructions for filling out fields in the PLOT SURVEY FORM (adapted from Salas et al. 2004)

IDENTIFIERS/LOCATORS

Plot Code

Code indicating the specific plot within the vegetation polygon.

Surveyors

Names of surveyors, with principal surveyor listed first.

Date

Date the survey was taken; year, month and day.

BPU Code

The biophysical unit identified.

Provisional Community Name

Using the provisional classification of the park that was provided, assign the name of the vegetation type which most closely resembles this type. Enter the finest level of the classification possible. If it's a new type, name it based on the two or three most dominant species in the plot.

Quad Name

Appropriate name/scale from survey map used; use 7.5-minute quadrangle if possible.

Park Site Name

Provisional name assigned by field worker that describes where the data were collected. It should represent an identifiable feature on a topographic map.

GPS Rover File

Record the number of the file from the GPS unit.

Field UTM X

Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Field UTM Y

Use GPS; do not estimate. If you can't get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Error

Error is recorded from the GPS unit.

Plot Length and Plot Width

Enter width and length dimensions for square or rectangular plots. Choose the appropriate plot size based on the following:

Vegetation Class	Standard Plot Dimensions	PLOT AREA
Forest	20 m x 20 m	400 m ²
Woodland	20 m x 20 m	400 m ²
Shrubland	20 m x 20 m	400 m ²
Dwarf-shrubland (heath)	10 m x 10 m	100 m ²
Herbaceous	10 m x 10 m	100 m ²
Nonvascular	5 m x 5 m	25 m ²

Photo numbers

If photos of the plot have been taken at the time of sampling, indicate their numbers from the ones the camera assigns.

Plot Permanent

Note if the plot has been permanently marked.

Plot Representativeness

Does this plot represent the full variability of the polygon? If not, were additional plots taken?

Note: we distinguish in this section the plot's ability to represent the stand or polygon you are sampling as one component and the ability of this sample to represent the range of variability of the association in the entire mapping area. The former comment may be ascertained by reconnaissance of the stand. The latter comment comes only after some familiarity with the vegetation type throughout the mapping area and may be left blank if you have no opinion at this time.

ENVIRONMENTAL DESCRIPTION

Elevation

Elevation of the plot obtained from the GPS

Slope

Measure the slope in percent using a clinometer.

Aspect

Measure the aspect using a compass (be sure compass is set to correct for the magnetic declination).

Topographic Position

Choose one:

INTERFLUVE (crest, summit, ridge). Linear top of ridge, hill, or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways.

SHOULDER (shoulder slope, upper slope, convex creep slope).
Geomorphic component that forms the uppermost inclined surface at the top of a slope. Includes the transition zone from backslope to summit. Surface is dominantly convex in profile and erosional in origin.

BACKSLOPE. Subset of midslopes that are steep, linear and may include cliff segments (fall faces).

FOOTSLOPE (lower slope, foot slope, colluvial footslope). Inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between backslope and toeslope.

TOESLOPE (alluvial toeslope). Outermost gently inclined surface at base of a slope. In profile, commonly gentle and linear and characterized by alluvial deposition.

TERRACE Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL (narrow valley bottom, gully, arroyo). Bed of single or braided watercourses commonly barren of vegetation and formed of modern alluvium.

BASIN FLOOR (depression). Nearly level to gently sloping, bottom surface of a basin.

Describe Topographic Position (Optional)
Give more details here, if needed.

Cowardin System

Indicate “upland” if the system is not a wetland. If the system is a wetland, check off the name of the USFWS system which best describes its hydrology and landform.

- Riverine: Below the high water mark on a moving water system (a creek bed). A community of *Eleocharis* on a sand bar would be in this category.
- Palustrine: In the riparian zone. Plants regularly have wet roots through much of the summer. A community of willows and sedges would be in this category.
- Lacustrine: Below the high water mark of a lake. The marshy debris on the edge of a lake would be in this category.

Assess the hydrologic regime of the plot using the descriptions below (adapted from Cowardin et al. 1979).

PERMANENTLY FLOODED - Water covers the land surface at all times of the year in all years. Equivalent to Cowardin's "permanently flooded."

SEMI-PERMANENTLY FLOODED - Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.

SEASONALLY FLOODED - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases and is very variable, extending from saturated to a water table well below the ground surface. Includes Cowardin's Seasonal, Seasonal-Saturated, and Seasonal-Well Drained modifiers.

SATURATED - Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. Equivalent to Cowardin's Saturated modifier.

TEMPORARILY FLOODED - Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes floodplain wetlands. Equivalent to Cowardin's Temporary modifier.

INTERMITTENTLY FLOODED - Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rain storms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes, but can be used in other parts of the U.S. where appropriate. This modifier can be applied to both wetland and non-wetland situations. Equivalent to Cowardin's Intermittently Flooded modifier.

UNKNOWN - The water regime of the area is not known. The unit is simply described as a non-tidal wetland.

Unvegetated Surface

Estimate the approximate percentage of the *total* surface area covered by each category.

Soil Texture

Using the key below, assess average soil texture.

Simplified Key to Soil Texture

Soil does not remain in a ball when squeezed.....sand
Soil remains in a ball when squeezed.....2

Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you can push up over your finger.

- 2. Soil makes no ribbon.....loamy sand
- 2. Soil makes a ribbon (may be very short).....3

- 3. Ribbon extends less than 1 inch before breaking.....4

Add excess water to small amount of soil:

- 4. Soil feels smooth.....silt loam
- 4. Soil feels at least slightly gritty.....5

Squeeze a moistened ball:

- 5. Cast is formed which can be handled CAREFULLY without breaking..... sandy loam
- 5. Cast is formed which can be handled FREELY without breaking.....loam

- 3. Ribbon extends 1 inch or more before breaking.....6

- 5. Soil makes a ribbon that breaks when 1 to 2 inches long;
cracks if bent into a ring.....7

Add excess water to small amount of soil:

- 7. Soil feels at least slightly gritty.....clay loam
- 7. Soil feels smooth.....silt

- 6. Soil makes a ribbon 2+ inches long;
does NOT crack when bent into a ring..... 8

Add excess water to a small amount of soil:

- 8. Soil feels at least slightly gritty.....clay
- 8. Soil feels smooth.....silty clay

HANDBOOK ON SOILS

In the field, soil texture is determined by the feel of a moist soil when it is rubbed between the thumb and fingers. While sand particles feel gritty, silt particles have a smooth velvety feel and clay is both sticky and plastic, an estimate of the relative proportions of the separates may be made. This procedure, of course, will not give the exact percentage of sand, silt, and clay, but, with a little practice on samples of known composition, the relative proportions of the individual separates can be closely estimated. Practice with known samples is the only way to acquire this knowledge.

The outstanding physical characteristics of the main textural grades as determined by the feel of the soil are described below.

1. Sandy Soil. A sandy soil is loose and single grained. The individual grains can be seen readily or felt. Squeezed in the hand when dry, it will fall apart when pressure is released. Squeezed when moist, it will form a cast, but will crumble when touched.
2. Sandy Loam Soil. A sandy loam soil contains much sand, but has enough silt and clay to make it somewhat coherent. Individual sand grains can be easily seen and felt. Squeezed when dry, it will form a cast which will readily fall apart; but if squeezed when moist a cast can be formed which will bear careful handling without breaking.
3. Loam Soil. A loam soil is about an equal mixture of the sand and silt with the clay content being between 7 and 27 percent. A loam is mellow with a somewhat sandy feel, yet fairly smooth and slightly plastic. Squeezed when moist, it will form a cast which can be handled freely without breaking.
4. Silt Loam Soil. A silt loam soil, when dry, may appear cloddy, but lumps are readily broken, and when pulverized, it feels soft and floury. When wet, the soil readily runs together. Either dry or moist, it will form casts which can be handled freely without breaking, but when moistened and extruded between the thumb and fingers, it will not form a ribbon, but will give a broken appearance.
5. Clay Loam Soil. A clay loam soil is fine-textured and usually breaks into clods or lumps that are hard when dry. When moist and extruded between the thumb and fingers, it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand, it does not crumble readily, but tends to work into a heavy, compact mass.
6. Clay Soil. A clay soil is fine-textured and usually forms very hard lumps or clods when dry and is plastic and sticky when wet. When the moist soil is ribboned out between the thumb and fingers, it will form a long flexible strip. A clay soil leaves a "slick" surface on the thumb and fingers when rubbed together and tends to hold the thumb and fingers together due to the stickiness of the clay.

The characteristics described above are suggestive only, and will only apply to a group of similar soils. The characteristics of clay vary with the kind of clay mineral. For this reason, textural grades may exhibit different properties from region to region. For instance, clays of the montmorillonite group are very sticky and plastic; those of the oxide group are plastic and waxy with relatively little stickiness.

The preceding discussion has been directed to those soil particles whose diameters are less than 2 millimeters--the sands, silts, and clays. Soils may also contain larger sized particles that may be collectively called coarse fragments. These large particles may on occasion exceed the smaller soil particles in volume.

Soil Drainage

The soil drainage classes are defined in terms of (1) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

WELL DRAINED - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.

MODERATELY WELL DRAINED - The soil moisture content is in excess of field capacity for a small but significant period of the year.

POORLY DRAINED - The soil moisture content is in excess of field capacity in all horizons for a large part of the year.

VEGETATION DESCRIPTION

Leaf Phenology

Select the value which best describes the leaf phenology of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

EVERGREEN - Greater than 75% of the total woody cover is never without green foliage.

COLD DECIDUOUS - Greater than 75% of the total woody cover sheds its foliage in connection with an unfavorable season mainly characterized by winter frost.

MIXED: EVERGREEN & COLD DECIDUOUS - Evergreen and deciduous species generally contribute 25-75% of the total woody cover. Evergreen and cold-deciduous species are mixed.

PERENNIAL - Herbaceous vegetation composed of more than 50% perennial species.

ANNUAL - Herbaceous vegetation composed of more than 50% annual species.

Leaf Type

Select the value which best describes the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

BROAD-LEAVED - Woody vegetation primarily broad-leaved (generally contributes greater than 50 percent of the total woody cover).

NEEDLE-LEAVED - Woody vegetation primarily needle-leaved (generally contributes greater than 50 percent cover).

GRAMINOID - Herbaceous vegetation composed of more than 50 percent graminoid/stipe leaf species.

FORB (BROAD-LEAF-HERBACEOUS) - Herbaceous vegetation composed of more than 50% broad-leaf forb species.

PTERIDOPHYTE - Herbaceous vegetation composed of more than 50 percent species with frond or frond-like leaves. (Ferns)

Physiognomic Class

Choose one:

Forest: Trees with their crowns overlapping (generally forming 60-100% cover).

Woodland: Open stands of trees with crowns not usually touching (generally forming 25-60% cover). Canopy tree cover may be less than 25% in cases where it exceeds shrub, dwarf-shrub, herb, and nonvascular cover.

Shrubland: Shrubs generally greater than 2.5 feet tall with individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover.

Dwarf-Shrubland: Low-growing shrubs usually under 2.5 feet tall. Individuals or clumps overlapping to not touching (generally forming more than 25% cover, trees and tall shrubs generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover.

Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover.

Nonvascular: Nonvascular cover (bryophytes, non-crustose lichens, and algae) dominant (generally forming at least 25% cover). Nonvascular cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and herb cover.

Sparse Vegetation: Abiotic substrate features dominant. Vegetation is scattered to nearly absent and generally restricted to areas of concentrated resources (total vegetation cover is typically less than 25% and greater than 0%).

Strata, Height Class, Cover Class, Diagnostic Species

Visually divide the community into vegetation layers (strata). Indicate the average height class of the stratum in the first column, using the Height Scale on the form. Enter the average percent cover class of the whole stratum in the second column, using the Cover Scale on the form. Height and Cover classes are also listed below.

Trees are defined as single-stemmed woody plants, generally 15 feet in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 15 feet in height at maturity and under optimal growing conditions.

List the dominant species in each stratum.

Animal Use Evidence

Comment on any evidence of wildlife (i.e., tracks, scat, gopher or prairie dog mounds, etc.). Notes on domestic animals should be made in the field below.

Natural and Anthropogenic Disturbance

Comment on any evidence of natural or anthropogenic disturbance and specify the source.

Environmental Comments

Enter any additional noteworthy comments on the environmental setting. This field can be used to describe site history such as fire events (date since last fire or evidence of severity) as well as other disturbance or reproduction factors

Other Comments

Any miscellaneous comments.

Species/Strata/Percent Cover Table

The main use of the strata information is to categorize the plots by life form, in order to subset the data into forest, woodland, shrublands, and herbaceous plots for analysis. It is imperative that things be called the same throughout the data set.

Starting with the uppermost stratum, list all the species present and their cover class using the scale provided below. If a species is in the tree layer (single-stemmed woody plants, generally 15 feet in height or greater at maturity), list whether it is T1 (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If a species is in the shrub layer, note if S1 (tall shrub), or S2 (short shrub), or S3 (dwarf shrub). If in the ground layer, note if H (herbaceous) or N (nonvascular). Some species will be in more than one layer. For example, Cottonwoods might have one or two especially tall specimens, which would be in the T1 (emergent tree) layer. Then the majority of the mature trees would be in T2 (tree canopy). The saplings that are coming up in the understory would be in the T3.

Seedlings are defined as trees less than “breast height” or less than 4.5 feet tall. Seedlings between knee height and breast height should be labeled as being in the short shrub layer (S2), and those below knee height should be labeled as being in the dwarf shrub layer (S3).

Cover Scale for Species Percent Cover

Use the cover scales provided on the forms.

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM

IDENTIFIERS/LOCATORS

Plot Code _____	Polygon Code _____
Provisional Community Name _____	
State ____ Park Name _____	Park Site Name _____
Quad Name _____	Quad Code _____
GPS file name _____	Field UTMX _____ m E Field UTM Y _____ m N
Error +/- _____ m	
<i>please do not complete the following information when in the field</i>	
Corrected UTMX _____ m E	Corrected UTM Y _____ m N UTM Zone _____
Survey Date _____	Surveyors _____
Directions to Plot _____	
Plot length _____	Plot width _____ Plot Photos (y/n) ____ Roll Number _____ Frame Number _____ Plot Permanent (y/n) ____
Plot representativeness _____	

ENVIRONMENTAL DESCRIPTION

Elevation _____	Slope _____	Aspect _____
Topographic Position _____		
Landform _____		
Surficial Geology _____		

Cowardin System	<u>Non-Tidal</u>	
____ Upland	____ Permanently Flooded	____ Saturated
____ Riverine	____ Semipermanently Flooded	____ Seasonally Flooded/Saturated
____ Palustrine	____ Seasonally/Temporarily Flooded	____ Intermittently Flooded
____ Lacustrine		

Environmental Comments:	Soil Taxon/Description
	Unvegetated Surface: <i>(please use the cover scale on next page)</i> ____ Bedrock ____ Litter, duff ____ Wood (> 1 cm) ____ Large rocks (cobbles, boulders > 10 cm) ____ Small rocks (gravel, 0.2-10 cm) ____ Sand (0.1-2 mm) ____ Bare soil ____ Other: _____
Soil Texture ____ sand ____ loamy sand ____ sandy loam ____ loam ____ silt loam ____ silt ____ clay loam ____ silty clay ____ clay ____ peat ____ muck	Soil Drainage ____ Rapidly drained ____ Well drained ____ Moderately well drained ____ Somewhat poorly drained ____ Poorly drained ____ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface		Height Scale for Strata	
<u>Trees and Shrubs</u>	Broad-leaved	Forest				
Evergreen	Needle-leaved	Woodland	01	5%	01	<0.5 m
Cold-deciduous	Microphyllous	Shrubland	02	10%	02	0.5-1m
Drought-deciduous	Graminoid	Dwarf Shrubland	03	20%	03	1-2 m
Mixed evergreen - cold-deciduous	Forb	Herbaceous	04	30%	04	2-5 m
Mixed evergreen - drought-deciduous	Pteridophyte	Nonvascular	05	40%	05	5-10 m
		Sparsely Vegetated	06	50%	06	10-15 m
			07	60%	07	15-20 m
			08	70%	08	20-35 m
			09	80%	09	35 - 50 m
			10	90%	10	>50 m
			11	100%		
<u>Herbs</u>						
Annual						
Perennial						

Strata	Height Class	Cover Class	Diagnostic species (if known)
T1 Emergent			
T2 Canopy			
T3 Sub-canopy			
S1 Tall shrub			
S2 Short Shrub			
H Herbaceous			
N Non-vascular			
V Vine/liana			
E Epiphyte			
<i>please see above table for height and cover scales</i>			
Animal Use Evidence			
Natural and Anthropogenic Disturbance Comments			
Other Comments			

Species/percent cover: Starting with the uppermost stratum, list all species with % cover for each species in the stratum. For each tree species estimate seedling, sapling, mature and total cover indicating stratum. Also for forests and woodlands, on a separate page or line below each tree species, list the DBH of all trees above 5 cm diameter. Separate measurements with a comma (note if measurements are from multi-stemmed tree). Put an asterisk next to any species that are known diagnostics for a particular community in the classification. Also list species outside the plot at the end of the table or designate with a 0 in Cover Class column.

Cover Class Scale	
T = >0-1%	5 = >45-55%
P = >1-5%	6 = >55-65%
1 = >5-15%	7 = >65-75%
2 = >15-25%	8 = >75-85%
3 = >25-35%	9 = >85-95%
4 = >35-45%	10 = >95%

IDENTIFIERS/LOCATORS

PLANT ASSOCIATION INFORMATION

ENVIRONMENTAL DESCRIPTION

Unvegetated Surface Cover+: *(please use the cover scale below)*86

2009 ACCURACY ASSESSMENT POINT FORM – JOHN DAY FOSSIL BEDS NATIONAL MONUMENT
UPPER COLUMBIA BASIN NETWORK VEGETATION MAPPING PROJECT

VEGETATION DESCRIPTION

Leaf phenology (dominant stratum)	Leaf Type (of dominant stratum)	Physognomic Class	Height Class (m)	Cover Class
<u>Trees and Shrubs</u>		<u>Pick one</u>	T < 1ft.	t < 0.5%
_____ Evergreen	_____ Broad-leaved	_____ Forest	01 1-5ft.	T 0.5- 0.99%
_____ Deciduous	_____ Needle-leaved	_____ Woodland	05 5-15ft.	01 1-1.9%
_____ Mixed evergreen - deciduous	_____ Graminoid	_____ Shrubland	15 15-30ft.	02 2-4.9%
	_____ Forb		30 >30FT	05 5-9.9%
<u>Herbs</u>	_____ Pteridophyte	_____ Dwarf shrubland		10 10-14%
_____ Perennial		_____ Herbaceous		15 15-24%
_____ Annual	_____ Non Vascular	_____ Nonvascular		25 25-34%
	_____ Mixed	_____ Sparsely vegetated		35 35-49%
				50 50-74%
				75 75-94%
				95 >95%

Strata	Height Class	Cover Class	2 - Dominant species (mark any known diagnostic species with a *)	Individual Species Cover
T1 Emergent	_____	_____	_____	_____
T2 Canopy	_____	_____	_____	_____
			_____	_____
			_____	_____
T3 Sub-canopy	_____	_____	_____	_____
			_____	_____
S1 Tall shrub	_____	_____	_____	_____
			_____	_____
			_____	_____
S2 Short Shrub	_____	_____	_____	_____
			_____	_____
			_____	_____
S3 Dwarf-shrub	_____	_____	_____	_____
			_____	_____
H Herbaceous	_____	_____	_____	_____
			_____	_____
			_____	_____
N Non-vascular	_____	_____	_____	_____

☐ Please check this box if AA point has more than one plant association (e.g. two or more species list at a point recorded on form)

Appendix C – Dichotomous Key to JODA Plant Associations

KEY TO PLANT ASSOCIATIONS OF THE JOHN DAY FOSSIL BEDS NATIONAL MONUMENT, CLARNO UNIT

Instructions:

1. Select a relatively uniform area of vegetation and topography to key out. A representative 1/10 acre plot is a simple way to examine a stand, just be sure the plot represents the stand of interest.
2. “Present” means the species is typically found on a representative plot, i.e. it regularly occurs in the stand.
3. If the stand or plot meets the criteria in a line, then read to the right or (if blank) to the next indented line down. If the stand or plot does not meet the criteria, then go to the next line down that is not indented from the current line.
4. Some associations key to multiple different lines. For associations that may be distinguished by any one of a number of different characteristics, the criteria are broken into multiple lines so as to avoid excessive and confusing use of “and” and “or” statements. Just go to the next line down if the criteria are not met.
5. Percentage values refer to crown cover, that is the vertical projection below the entire crown of the plant. Do not subtract for spaces between leaves and branches. Total cover requires adding the crown cover of each of the species, e.g. 7+22 = 29%. Overlap between the species gets counted twice. One species may be absent.
6. The key is not the classification. After you have keyed out a stand, always read the association description of vegetation composition, geographic distribution, and physical environment. If it sounds like it fits in most regards, you have made a correct identification. If there are multiple inconsistencies between the stand and the description, the key probably was incorrect. In this case, you probably need to try the key again and follow slightly different leads or identify the stand by reading the descriptions. There are also many undescribed communities in the area and the key does not deal with non-forested wetlands or riparian communities for the most part, so the vegetation you are looking at may be an undescribed type.

KEY TO PHYSIOGNOMIC CATEGORIES: (page numbers refer to vegetation types key)

- Trees > 25%. Trees are woody plants > 10 meters tall **Key to Forest and Woodland Types p. 1**
- Shrubs > 15% **Key to Shrubland Types p. 2**
- Herbaceous Vegetation > 10% **Key to Herbaceous Vegetation Types p. 3**
- Herbaceous Vegetation < 10% **Key to Barren Vegetation Types p. 4**

KEY TO FOREST AND WOODLAND TYPES (page numbers refer to description document)

- 1a. Deciduous trees (or tall shrubs) dominant forest or woodland species 2
- 2a. Riparian forest, woodland or tall shrubland 3
- 3a. Riparian forest with significant cottonwood cover (*Populus balsamifera* ssp. *trichocarpa* > 10%)
..... ***Populus balsamifera* ssp. *trichocarpa* Forest and Woodland Alliance, 4**

4a. <i>Alnus incana</i> dominant shrub, > 5%.....	POPBAL / ALNINC, p. 12
4b. <i>Salix exigua</i> dominant shrub, > 5%.....	POPBAL / SALEXI, p. 13
3b. Not as above, <i>Prunus virginiana</i> dominant tree or shrub > 10%, riparian or moist canyon slope.....	<i>Prunus virginiana</i> Forest Alliance, PRUVIR – (PRUAME), p. 52
2b. Canyon toe-slope, or riparian margin edge with <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%.....	<i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22
1b. Conifer trees (western juniper or <i>Juniperus occidentalis</i>) > 10% the dominant forest or woodland species	<i>Juniperus occidentalis</i> Woodland Alliance, 5
5a. Shrubs (<i>Artemisia tridentata</i> , <i>Artemisia rigida</i> or <i>Purshia tridentata</i>) > 2%.....	
6a. <i>Artemisia tridentata</i> the dominant shrub > 2%, JUNOCC / ARTTRIW woodland steppe community	JUNOCC / ARTTRIW / PSESPI, p. 20
6b. Either <i>Artemisia rigida</i> or <i>Purshia</i> dominant or codominant.....	7
7a. <i>Purshia tridentata</i> > 5%, dominant or usually with <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> , ash or stony areas, but not a scabland.....	JUNOCC / ARTTRIW - PURTRI, p. 18
7b. Scabland, <i>Artemisia rigida</i> dominant shrub, > 5%	JUNOCC / ARTRIG / PSESPI, p. 17
5b. Shrub cover < 2%, JUNOCC savanna associations	8
8a. Moist site, usually north slopes, <i>Festuca idahoensis</i> > 10%.....	JUNOCC / FESIDA, p. 98
8b. Not as above, <i>Pseudoroegneria</i> usually > 5%	9
9a. Ash habitats, extensive exposed soil, <i>Achnatherum thurberianum</i> > 5%	JUNOCC / ACHTHU, p. 97
9b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	JUNOCC / PSESPI, p. 100

KEY TO SHRUBLAND TYPES (page numbers refer to description document)

1a. Big sagebrush (<i>Artemisia tridentata</i>) dominant shrub > 5%, shrubland or shrub steppe	
2a. <i>Artemisia tridentata</i> only dominant shrub > 5% (excluding rabbitbrush or snakebrush species)	
3a. Bunchgrasses comprise most vegetation cover, always with higher cover than sagebrush	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrub Steppe Alliance, 4
4a. Moist sites, <i>Festuca idahoensis</i> > 5%, <i>Pseudoroegneria spicata</i> often present	ARTTRIW / FESIDA, p. 108
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	5
5a. Giant bunchgrass important in understory, <i>Leymus cinereus</i> > 5%	ARTTRIW / LEYCIN, p. 26
5b. Not as above, <i>Leymus cinereus</i> < 5%	6

6a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ARTTRIW / ACHTHU - PSESPI, p. 107
6b. Not as above, <i>Achnatherum thurberianum</i> < 5%	ARTTRIW / PSESPI, p. 109
3b. Not as above, either sagebrush, annuals, or <i>poa secunda</i> comprise most cover	 <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Alliance , ARTTRIW / POASEC, p. 33
2b. Big sagebrush (<i>Artemisia tridentata</i>) codominant with other shrubs (PURTRI, ATRCON, SARVER)	7
7a. Mixed sagebrush – bitterbrush shrubland, <i>Artemisia tridentata</i> codominant shrub, > 5% with <i>Purshia tridentata</i> > 2%	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Purshia tridentata</i> Shrub Alliance ARTTRIW - PURTRI / PSESPI, p. 32
7b. <i>Artemisia tridentata</i> codominant with either <i>Atriplex confertifolia</i> or <i>Sarcobatus vermiculatus</i> > 2%	 <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Sarcobatus vermiculatus</i> Steppe Alliance , ARTTRI - ATRCON – SARVER, p. 30
1b. <i>Artemisia tridentata</i> not dominant or codominant	8
8a. Salt desert, alkaline or ash shrublands	9
9a. <i>Atriplex confertifolia</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%	 <i>Atriplex confertifolia</i> Shrubland Alliance , 10
10a. <i>Pseudoroegneria spicata</i> > 5%	ATRCON / PSESPI, p. 48
10b. <i>Poa secunda</i> , <i>Sporobolus cryptandrus</i> , or <i>Elymus elymoides</i> > 5%; <i>Pseudoroegneria spicata</i> absent	ATRCON / ELYELY, p. 46
9b. Not as above, either <i>Sarcobatus vermiculatus</i> or <i>Tetradymia canescens</i> important	11
11a. <i>Sarcobatus vermiculatus</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%	 <i>Sarcobatus vermiculatus</i> Shrubland Alliance , SARVER / LEYCIN, p. 70
11b. <i>Tetradymia canescens</i> dominant shrub, > 5% cover	 <i>Tetradymia canescens</i> Shrubland Alliance , TETCAN / POASEC, p. 43
8b. Rocky, shallow soiled, or steep canyon shrubland	12
12a. Canyons and steep slopes <i>Salvia dorrii</i> dominant shrub, > 10% cover, ...	 <i>Salvia dorrii</i> Shrubland Alliance , SالدOR / PSESPI, p. 75
12b. Not as above, generally on flats or gentle slopes	13
13a. <i>Artemisia rigida</i> dominant shrub, > 5%, scabland	<i>Artemisia rigida</i> Shrubland Alliance ARTRIG / PSESPI, p. 115
13b. <i>Gutierrezia sarathae</i> > 10 %, weedy	<i>Gutierrezia sarathae</i> Semi-Natural Alliance , 15
14a. <i>Gutierrezia sarathae</i> and <i>Taeniatherum caput-medusae</i> codominant	GUTSAR / TAECAP, p. 74
14b. <i>Gutierrezia sarathae</i> and <i>Bromus tectorum</i> codominant	GUTSAR / BROTEC, p. 73

KEY TO GRASS OR GRAMINOID DOMINATED TYPES: (page numbers refer to description document)

Vegetation cover > 10%, shrub < 5%, except for *Chrysothamnus viscidiflorus*

1a. Upland grasslands	2
2a. Native bunchgrass dominated communities.....	3
3a. <i>Sporobolus cryptandrus</i> dominant > 5% cover	
..... <i>Sporobolus cryptandrus</i> Herbaceous Alliance, SPICRY - POASEC, p. 85	
3b. <i>Pseudoroegneria spicata</i> dominant or codominant	<i>Pseudoroegneria spicata</i> Herbaceous Alliance, 4
4a. <i>Festuca idahoensis</i> codominant with <i>Pseudoroegneria spicata</i> , both > 5% cover and dominant.....	
..... PSESPI – FESIDA CANYON, p. 81	
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	
5a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ACHTHU - PSESPI, p. 82
5b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	PSESPI - BALSAG - POASEC, p. 79
2b. Exotic annual grass dominant (shrubs including some sagebrush, snakeweed or rabbitbrush can be present) .	6
6a. Dominant grasses non-native annual grasses (cheatgrass or medusahead)	7
7a. <i>Taeniatherum caput-medusae</i> > 20%, shrubs less than 10%, <i>Bromus tectorum</i> not codominant	
..... <i>Taeniatherum caput-medusae</i> Exotic Grassland	
7b. <i>Bromus tectorum</i> > 20%, dominant or co-dominant species	8
8a. <i>Bromus tectorum</i> and <i>Taeniatherum caput-medusae</i> codominant, each over 10%	
..... <i>Bromus tectorum</i> – <i>Taeniatherum caput-medusae</i> Exotic Grassland	
8b. <i>Bromus tectorum</i> > 20%, primary dominant	<i>Bromus tectorum</i> Exotic Grassland
1b. Wetlands	
8a Tall graminoid-dominated wetlands in riparian areas, with <i>Typha</i> species.....	
..... <i>Typha latifolia</i> Herbaceous Alliance, TYPLAT, p. 90	
8b. Not as above, spring or wetland community.....	springs and seeps

KEY TO BARREN TYPES: (page numbers refer to description document)

Vegetation cover < 10%

1a. Herbaceous dominated ash bed or painted hill	2
2a. <i>Helianthus nuttallii</i> > 50% of total cover.....	HELNUT Ash Bed, p. 120
2b. <i>Cleome platycarpa</i> > 50% of total cover	CLEPLA Ash Bed, p. 120
1b. Shrub dominated ash bed or painted hill.....	3
3a. <i>Atriplex confertifolia</i> or salt desert shrubs dominant	ARTCON Sparse, p. 47
3b. Not as above	4

- 4a. *Purshia tridentata* and *Achnatherum thurberianum* dominant **PURTRI Ash Bed, p. 120**
- 4b. *Ericameria nauseosa* dominant **ERINAU Sparse, p. 120**

KEY TO PLANT ASSOCIATIONS OF THE JOHN DAY FOSSIL BEDS NATIONAL MONUMENT, PAINTED HILLS UNIT

Instructions:

1. Select a relatively uniform area of vegetation and topography to key out. A representative 1/10 acre plot is a simple way to examine a stand, just be sure the plot represents the stand of interest.
2. "Present" means the species is typically found on a representative plot, i.e. it regularly occurs in the stand.
3. If the stand or plot meets the criteria in a line, then read to the right or (if blank) to the next indented line down. If the stand or plot does not meet the criteria, then go to the next line down that is not indented from the current line.
4. Some associations key to multiple different lines. For associations that may be distinguished by any one of a number of different characteristics, the criteria are broken into multiple lines so as to avoid excessive and confusing use of "and" and "or" statements. Just go to the next line down if the criteria are not met.
5. Percentage values refer to crown cover, that is the vertical projection below the entire crown of the plant. Do not subtract for spaces between leaves and branches. Total cover requires adding the crown cover of each of the species, e.g. 7+22 = 29%. Overlap between the species gets counted twice. One species may be absent.
6. The key is not the classification. After you have keyed out a stand, always read the association description of vegetation composition, geographic distribution, and physical environment. If it sounds like it fits in most regards, you have made a correct identification. If there are multiple inconsistencies between the stand and the description, the key probably was incorrect. In this case, you probably need to try the key again and follow slightly different leads or identify the stand by reading the descriptions. There are also many undescribed communities in the area and the key does not deal with non-forested wetlands or riparian communities for the most part, so the vegetation you are looking at may be an undescribed type.

KEY TO PHYSIOGNOMIC CATEGORIES: (page numbers refer to vegetation types key)

Trees > 25%. Trees are woody plants > 10 meters tall; or shrub dominated riparian community		Key to Forest and Woodland Types p. 1
Shrubs > 15%		Key to Shrubland Types p. 2
Herbaceous Vegetation > 10%		Key to Herbaceous Vegetation Types p. 4
Herbaceous Vegetation < 10%		Key to Sparse Vegetation Types p. 5

KEY TO FOREST AND WOODLAND AND RIPARIAN SHRUBLAND TYPES (page numbers refer to description document)

- 1a. Deciduous trees (or tall shrubs) dominant forest or woodland species
 - 2a. Riparian forest with significant cottonwood cover (*Populus balsamifera* ssp. *trichocarpa* > 10%)
Populus balsamifera ssp. *trichocarpa* Forest and Woodland Alliance, POPBAL / SALEXI, p. 13
 - 2b. *Populus balsamifera* ssp. *trichocarpa* minor component, riparian shrublands..... 3

3a. <i>Salix exigua</i> important, >5% cover	<i>Salix exigua</i> Shrubland Alliance, 4
4a. <i>Salix exigua</i> and <i>Rosa woodsii</i> dominant shrubs, each > 5%	SALEXI – ROSWOO, p. 63
4b. <i>Rosa woodsii</i> not important, graminoids, including <i>Eleocharis palustris</i> , <i>Schoenoplectus americanus</i> or <i>Phalaris arundinacea</i> usually dominant in understory	SALEXI / ELEPAL – SCHAME, p. 1
3b. Not as above.....	4
5a. <i>Rosa woodsii</i> dominant shrub > 10%, <i>Sambucus cerulea</i> or <i>Symphoricarpos</i> sp. often present.....	<i>Rosa woodsii</i> Shrubland Alliance, ROSWOO, p. 55
5b. Not as above, <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%, riparian or moist canyon slope.....	<i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22
1b. Conifer trees (western juniper or <i>Juniperus occidentalis</i>) > 10%, the dominant forest or woodland species, ...	5
6a. Understory shrubs (<i>Artemisia tridentata</i> , <i>Artemisia rigida</i> , or <i>Purshia tridentata</i>) > 2%	<i>Juniperus occidentalis</i> Woodland Alliance, 7
7a. <i>Artemisia tridentata</i> the dominant shrub, > 2%, <i>Pseudoroegneria spicata</i> > 5% or dominant grass.....	JUNOCC / ARTTRIW / PSESPI, p. 20
7b. Not as above, <i>Artemisia rigida</i> dominant or <i>Purshia tridentata</i> codominant	8
8a. Scabland, <i>Artemisia rigida</i> dominant shrub, > 5%.....	JUNOCC / ARTRIG / PSESPI, p. 17
8b. Not as above, <i>Purshia tridentata</i> > 5 %	JUNOCC / ARTTRIW - PURTRI, p. 18
6b. Shrub cover < 2%, ...	<i>Juniperus occidentalis</i> Herbaceous Alliance, 9
9a. Ash or pumice habitats, <i>Achnatherum thurberianum</i> > 5% or the dominant grass	JUNOCC / ACHTHU, p. 97
9b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	JUNOCC / PSESPI, p. 100

KEY TO SHRUBLAND TYPES (page numbers refer to description document)

1a. Big sagebrush (<i>Artemisia tridentata</i>) dominant shrub > 5%, shrubland or shrub steppe	
2a. <i>Artemisia tridentata</i> only dominant shrub > 5% (excluding rabbitbrush or snakebrush species)	
3a. Bunchgrasses comprise most vegetation cover, always with higher cover than sagebrush	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrub Steppe Alliance, p. 1, 4
4a. Moist sites, <i>Festuca idahoensis</i> > 5%, <i>Pseudoroegneria spicata</i> often present	ARTTRIW / FESIDA, p. 108
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	5
6a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ARTTRIW / ACHTHU - PSESPI, p. 107

6b. Not as above, <i>Achnatherum thurberianum</i> < 5%	ARTTRIW / PSESPI, p. 109
3b. Not as above, either sagebrush or annuals (<i>Bromus tectorum</i>) comprise most cover	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Alliance, 7
7a. <i>Pseudoroegneria spicata</i> < 5%, <i>Poa secunda</i> > 5%.....	ARTTRIW / POASEC, p. 33
7b. <i>Bromus tectorum</i> > 25%, dominant understory species	ARTTRIW / BROTEC, p. 36
2b. Big sagebrush (<i>Artemisia tridentata</i>) codominant, present with other shrubs (PURTRI, ATRCON, SARVER)	
7a. <i>Artemisia tridentata</i> codominant shrub, > 5% with <i>Purshia tridentata</i> > 2%.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> - <i>Purshia tridentata</i> Shrub Alliance, ARTTRIW - PURTRI / PSESPI, p. 32
7b. <i>Artemisia tridentata</i> codominant with either <i>Atriplex confertifolia</i> or <i>Sarcobatus vermiculatus</i> > 2%	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Sarcobatus vermiculatus</i> Steppe Alliance, ARTTRI - ATRCON – SARVER, p. 30
1b. <i>Artemisia tridentata</i> not dominant or codominant, < 3% cover.....	8
8a. Shrublands on salt desert, alkaline or ash habitats, exposed soil > 30%.....	9
9a. <i>Atriplex confertifolia</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%	<i>Atriplex confertifolia</i> Shrubland Alliance, 10
10a. Native understory, usually with ACHHYM, PSESPI, ELYELY, or POASEC.....	11
11a. <i>Pseudoroegneria spicata</i> > 5%	ATRCON / PSESPI, p. 48
11b. <i>Poa secunda</i> , <i>Sporobolus cryptandrus</i> , or <i>Elymus elymoides</i> > 5%, <i>Pseudoroegneria spicata</i> absent	ATRCON / ELYELY, p. 46
10b. Non-native understory dominants of exotic grasses (<i>Bromus tectorum</i> or <i>Poa bulbosa</i>)	ARTCON / BROTEC, p. 43
9b. Not as above, either <i>Sarcobatus vermiculatus</i> or <i>Tetradymia canescens</i> important	12
12a. <i>Sarcobatus vermiculatus</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%.....	<i>Sarcobatus vermiculatus</i> Shrubland Alliance, 13
13a. Giant bunchgrass, <i>Leymus cinereus</i> dominant grass, > 5%	SARVER / LEYCIN, p. 70
13b. Exotic grasses (usually <i>Poa bulbosa</i> or <i>Bromus tectorum</i>) dominant	SARVER / BROTEC, p. 71
12b. <i>Tetradymia canescens</i> dominant shrub, > 5% cover	<i>Tetradymia canescens</i> Shrubland Alliance, TETCAN / POASEC, p. 43
8b. Not as above, rocky, shallow soiled areas, steep canyons or weedy flats.....	14
14a. Rocky, shallow soiled areas dominated by <i>Artemisia arbuscula</i> , <i>Artemisia rigida</i> , or <i>Eriogonum strictum</i>	15

15a. <i>Artemisia arbuscula</i> dominant shrub, > 10%, tall bunchgrass understory	
..... <i>Artemisia arbuscula</i> Dwarf Shrubland Alliance, ARTARB / PSESPI, p. 103	
15b. Not as above, scablands with <i>Artemisia rigida</i> or <i>Eriogonum strictum</i> dominant shrub	16
16a. <i>Artemisia rigida</i> dominant shrub, > 5%, scabland.....	
..... <i>Artemisia rigida</i> Shrubland Alliance	
..... ARTRIG / PSESPI, p. 115	
16b. <i>Eriogonum strictum</i> dominant shrub, scabland with <i>Poa secunda</i> codominant	
..... <i>Poa secunda</i> Dwarf Shrub Herbaceous Alliance, ERISTR / POASEC, p. 117	
14b. Not as above, either canyon slopes or weedy flats.....	17
17a. Canyons and steep slopes <i>Salvia dorrii</i> dominant shrub, > 10% cover	
..... <i>Salvia dorrii</i> Shrubland Alliance, SALDOR / PSESPI, p. 76	
17b. Not as above, generally on flats or gentle slopes, usually weedy areas, semi-natural vegetation ...	18
19a. Rabbitbrush species dominant.....	
..... <i>Chrysothamnus viscidiflorus</i> Semi-Natural Shrubland Alliance, CHRVIS / BROTEC, p. 72	
19b. <i>Gutierrezia sarathae</i> > 10 %, weedy, and dominant shrub.....	
..... <i>Gutierrezia sarathae</i> Semi-Natural Shrubland Alliance, 20	
20a. Annual grasses (<i>Bromus tectorum</i>) dominant	GUTSAR / BROTEC, p. 73
20b. Perennial grass (<i>Poa bulbosa</i>) dominant in understory	GUTSAR / POABUL, p. 74

KEY TO GRASS AND FORB DOMINATED TYPES (page numbers refer to description document)

Vegetation cover > 10%

1a. Upland grasslands	2
2a. Native bunchgrass dominated communities.....	3
3a. <i>Sporobolus cryptandrus</i> dominant > 5% cover	
..... <i>Sporobolus cryptandrus</i> Herbaceous Alliance, SPICRY - POASEC, p. 85	
3b. <i>Pseudoroegneria spicata</i> dominant or codominant	<i>Pseudoroegneria spicata</i> Herbaceous Alliance, 4
4a. <i>Festuca idahoensis</i> codominant with <i>Pseudoroegneria spicata</i> , both > 5% cover and dominant.....	
..... PSESPI – FESIDA CANYON, p. 81	
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	
5a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ACHTHU - PSESPI, p. 82
5b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	PSESPI - BALSAG - POASEC, p. 79
2b. Exotic grass dominant (shrubs, including some sagebrush, snakeweed or rabbitbrush, can be present).....	6
6a. Dominant grasses non-native annual grasses (cheatgrass or medusahead)	7
7a. <i>Taeniatherum caput-medusae</i> > 20%, shrubs less than 10%, <i>Bromus tectorum</i> not codominant.....	
..... <i>Taeniatherum caput-medusae</i> Exotic Grassland	

7b. <i>Bromus tectorum</i> > 20%, dominant or co-dominant species	8
8a. <i>Bromus tectorum</i> and <i>Taeniatherum caput-medusae</i> codominant, each over 10%	
..... <i>Bromus tectorum</i> – <i>Taeniatherum caput-medusae</i> Exotic Grassland	
8b. <i>Bromus tectorum</i> > 20%, primary dominant	<i>Bromus tectorum</i> Exotic Grassland
6b. Dominant grasses non-native perennial grasses (bulbose bluegrass or intermediate wheatgrass)	9
9a. <i>Thinopyrum intermedium</i> (intermediate wheatgrass) > 20%, dominant	
..... <i>Thinopyrum intermedium</i> Exotic Grassland	
9b. <i>Poa bulbosa</i> > 20%, dominant	<i>Poa bulbosa</i> Exotic Grassland
1b. Tall graminoid-dominated wetlands in riparian areas, with <i>Typha</i> species	
..... <i>Typha latifolia</i> Herbaceous Alliance, TYPLAT, p. 92	

KEY TO BARREN TYPES: (page numbers refer to description document)

Vegetation cover < 10%

1a. Herbaceous dominated ash bed or painted hill	2
2a. <i>Helianthus nuttallii</i> > 50% of total cover	HELNUT Ash Bed, p. 120
2b. <i>Cleome platycarpa</i> > 50% of total cover	CLEPLA Ash Bed, p. 120
1b. Shrub dominated ash bed or painted hill	3
3a. <i>Atriplex confertifolia</i> or salt desert shrubs dominant	ARTCON Sparse, p. 47
3b. Not as above	4
4a. <i>Purshia tridentata</i> and <i>Achnatherum thurberianum</i> dominant	PURTRI Ash Bed, p. 120
4b. <i>Ericameria nauseosa</i> dominant	ERINAU Sparse, p. 120

KEY TO PLANT ASSOCIATIONS OF THE JOHN DAY FOSSIL BEDS NATIONAL MONUMENT, SHEEP ROCK UNIT – including Sheep Rock, Cathedral Rock, and Foree

Instructions:

1. Select a relatively uniform area of vegetation and topography to key out. A representative 1/10 acre plot is a simple way to examine a stand, just be sure the plot represents the stand of interest.
2. “Present” means the species is typically found on a representative plot, i.e. it regularly occurs in the stand.
3. If the stand or plot meets the criteria in a line, then read to the right or (if blank) to the next indented line down. If the stand or plot does not meet the criteria, then go to the next line down that is not indented from the current line.
4. Some associations key to multiple different lines. For associations that may be distinguished by any one of a number of different characteristics, the criteria are broken into multiple lines so as to avoid excessive and confusing use of “and” and “or” statements. Just go to the next number down if the criteria are not met.
5. Percentage values refer to crown cover, that is the vertical projection below the entire crown of the plant. Do not subtract for spaces between leaves and branches. Total cover requires adding the crown cover of each of the species, e.g. 7+22 = 29%. Overlap between the species gets counted twice. One species may be absent.
6. The key is not the classification. After you have keyed out a stand, always read the association description of vegetation composition, geographic distribution, and physical environment. If it sounds like it fits in most regards, you have made a correct identification. If there are multiple inconsistencies between the stand and the description, the key probably was incorrect. In this case, you probably need to try the key again and follow slightly different leads or identify the stand by reading the descriptions. There are also many undescribed communities in the area and the key does not deal with non-forested wetlands or riparian communities for the most part, so the vegetation you are looking at may be an undescribed type.

KEY TO PHYSIOGNOMIC CATEGORIES: (page numbers refer to vegetation types key)

Trees > 25%. Trees are woody plants > 10 meters tall	Key to Forest and Woodland Types p. 1
Shrubs > 15%	Key to Shrubland Types p. 3
Herbaceous Vegetation > 10%	Key to Herbaceous Vegetation Types p. 4
Herbaceous Vegetation < 10%	Key to Sparse Vegetation Types p. 5

KEY TO FOREST AND WOODLAND AND RIPARIAN SHRUBLAND TYPES (page numbers refer to description document)

1a. Deciduous trees (or tall shrubs) dominant forest or woodland species	2
2a. Riparian (streamside) forest, woodland and tall shrubland communities	3
3a. <i>Alnus rhombifolia</i> > 15%, dominant tree	<i>Alnus rhombifolia</i> Forest and Woodland Alliance, 4
4a. <i>Philadelphus lewisii</i> dominant shrub, > 5%	ALNRHO / PHILEW, p. 7

4b. Not as above, <i>Rosa</i> or other species more important in the understory.....	ALNRHO / ROSWOO, p. 9
3b. <i>Alnus rhombifolia</i> minor component.....	5
5a. <i>Populus balsamifera</i> ssp. <i>trichocarpa</i> > 10%, dominant tree.....	
<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> Forest and Woodland Alliance, POPBAL / SALEXI, p. 13	
5b. <i>Populus balsamifera</i> ssp. <i>trichocarpa</i> minor component.....	6
6a. <i>Salix exigua</i> important, >5% cover.....	<i>Salix exigua</i> Shrubland Alliance, 7
7a. <i>Salix exigua</i> dominant on relatively barren river gravels.....	
..... <i>Salix exigua</i> Dry Alluvial Bar Association, p. 60	
7b. Not as above, <i>Salix exigua</i> in largely vegetated riparian	8
8a. <i>Salix exigua</i> and <i>Rosa woodsii</i> dominant shrubs, each > 5%	
..... SALEXI – ROSWOO, p. 63	
8b. <i>Rosa woodsii</i> not important, graminoids, including <i>Eleocharis palustris</i> , <i>Schoenoplectus americanus</i> or <i>Phalaris arundinacea</i> usually dominant in understory	
..... SALEXI / ELEPAL – SCHAME, p. 63	
6b. Not as above	9
9a. <i>Rosa woodsii</i> important, >5% cover	10
10a. <i>Salix exigua</i> and <i>Rosa woodsii</i> dominant shrubs, each > 5%	
..... <i>Salix exigua</i> Shrubland Alliance, SALEXI – ROSWOO, p. 63	
10b. <i>Rosa woodsii</i> dominant shrub > 10%, <i>Sambucus cerulea</i> or <i>Symphoricarpos</i> sp. often present ...	
..... <i>Rosa woodsii</i> Shrubland Alliance, ROSWOO, p. 55	
9b. Not as above, <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%, riparian or moist canyon slope	
..... <i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22	
2b. Deciduous trees (or tall shrubs > 2 meters tall) dominant forest or woodland species, upland or canyon setting, not truly riparian	11
11a. <i>Cercocarpus ledifolius</i> > 10%, only tree or tall shrub present, non-riparian.....	
..... <i>Cercocarpus ledifolius</i> Shrubland Alliance, 12	
12a. <i>Artemisia tridentata</i> > 5%, main understory shrub.....	CERLED / ARTTRI, p. 38
12b. <i>Pseudoroegneria spicata</i> > 10%, limited sagebrush or shrubs.....	CERLED / PSESPI, p. 40
11b. Not as above, <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%, moist canyon slope	
..... <i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22	
1b. Conifer trees (western juniper or <i>Juniperus occidentalis</i>) > 10%, the dominant forest or woodland species, .	13
13a. <i>Cercocarpus ledifolius</i> > 5%, co-dominant with juniper.....	<i>Juniperus occidentalis</i> – <i>Cercocarpus ledifolius</i>
..... Woodland Alliance, JUNOCC / CERLED / PSESPI, p. 16	
13b. Not as above, no <i>Cercocarpus ledifolius</i> , <i>Juniperus occidentalis</i> only tree or tall shrub	14

14a. Shrubs (<i>Artemisia tridentata</i> , <i>Artemisia rigida</i> or <i>Purshia tridentata</i>) > 2%	<i>Juniperus occidentalis</i> Woodland Alliance, 15
15a. <i>Artemisia tridentata</i> the dominant shrub, > 2%	JUNOCC / ARTTRIW / PSESPI, p. 20
15b. <i>Artemisia rigida</i> dominant or <i>Purshia tridentata</i> codominant.....	16
16a. Scabland, <i>Artemisia rigida</i> dominant shrub, > 5%	JUNOCC / ARTRIG / PSESPI, p. 17
16b. Not as above, <i>Purshia tridentata</i> > 5 %	JUNOCC / ARTTRIW - PURTRI, p. 18
14b. Shrub cover < 2%, ...	<i>Juniperus occidentalis</i> Herbaceous Alliance, 17
17a. Moist site, <i>Festuca idahoensis</i> > 5%, codominant or dominant	JUNOCC / FESIDA, p. 98
17a. Not as above, <i>Festuca idahoensis</i> minor	18
18a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	JUNOCC / ACHTHU, p. 97
18b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	JUNOCC / PSESPI, p. 100
KEY TO SHRUBLAND TYPES (page numbers refer to description document)	
1a. Big sagebrush (<i>Artemisia tridentata</i>) dominant shrub > 5%, shrubland or shrub steppe.....	2
2a. <i>Artemisia tridentata</i> only dominant shrub > 5% (excluding rabbitbrush or snakebrush species).....	3
3a. Bunchgrasses comprise most vegetation cover, always with higher cover than sagebrush	 <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrub Steppe Alliance, 4
4a. Moist sites, <i>Festuca idahoensis</i> > 5%, <i>Pseudoroegneria spicata</i> often present	ARTTRIW / FESIDA, p. 108
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	5
5a. Giant bunchgrass important in understory, <i>Leymus cinereus</i> > 5% (this may be <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> OR ssp. <i>tridentata</i>)	ARTTRI / LEYCIN, p. 1
5b. Not as above, <i>Leymus cinereus</i> < 5%	6
6a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ARTTRIW / ACHTHU - PSESPI, p. 107
6b. Not as above, <i>Achnatherum thurberianum</i> < 5%	ARTTRIW / PSESPI, p. 109
3b. Not as above, either sagebrush or annuals (<i>Bromus tectorum</i>) comprise most cover	 <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Alliance, p. 1, 7
7a. <i>Pseudoroegneria spicata</i> < 5%, <i>Poa secunda</i> > 5%.....	ARTTRIW / POASEC, p. 33
7b. <i>Bromus tectorum</i> > 25%, dominant understory species	ARTTRIW / BROTEC, p. 36
2b. Big sagebrush (<i>Artemisia tridentata</i>) codominant, present with other shrubs (PURTRI, ATRCON, SARVER)	
8a. <i>Artemisia tridentata</i> codominant shrub, > 5% with <i>Purshia tridentata</i> > 2%.....	 <i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> - <i>Purshia tridentata</i> Shrub Alliance

.....	ARTTRIW - PURTRI / PSESPI, p. 32
8b. <i>Artemisia tridentata</i> codominant with either <i>Atriplex confertifolia</i> or <i>Sarcobatus vermiculatus</i> > 2%	
.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Sarcobatus vermiculatus</i> Steppe Alliance,
.....	ARTTRI - ATRCON – SARVER, p. 4
1b. <i>Artemisia tridentata</i> not dominant or codominant.....	9
9a. Shrublands on salt desert, alkaline or ash habitats, exposed soil > 30%.....	10
10a. <i>Atriplex confertifolia</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%	
.....	<i>Atriplex confertifolia</i> Shrubland Alliance, 11
11a. Native understory, usually with ACHHYM, PSESPI, ELYELY, or POASEC.....	12
12a. <i>Pseudoroegneria spicata</i> > 5%	ATRCON / PSESPI, p. 48
12b. <i>Poa secunda</i> , <i>Sporobolus cryptandrus</i> , or <i>Elymus elymoides</i> > 5%, <i>Pseudoroegneria spicata</i> absent	ATRCON / ELYELY, p. 46
11b. Non-native understory dominants of exotic grasses (<i>Bromus tectorum</i> or <i>Poa bulbosa</i>)	
.....	ARTCON / BROTEC, p. 43
10b. Not as above, either <i>Sarcobatus vermiculatus</i> or <i>Tetradymia canescens</i> important	13
13a. <i>Sarcobatus vermiculatus</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%.....	
.....	<i>Sarcobatus vermiculatus</i> Shrubland Alliance, 14
14a. <i>Leymus cinereus</i> dominant grass, > 5%.....	SARVER / LEYCIN, p. 70
14b. Exotic grasses (usually <i>Poa bulbosa</i> or <i>Bromus tectorum</i>) dominant	
.....	SARVER / BROTEC, p. 71
13b. <i>Tetradymia canescens</i> dominant shrub, > 5% cover	
.....	<i>Tetradymia canescens</i> Shrubland Alliance, TETCAN / POASEC, p. 43
9b. Not as above, rocky, shallow soiled areas, steep canyons or weedy flats.....	15
15a. Rocky, shallow soiled areas dominated by <i>Artemisia arbuscula</i> or <i>Artemisia rigida</i>	16
16a. <i>Artemisia arbuscula</i> dominant shrub, > 10%	
.....	<i>Artemisia arbuscula</i> Dwarf Shrubland Alliance, ARTARB / PSESPI, p. 103
16b. <i>Artemisia rigida</i> dominant shrub, > 5%	<i>Artemisia rigida</i> Shrubland Alliance
.....	ARTRIG / PSESPI, p. 115
15b. Not as above, either canyon slopes or weedy flats.....	17
17a. <i>Salvia dorrii</i> dominant shrub, > 10% cover, canyons and steep slopes	
.....	<i>Salvia dorrii</i> Shrubland Alliance, SALDOR / PSESPI, p. 76
17b. Not as above, generally on flats or gentle slopes, usually weedy areas, semi-natural vegetation ...	18
18a. Rabbitbrush species dominant, <i>Chrysothamnus viscidiflorus</i> > 10%, only important shrub	

Chrysothamnus viscidiflorus Semi-Natural Shrubland Alliance, CHRVIS / BROTEC, p. 72

18b. *Gutierrezia sarathae* > 10 %, weedy, and dominant shrub.....
.....*Gutierrezia sarathae* Semi-Natural Alliance, 19

19a. Annual grasses (*Bromus tectorum*) dominant grass GUTSAR / BROTEC, p. 73

19b. Perennial grass (*Poa bulbosa*) dominant in understory GUTSAR / POABUL, p. 74

KEY TO GRASS AND FORB DOMINATED TYPES (page numbers refer to description document)

Vegetation cover > 10%

1a. Upland grasslands 2

2a. Native bunchgrass dominated communities..... 3

3a. *Sporobolus cryptandrus* dominant > 5% cover
.....*Sporobolus cryptandrus* Herbaceous Alliance, SPICRY - POASEC, p. 85

3b. *Pseudoroegneria spicata* dominant or codominant*Pseudoroegneria spicata* Herbaceous Alliance, 4

4a. *Festuca idahoensis* codominant with *Pseudoroegneria spicata*, both > 5% cover and dominant.....
..... PSESPI – FESIDA CANYON, p. 81

4b. Not as above, *Festuca idahoensis* < 5%.....

5a. Ash habitats, *Achnatherum thurberianum* > 5% ACHTHU - PSESPI, p. 82

5b. Not as above, *Pseudoroegneria spicata* > 5% PSESPI - BALSAG - POASEC, p. 79

2b. Exotic grass dominant (shrubs, including some sagebrush, snakeweed or rabbitbrush, can be present)..... 6

6a. Dominant grasses non-native annual grasses (cheatgrass or medusahead) 7

7a. *Taeniatherum caput-medusae* > 20%, shrubs less than 10%, *Bromus tectorum* not codominant.....
.....*Taeniatherum caput-medusae* Exotic Grassland

7b. *Bromus tectorum* > 20%, dominant or co-dominant species..... 8

8a. *Bromus tectorum* and *Taeniatherum caput-medusae* codominant, each over 10%
.....*Bromus tectorum* – *Taeniatherum caput-medusae* Exotic Grassland

8b. *Bromus tectorum* > 20%, primary dominant *Bromus tectorum* Exotic Grassland

6b. Dominant grasses non-native perennial grasses (bulbose bluegrass, crested or intermediate wheatgrass)..... 9

9a. *Thinopyrum intermedium* (intermediate wheatgrass) > 20%, dominant.....
..... *Thinopyrum intermedium* Exotic Grassland

9b. Crested wheatgrass (*Agropyron cristatum*) dominant*Agropyron cristatum* Exotic Grassland

1b. Tall graminoid-dominated wetlands in riparian areas, with *Typha* species
.....*Typha latifolia* Herbaceous Alliance, TYPLAT, p. 92

KEY TO BARREN TYPES: (page numbers refer to description document)

Vegetation cover < 10%

- 1a. Herbaceous dominated ash bed or painted hill 2
 - 2a. *Helianthus nuttallii* > 50% of total cover..... **HELNUT Ash Bed, p. 120**
 - 2b. *Cleome platycarpa* > 50% of total cover **CLEPLA Ash Bed, p. 120**
- 1b. Shrub dominated ash bed or painted hill..... 3
 - 3a. *Atriplex confertifolia* or salt desert shrubs dominant **ARTCON Sparse, p. 47**
 - 3b. Not as above 4
 - 4a. *Purshia tridentata* and *Achnatherum thurberianum* dominant **PURTRI Ash Bed, p. 120**
 - 4b. *Ericameria nauseosa* dominant **ERINAU Sparse, p. 120**

KEY TO PLANT ASSOCIATIONS OF THE JOHN DAY FOSSIL BEDS NATIONAL MONUMENT, ALL UNITS (SHEEP ROCK, PAINTED HILLS, and CLARNO)

Instructions:

1. Select a relatively uniform area of vegetation and topography to key out. A representative 1/10 acre plot is a simple way to examine a stand, just be sure the plot represents the stand of interest.
2. "Present" means the species is typically found on a representative plot, i.e. it regularly occurs in the stand.
3. If the stand or plot meets the criteria in a line, then read to the right or (if blank) to the next indented line down. If the stand or plot does not meet the criteria, then go to the next line down that is not indented from the current line.
4. Some associations key to multiple different lines. For associations that may be distinguished by any one of a number of different characteristics, the criteria are broken into multiple lines so as to avoid excessive and confusing use of "and" and "or" statements. Just go to the next line down if the criteria are not met.
5. Percentage values refer to crown cover, that is the vertical projection below the entire crown of the plant. Do not subtract for spaces between leaves and branches. Total cover requires adding the crown cover of each of the species, e.g. 7+22 = 29%. Overlap between the species gets counted twice. One species may be absent.
6. The key is not the classification. After you have keyed out a stand, always read the association description of vegetation composition, geographic distribution, and physical environment. If it sounds like it fits in most regards, you have made a correct identification. If there are multiple inconsistencies between the stand and the description, the key probably was incorrect. In this case, you probably need to try the key again and follow slightly different leads or identify the stand by reading the descriptions. There are also many undescribed communities in the area and the key does not deal with non-forested wetlands or riparian communities for the most part, so the vegetation you are looking at may be an undescribed type.

KEY TO PHYSIOGNOMIC CATEGORIES: (page numbers refer to vegetation types key)

Trees > 25%. Trees are woody plants > 10 meters tall	Key to Forest and Woodland Types p. 1
Shrubs > 15%	Key to Shrubland Types p. 3
Herbaceous Vegetation > 10%	Key to Herbaceous Vegetation Types p. 5
Herbaceous Vegetation < 10%	Key to Sparse Vegetation Types p. 6

KEY TO FOREST AND WOODLAND AND RIPARIAN SHRUBLAND TYPES (page numbers refer to description document)

- 1a. Deciduous trees (or tall shrubs) dominant forest or woodland species
- 2a. Riparian (streamside) forest, woodland and tall shrubland communities..... 3
- 3a. *Alnus rhombifolia* > 15%, dominant tree *Alnus rhombifolia* Forest and Woodland Alliance, 4
- 4a. *Philadelphus lewisii* dominant shrub, > 5% ALNRHO / PHILEW, p. 7

4b. Not as above, <i>Rosa</i> or other species more important in the understory.....	ALNRHO / ROSWOO, p. 9
3b. <i>Alnus rhombifolia</i> minor component.....	5
5a. Riparian forest with significant cottonwood cover (<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> > 10%).....	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> Forest and Woodland Alliance, 6
6a. <i>Alnus incana</i> dominant shrub, > 5%.....	POPBAL / ALNINC, p. 12
6b. <i>Salix exigua</i> dominant shrub, > 5%.....	POPBAL / SALEXI, p. 13
5b. <i>Populus balsamifera</i> ssp. <i>trichocarpa</i> minor component.....	7
7a. <i>Salix exigua</i> important, >5% cover.....	<i>Salix exigua</i> Shrubland Alliance, 8
8a. <i>Salix exigua</i> dominant on relatively barren river gravels.....	<i>Salix exigua</i> Dry Alluvial Bar Association, p. 60
8b. Not as above, <i>Salix exigua</i> in largely vegetated riparian	9
9a. <i>Salix exigua</i> and <i>Rosa woodsii</i> dominant shrubs, each > 5%	SALEXI – ROSWOO, p. 63
9b. <i>Rosa woodsii</i> not important, graminoids, including <i>Eleocharis palustris</i> , <i>Schoenoplectus americanus</i> or <i>Phalaris arundinacea</i> usually dominant in understory	SALEXI / ELEPAL – SCHAME, p. 65
7b. Not as above	10
10a. <i>Rosa woodsii</i> dominant shrub > 10%, <i>Sambucus cerulea</i> or <i>Symphoricarpos</i> sp. often present.....	<i>Rosa woodsii</i> Shrubland Alliance, ROSWOO, p. 55
10b. Not as above, <i>Rosa woodsii</i> minor or either <i>Prunus virginiana</i> or <i>Celtis</i> dominant.....	11
11a. <i>Prunus virginiana</i> dominant tree or shrub > 10%, riparian or moist canyon slope.....	<i>Prunus virginiana</i> Forest Alliance, PRUVIR – (PRUAME), p. 52
11b. <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%, riparian or moist canyon slope.....	<i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22
2b. Deciduous trees (or tall shrubs > 2 meters tall) dominant forest or woodland species, upland or canyon setting, not truly riparian.....	12
12a. <i>Cercocarpus ledifolius</i> > 10%, only tree or tall shrub present non-riparian.....	<i>Cercocarpus ledifolius</i> Woodland Alliance, 12
13a. <i>Artemisia tridentata</i> > 5%, main understory shrub.....	CERLED / ARTTRI, p. 38
13b. <i>Pseudoroegneria spicata</i> > 10%, limited sagebrush or shrubs.....	CERLED / PSESPI, p. 40
12b. Not as above, <i>Celtis laevigata</i> var. <i>reticulata</i> > 10%, moist canyon slope.....	<i>Celtis laevigata</i> var. <i>reticulata</i> Woodland Alliance, CELLAER / PSESPI, p. 22
1b. Conifer trees (western juniper or <i>Juniperus occidentalis</i>) > 10%, the dominant forest or woodland species, ...	

.....	Columbia Plateau Western Juniper Woodland and Savanna Group, 14
14a. <i>Cercocarpus ledifolius</i> > 5%, co-dominant with juniper	
.....	<i>Juniperus occidentalis</i> – <i>Cercocarpus ledifolius</i> Woodland Alliance,
.....	JUNOCC / CERLED / PSESPI, p. 16
14b. Not as above, no <i>Cercocarpus ledifolius</i> , <i>Juniperus occidentalis</i> only tree or tall shrub	15
15a. Shrubs (<i>Artemisia tridentata</i> , <i>Artemisia rigida</i> or <i>Purshia tridentata</i>) > 2%	<i>Juniperus occidentalis</i> Woodland Alliance, 16
16a. <i>Artemisia tridentata</i> the dominant shrub, > 2%	JUNOCC / ARTTRIW / PSESPI, p. 20
16b. <i>Artemisia rigida</i> dominant or <i>Purshia tridentata</i> codominant	17
17a. <i>Artemisia rigida</i> dominant shrub, > 5%, scabland	JUNOCC / ARTRIG / PSESPI, p. 17
17b. Not as above, <i>Purshia tridentata</i> > 5 %	JUNOCC / ARTTRIW - PURTRI, p. 18
15b. Shrub cover < 2%	<i>Juniperus occidentalis</i> Herbaceous Alliance, 18
18a. <i>Festuca idahoensis</i> > 5%, dominant or codominant with <i>Pseudoroegneria spicata</i>	JUNOCC / FESIDA, p. 98
18b. Not as above, <i>Festuca idahoensis</i> minor.....	19
19a. Ash or pumice habitats, <i>Achnatherum thurberianum</i> > 5%.....	JUNOCC / ACHTHU, p. 97
19b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	JUNOCC / PSESPI, p. 100

KEY TO SHRUBLAND TYPES (page numbers refer to description document)

1a. Big sagebrush (<i>Artemisia tridentata</i>) dominant shrub > 5%, shrubland or shrub steppe.....	2
2a. <i>Artemisia tridentata</i> only dominant shrub > 5% (excluding rabbitbrush or snakebrush species).....	3
3a. Bunchgrasses comprise most vegetation cover, always with higher cover than sagebrush	
.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrub Steppe Alliance, 4
4a. Moist sites, <i>Festuca idahoensis</i> > 5%, <i>Pseudoroegneria spicata</i> often present	ARTTRIW / FESIDA, p. 108
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	5
5a. Giant bunchgrass important in understory, <i>Leymus cinereus</i> > 5%	ARTTRIW / LEYCIN, p. 26
5b. Not as above, <i>Leymus cinereus</i> < 5%.....	6
6a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ARTTRIW / ACHTHU - PSESPI, p. 107
6b. Not as above, <i>Achnatherum thurberianum</i> < 5%	ARTTRIW / PSESPI, p. 109
3b. Not as above, either sagebrush or annuals (<i>Bromus tectorum</i>) comprise most cover	

.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Alliance, 7
7a. <i>Pseudoroegneria spicata</i> < 5%, <i>Poa secunda</i> > 5%.....	ARTTRI / POASEC, p. 33
7b. <i>Bromus tectorum</i> > 25%, dominant understory species	ARTTRI / BROTEC, p. 36
2b. Big sagebrush (<i>Artemisia tridentata</i>) codominant, present with other shrubs (PURTRI, ATRCON, SARVER)	
8a. <i>Artemisia tridentata</i> codominant shrub, > 5% with <i>Purshia tridentata</i> > 2%.....	
.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> - <i>Purshia tridentata</i> Shrubland Alliance
.....	ARTTRI - PURTRI / PSESPI, p. 32
8b. <i>Artemisia tridentata</i> codominant with either <i>Atriplex confertifolia</i> or <i>Sarcobatus vermiculatus</i> > 2%	
.....	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> – <i>Sarcobatus vermiculatus</i> Steppe Alliance,
.....	ARTTRI - ATRCON – SARVER, p. 30
1b. <i>Artemisia tridentata</i> not dominant or codominant.....	9
9a. Shrublands on salt desert, alkaline or ash habitats, exposed soil > 30%.....	10
10a. <i>Atriplex confertifolia</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%	
.....	<i>Atriplex confertifolia</i> Shrubland Alliance, 11
11a. Native understory, usually with ACHHYM, PSESPI, ELYELY, or POASEC.....	12
12a. <i>Pseudoroegneria spicata</i> > 5%	ATRCON / PSESPI, p. 48
12b. <i>Poa secunda</i> , <i>Sporobolus cryptandrus</i> , or <i>Elymus elymoides</i> > 5%, <i>Pseudoroegneria spicata</i> absent	ATRCON / ELYELY, p. 46
11b. Non-native understory dominants of exotic grasses (<i>Bromus tectorum</i> or <i>Poa bulbosa</i>)	
.....	ARTCON / BROTEC, p.45
10b. Not as above, either <i>Sarcobatus vermiculatus</i> or <i>Tetradymia canescens</i> important	13
13a. <i>Sarcobatus vermiculatus</i> dominant shrub, > 5% cover, <i>Artemisia tridentata</i> < 5%.....	
.....	<i>Sarcobatus vermiculatus</i> Shrubland Alliance, 14
14a. <i>Leymus cinereus</i> dominant grass, > 5%.....	SARVER / LEYCIN, p. 70
14b. Exotic grasses (usually <i>Poa bulbosa</i> or <i>Bromus tectorum</i>) dominant	
.....	SARVER / BROTEC, p. 71
13b. <i>Tetradymia canescens</i> dominant shrub, > 5% cover	
.....	<i>Tetradymia canescens</i> Shrubland Alliance, TETCAN / POASEC, p. 43
9b. Not as above, rocky, shallow soiled areas, steep canyons or weedy flats.....	15
15a. Rocky, shallow soiled areas dominated by <i>Artemisia arbuscula</i> , <i>Artemisia rigida</i> , or <i>Eriogonum strictum</i>	16
16a. <i>Artemisia arbuscula</i> dominant shrub, > 10%	
.....	<i>Artemisia arbuscula</i> Dwarf Shrubland Alliance, ARTARB / PSESPI, p. 103

16b. Not as above, <i>Artemisia rigida</i> or <i>Eriogonum strictum</i> dominant shrub	17
17a. <i>Artemisia rigida</i> dominant shrub, > 5%, scabland.....	<i>Artemisia rigida</i> Shrubland Alliance
.....	ARTRIG / PSESPI, p. 115
17b. <i>Eriogonum strictum</i> dominant shrub, scabland with <i>Poa secunda</i> codominant	
.....	<i>Poa secunda</i> Dwarf Shrub Herbaceous Alliance, ERISTR / POASEC, p. 117
15b. Not as above, either canyon slopes or weedy flats.....	18
18a. Canyons and steep slopes <i>Salvia dorrii</i> dominant shrub, > 10% cover	
.....	<i>Salvia dorrii</i> Shrubland Alliance, SALDOR / PSESPI, p. 76
18b. Not as above, generally on flats or gentle slopes, usually weedy areas, semi-natural vegetation ...	19
19a. Rabbitbrush species dominant, <i>Chrysothamnus viscidiflorus</i> > 10%, only important shrub	
.....	<i>Chrysothamnus viscidiflorus</i> Semi-Natural Shrubland Alliance, CHRVIS / BROTEC, p. 72
19b. <i>Gutierrezia sarathae</i> > 10 %, weedy, and dominant shrub.....	
.....	<i>Gutierrezia sarathae</i> Semi-Natural Alliance, 20
20a. Annual grasses (<i>Bromus tectorum</i> or <i>Taeniatherum caput-medusae</i>) dominant.....	21
21a. <i>Taeniatherum caput-medusae</i> dominant grass	GUTSAR / TAECAP, p. 74
21b. <i>Bromus tectorum</i> dominant grass.....	GUTSAR / BROTEC, p. 73
20b. Perennial grass (<i>Poa bulbosa</i>) dominant in understory	GUTSAR / POABUL, p. 74

KEY TO GRASS AND FORB DOMINATED TYPES (page numbers refer to description document)

Vegetation cover > 10%

1a. Upland grasslands	2
2a. Native bunchgrass dominated communities.....	3
3a. <i>Sporobolus cryptandrus</i> dominant > 5% cover	
.....	<i>Sporobolus cryptandrus</i> Herbaceous Alliance, SPICRY - POASEC, p. 85
3b. <i>Pseudoroegneria spicata</i> dominant or codominant	<i>Pseudoroegneria spicata</i> Herbaceous Alliance, 4
4a. <i>Festuca idahoensis</i> codominant with <i>Pseudoroegneria spicata</i> , both > 5% cover and dominant.....	
.....	PSESPI – FESIDA CANYON, p. 81
4b. Not as above, <i>Festuca idahoensis</i> < 5%.....	
5a. Ash habitats, <i>Achnatherum thurberianum</i> > 5%	ACHTHU - PSESPI, p. 82
5b. Not as above, <i>Pseudoroegneria spicata</i> > 5%	PSESPI - BALSAG - POASEC, p. 79
2b. Exotic grass dominant (shrubs, including some sagebrush, snakeweed or rabbitbrush, can be present)	
NOTE: These are dominance types, characterized by high cover of an individual weedy grass. They are ...	
not described in the associated document.....	6
6a. Dominant grasses non-native annual grasses (cheatgrass or medusahead)	7

7a. <i>Taeniatherum caput-medusae</i> > 20%, shrubs less than 10%, <i>Bromus tectorum</i> not codominant	
..... <i>Taeniatherum caput-medusae</i> Exotic Grassland	
7b. <i>Bromus tectorum</i> > 20%, dominant or co-dominant species	8
8a. <i>Bromus tectorum</i> and <i>Taeniatherum caput-medusae</i> codominant, each over 10%	
..... <i>Bromus tectorum</i> – <i>Taeniatherum caput-medusae</i> Exotic Grassland	
8b. <i>Bromus tectorum</i> > 20%, primary dominant	<i>Bromus tectorum</i> Exotic Grassland
6b. Dominant grasses non-native perennial grasses (bulbose bluegrass, crested or intermediate wheatgrass).....	9
9a. <i>Thinopyrum intermedium</i> (intermediate wheatgrass) > 20%, dominant	
..... <i>Thinopyrum intermedium</i> Exotic Grassland	
9b. Not as above, Crested wheatgrass (<i>Agropyron cristatum</i>) or bulbous bluegrass (<i>Poa bulbosa</i>) dominant	10
10a. <i>Agropyron cristatum</i> dominant, old seeding.....	<i>Agropyron cristatum</i> Exotic Grassland
10b. <i>Poa bulbosa</i> > 20%, dominant	<i>Poa bulbosa</i> Exotic Grassland
1b. Tall graminoid-dominated wetlands in riparian areas, with <i>Typha</i> species	
..... <i>Typha latifolia</i> Herbaceous Alliance, TYPLAT, p. 92	

KEY TO BARREN TYPES: (page numbers refer to description document)

Vegetation cover < 10%

1a. Herbaceous dominated ash bed or painted hill	2
2a. <i>Helianthus nuttallii</i> > 50% of total cover	HELNUT Ash Bed, p. 120
2b. <i>Cleome platycarpa</i> > 50% of total cover	CLEPLA Ash Bed, p. 120
1b. Shrub dominated ash bed or painted hill.....	3
3a. <i>Atriplex confertifolia</i> or salt desert shrubs dominant	ARTCON Sparse, p. 47
3b. Not as above	4
4a. <i>Purshia tridentata</i> and <i>Achnatherum thurberianum</i> dominant	PURTRI Ash Bed, p. 120
4b. <i>Ericameria nauseosa</i> dominant	ERINAU Sparse, p. 120

Appendix D – Vegetation Association Descriptions

John Day Fossil Beds National Monument Initial Plant Association List

A. Plant Associations

I. Plant Associations reported from the National Monument

Barren Types

1. [*Eriogonum microthecum* - *Physaria oregona* Dwarf-shrubland](#) (Note: this is an endemic Hell's Canyon ash bed community, that is very similar to some of the Sheep Rock ash beds, and it is the only ash bed community present. Berta called it *Eriogonum microthecum* / *Achnatherum thurberianum*, which represents a type not in the IVC. New data will alter the classification. While it is a dwarf shrubland in the IVC, it would properly be mapped as a barren, due to the fact that it has less than 10% vegetative cover.)

Grass Dominated Plant Associations (Grasslands)

2. [*Pseudoroegneria spicata* - *Festuca idahoensis* Canyon Herbaceous Vegetation](#)

Shrub Dominated Plant Associations (Shrublands and Steppe)

3. [*Artemisia rigida* / *Poa secunda* Shrub Herbaceous Vegetation](#) or [*Artemisia rigida* / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation](#)
4. [*Artemisia tridentata* ssp. *wyomingensis* / *Achnatherum thurberianum* Shrubland](#)
5. [*Artemisia tridentata* ssp. *tridentata* / *Bromus tectorum*](#) (not in IVC)
May be degraded [*Artemisia tridentata* ssp. *tridentata* / *Leymus cinereus* Shrubland](#), or [*Artemisia tridentata* \(ssp. *tridentata*, ssp. *xericensis*\) / *Pseudoroegneria spicata* Shrub Herbaceous Vegetation](#)
6. [*Artemisia tridentata* ssp. *tridentata* / *Hesperostipa comata* Shrubland](#)
7. [*Artemisia tridentata* ssp. *wyomingensis* / *Poa secunda* Shrubland](#)
8. [*Artemisia tridentata* ssp. *wyomingensis* / *Pseudoroegneria spicata* Shrubland](#)
9. [*Artemisia tridentata* ssp. *wyomingensis* / *Festuca idahoensis* Shrubland](#)
(in ORNHIC classification but not in IVC yet)
10. [*Artemisia tridentata* ssp. *wyomingensis* - *Purshia tridentata* / *Pseudoroegneria spicata* Shrubland](#)

11. [*Atriplex confertifolia* / *Poa secunda* = *Atriplex confertifolia* Sparse Shrubland](#) or perhaps [*Atriplex confertifolia* / *Achnatherum hymenoides* Shrubland](#) or perhaps [*Atriplex confertifolia* / *Elymus elymoides* Shrubland](#)
12. [*Gutierrezia sarothrae* / *Bromus tectorum*](#) (not in IVC). May not ever be included in IVC since it represents a degraded site.
13. [*Salvia dorrii* / *Pseudoroegneria spicata* Dwarf-shrubland](#)
14. [*Sarcobatus vermiculatus* / *Bromus tectorum* = *Sarcobatus vermiculatus* Disturbed Shrubland](#)
May be degraded [*Sarcobatus vermiculatus* / *Leymus cinereus* Shrubland](#) or [*Sarcobatus vermiculatus* / *Sporobolus airoides* Shrubland](#) or [*Sarcobatus vermiculatus* / *Distichlis spicata* Shrubland](#)

Riparian Shrublands

15. [*Salix exigua* Temporarily Flooded Shrubland](#) - (or other SAEX types)

Tree Dominated Plant Associations (Forests and Woodlands)

16. [*Cercocarpus ledifolius* / *Pseudoroegneria spicata* - *Festuca idahoensis* Woodland](#)
17. [*Juniperus occidentalis* / *Festuca idahoensis* Wooded Herbaceous Vegetation](#)
18. [*Juniperus occidentalis* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation](#)
19. [*Juniperus occidentalis* / *Purshia tridentata* / *Festuca idahoensis* - *Pseudoroegneria spicata* Wooded Herbaceous Vegetation](#)
20. [*Juniperus occidentalis* / *Purshia tridentata* / *Achnatherum thurberianum* Wooded Herbaceous Vegetation](#) – not in IVC. With data, it certainly could be added. A similar type is present at Juniper Hills Preserve in Crook County, although I'd be inclined to call it JUOC/ARTRW-PUTR/ACTH
21. [*Juniperus occidentalis* / *Artemisia tridentata* - *Purshia tridentata* Wooded Herbaceous Vegetation](#)
22. [*Juniperous occidentalis* / *Artemisia tridentata* / *Poa secunda*](#) (not in IVC) possibly = [*Juniperus occidentalis* / *Artemisia tridentata* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation](#)

Riparian Forests and Woodlands

23. [*Alnus rhombifolia* / *Rosa woodsii* Forest](#)

II. Plant Associations from the areas near the John Day Fossil Beds National Monument

Plant Associations not known from the site, but found nearby, either on the Sutton Mountain proposed Wilderness Area or on the Pine Creek Ranch site are included below.

a. Sutton Mountain Communities:

Shrublands and Steppe

1. [*Artemisia arbuscula* ssp. *arbuscula* / *Pseudoregneria spicata* Shrub Herbaceous Vegetation](#)
2. [*Artemisia arbuscula* ssp. *arbuscula* / *Festuca idahoensis* Shrub Herbaceous Vegetation](#)
3. [*Artemisia arbuscula* ssp. *arbuscula* / *Poa secunda* Shrub Herbaceous Vegetation](#)

Riparian Forests and Woodlands

4. [*Alnus rhombifolia* / *Prunus virginiana* Forest](#)
5. [*Populus balsamifera* ssp. *trichocarpa* - *Alnus rhombifolia* Forest](#)

b. Pine Creek Ranch Communities

Grasslands

1. [*Sporobolus cryptandrus* - *Poa secunda* Herbaceous Vegetation](#)
2. [*Sporobolus cryptandrus* Shrub Herbaceous Vegetation](#)

c. Other potential associations found nearby

1. [*Juniperus occidentalis* / *Poa secunda* - *Achnatherum occidentale* Wooded Herbaceous Vegetation](#) – Note: this was described from the Prineville Valley, and included in the IVC. New work by Arne Buechling at BIAK may have an alternative name for this type.
2. [*Celtis laevigata* var. *reticulata* / *Philadelphus lewisii* Woodland](#)
3. [*Celtis laevigata* var. *reticulata* / *Pseudoroegneria spicata* Woodland](#)
4. [*Alnus rhombifolia* / *Celtis laevigata* var. *reticulata* Forest](#)

B. Alliances

I. Alliances known from John Day Fossil Beds National Monument

Grassland and Herbaceous Alliances

Bluebunch Wheatgrass Herbaceous Alliance
Curley (Sandberg) Bluegrass Dwarf-shrub Herbaceous Alliance

Shrubland Alliances

Black Greasewood Intermittently Flooded Shrubland Alliance
Shadscale Shrubland Alliance
Wyoming Big Sagebrush Shrub Steppe Alliance
Wyoming Big Sagebrush Shrubland Alliance
Basin Big Sagebrush Shrubland Alliance
Rigid Sagebrush Shrub Steppe Alliance
Purple Sage Dwarf-shrubland Alliance
Slender Wild Buckwheat Dwarf-shrubland Alliance
Curl-leaf Mountain Mahogany Shrubland Alliance

Woodland and Forest Alliances

Western Juniper Woodland Alliance

II. Other Alliances known from John Day Fossil Beds National Monument Area

Grassland and Herbaceous Alliances

Curley (Sandberg) Bluegrass Herbaceous Alliance

Shrubland Alliances

Basin Big Sagebrush Shrub Steppe Alliance
Dwarf (Low) Sagebrush Shrub Herbaceous Alliance
Lewis' Mock Orange Intermittently Flooded Shrubland Alliance (this doesn't have to be flooded)
Antelope Bitterbrush Shrub Herbaceous Alliance

Woodland and Forest Alliances

Netleaf Hackberry Woodland Alliance (or Shrubland Alliance)

C. Ecological Systems

I. Ecological Systems from John Day Fossil Beds National Monument Area

Barren Ecological Systems

Columbia Plateau Ash and Tuff Badland

Ash beds, either barren, annual dominated, perennial forb dominated or open shrublands

Intermountain Basins Cliff and Canyon

Cliffs and canyons, barren with shrubs and grasslands. Large patches of Mountain Mahogany, western juniper, or big sagebrush steppe or shrubland as seen from above, would be mapped in the appropriate system below. Also, large patches of canyons dominated entirely by grasslands would be mapped as the Columbia Plateau Foothill and Canyon Dry Grassland.

Grassland and Herbaceous Ecological Systems

Columbia Basin Foothill and Canyon Dry Grassland

Bluebunch wheatgrass, Thurber's needlegrass, Fescue, and Sandberg bluegrass

Columbia Plateau Scabland Shrubland (can be a grassland or shrub steppe)

Scablands, always with Sandberg bluegrass dominant, often quite barren, sometimes buckwheat species or rigid sagebrush codominant.

Inter-Mountain Basins Semi-Desert Grassland

Indian rice grass, needle-and-thread, or sand dropseed dominated grasslands.

Shrubland and Steppe Ecological Systems

Columbia Plateau Scabland Shrubland (can be a grassland or shrub steppe)

Scablands, always with Sandberg bluegrass dominant, often quite barren, sometimes buckwheat species or rigid sagebrush codominant.

Columbia Plateau Low Sagebrush Steppe

Areas dominated by low sagebrush / bunchgrass vegetation

Inter-Mountain Basins Big Sagebrush Steppe

Wyoming and Basin big sagebrush or bitterbrush / bunchgrass vegetation. Bunchgrass cover generally greater than or = shrub cover. Shrub cover generally < 25%.

Inter-Mountain Basins Big Sagebrush Shrubland

Wyoming and Basin big sagebrush or bitterbrush dominated vegetation. Bunchgrass cover lower than or = shrub cover. Shrub cover always > 10%. Sagebrush / cheatgrass mapped here.

Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland

Mountain mahogany dominated shrublands. Often occurs with sagebrush.

Inter-Mountain Basins Greasewood Flat

Black Greasewood dominated playas (but not barren playa), and greasewood dominated salt desert scrub, usually with greasewood alone, sometimes with small amounts of basin sage.

Inter-Mountain Basins Mixed Salt-desert Scrub

Atriplex (shadscale) or Grayia (spiny hopsage) dominated scrub, often with some black greasewood or sagebrush.

Northern Rocky Mountain Montane-Foothill Deciduous Shrubland

Probably not present, but would be areas with serviceberry, ninebark, mock-orange, or sumac, often with bunchgrasses, sagebrush and bitterbrush.

Woodland and Forest Alliances

Columbia Basin Foothill Riparian Woodland and Shrubland

All riparian habitats within the National Monument

Columbia Plateau Western Juniper Woodland and Savanna

Appendix E – Species List

Family	Scientific Name	TSN	ParkStatus	Abundance	Nativity
Asteraceae	<i>Achillea millefolium</i>	35423	Present in Park	Unknown	Native
Poaceae	<i>Achnatherum hymenoides</i>	507943	Present in Park	Unknown	Native
Poaceae	<i>Achnatherum thurberianum</i>	507961	Present in Park	Unknown	Native
Asteraceae	<i>Agoseris heterophylla</i>	36492	Present in Park	Unknown	Native
Poaceae	<i>Agropyron spicatum</i>	40386	Present in Park	Unknown	Native
Liliaceae	<i>Allium tolmiei</i>	42671	Present in Park	Unknown	Native
Betulaceae	<i>Alnus rhombifolia</i>	19473	Present in Park	Unknown	Native
Amaranthaceae	<i>Amaranthus albus</i>	20719	Present in Park	Unknown	Native
Rosaceae	<i>Amelanchier alnifolia</i>	25109	Present in Park	Unknown	Native
Boraginaceae	<i>Amsinckia tessellata</i>	31706	Present in Park	Unknown	Native
Asteraceae	<i>Antennaria dimorpha</i>	36727	Present in Park	Unknown	Native
Asteraceae	<i>Anthemis cotula</i>	36330	Present in Park	Unknown	Native
Apocynaceae	<i>Apocynum cannabinum</i>	30157	Present in Park	Unknown	Native
Asteraceae	<i>Artemisia arbuscula</i>	35449	Present in Park	Unknown	Native
Asteraceae	<i>Artemisia ludoviciana</i>	35474	Present in Park	Unknown	Native
Asteraceae	<i>Artemisia rigida</i>	35491	Present in Park	Unknown	Native
Asteraceae	<i>Artemisia tridentata</i>	35498	Present in Park	Unknown	Native
Asclepiadaceae	<i>Asclepias speciosa</i>	30304	Present in Park	Unknown	Native
Fabaceae	<i>Astragalus diaphanus</i>	25494	Present in Park	Unknown	Native
Fabaceae	<i>Astragalus filipes</i>	25515	Present in Park	Unknown	Native
Fabaceae	<i>Astragalus misellus</i>	25583	Present in Park	Unknown	Native
Fabaceae	<i>Astragalus purshii</i>	25648	Present in Park	Unknown	Native
Asteraceae	<i>Bidens cernua</i>	35710	Present in Park	Unknown	Native
Asteraceae	<i>Blepharipappus scaber</i>	36845	Present in Park	Unknown	Native
Liliaceae	<i>Calochortus macrocarpus</i>	42858	Present in Park	Unknown	Native
Cyperaceae	<i>Carex angustata</i>	501204	Present in Park	Unknown	Native
Cyperaceae	<i>Carex stipata</i>	39434	Present in Park	Unknown	Native
Scrophulariaceae	<i>Castilleja applegatei</i> var. <i>fragilis</i>	533204	Present in Park	Unknown	Native
Scrophulariaceae	<i>Castilleja xanthotricha</i>	33180	Present in Park	Unknown	Native
Ulmaceae	<i>Celtis reticulata</i>	19045	Present in Park	Unknown	Native
Rosaceae	<i>Cercocarpus ledifolius</i>	25134	Present in Park	Unknown	Native
Asteraceae	<i>Chaenactis douglasii</i>	36987	Present in Park	Unknown	Native
Asteraceae	<i>Chaenactis nevii</i>	36994	Present in Park	Unknown	Native
Brassicaceae	<i>Chorispora tenella</i>	23099	Present in Park	Unknown	Native
Asteraceae	<i>Chrysopsis oregona</i>	510970	Present in Park	Unknown	Native
Asteraceae	<i>Cirsium undulatum</i>	36423	Present in Park	Unknown	Native
Onagraceae	<i>Clarkia pulchella</i>	27616	Present in Park	Unknown	Native
Ranunculaceae	<i>Clematis ligusticifolia</i>	18702	Present in Park	Unknown	Native
Capparaceae	<i>Cleome platycarpa</i>	22623	Present in Park	Unknown	Native
Polemoniaceae	<i>Collomia grandiflora</i>	31037	Present in Park	Unknown	Native
Asteraceae	<i>Conyza canadensis</i>	37113	Present in Park	Unknown	Native
Cornaceae	<i>Cornus stolonifera</i>	27818	Present in Park	Unknown	Native
Rosaceae	<i>Crataegus columbiana</i>	24551	Present in Park	Unknown	Native
Rosaceae	<i>Crataegus douglasii</i>	24557	Present in Park	Unknown	Native
Asteraceae	<i>Crepis atriobarba</i>	37172	Present in Park	Unknown	Native

Asteraceae	<i>Crepis intermedia</i>	37185	Present in Park	Unknown	Native
Asteraceae	<i>Crepis occidentalis</i>	37196	Present in Park	Unknown	Native
Asteraceae	<i>Crocidium multicaule</i>	37217	Present in Park	Unknown	Native
Poaceae	<i>Crypsis alopecuroides</i>	41603	Present in Park	Unknown	Native
Boraginaceae	<i>Cryptantha celosioides</i>	31792	Present in Park	Unknown	Native
Boraginaceae	<i>Cryptantha pterocarya</i>	31856	Present in Park	Unknown	Native
Cyperaceae	<i>Cyperus squarrosus</i>	501940	Present in Park	Unknown	Native
Dryopteridaceae	<i>Cystopteris fragilis</i>	17482	Present in Park	Unknown	Native
Fabaceae	<i>Dalea ornata</i>	26635	Present in Park	Unknown	Native
Brassicaceae	<i>Descurainia richardsonii</i>	22838	Present in Park	Unknown	Native
Poaceae	<i>Distichlis spicata</i>	40662	Present in Park	Unknown	Native
Brassicaceae	<i>Draba verna</i>	22923	Present in Park	Unknown	Native
Elaeagnaceae	<i>Elaeagnus angustifolia</i>	27770	Present in Park	Unknown	Native
Cyperaceae	<i>Eleocharis palustris</i>	40019	Present in Park	Unknown	Native
Onagraceae	<i>Epilobium minutum</i>	27313	Present in Park	Unknown	Native
Onagraceae	<i>Epilobium watsonii</i>	512932	Present in Park	Unknown	Native
Equisetaceae	<i>Equisetum hyemale</i>	17154	Present in Park	Unknown	Native
Equisetaceae	<i>Equisetum pratense</i>	17159	Present in Park	Unknown	Native
Equisetaceae	<i>Equisetum variegatum</i>	17149	Present in Park	Unknown	Native
Asteraceae	<i>Erigeron filifolius</i>	35863	Present in Park	Unknown	Native
Asteraceae	<i>Erigeron linearis</i>	35894	Present in Park	Unknown	Native
Asteraceae	<i>Erigeron philadelphicus</i>	35809	Present in Park	Unknown	Native
Asteraceae	<i>Erigeron pumilus</i>	35934	Present in Park	Unknown	Native
Polygonaceae	<i>Eriogonum compositum</i>	21097	Present in Park	Unknown	Native
Polygonaceae	<i>Eriogonum microthecum</i>	21192	Present in Park	Unknown	Native
Polygonaceae	<i>Eriogonum sphaerocephalum</i>	21249	Present in Park	Unknown	Native
Polygonaceae	<i>Eriogonum strictum</i>	21250	Present in Park	Unknown	Native
Polygonaceae	<i>Eriogonum vimineum</i>	21271	Present in Park	Unknown	Native
Asteraceae	<i>Eriophyllum lanatum</i>	37334	Present in Park	Unknown	Native
Brassicaceae	<i>Erysimum asperum</i>	22931	Present in Park	Unknown	Native
Euphorbiaceae	<i>Euphorbia serpyllifolia</i>	28134	Present in Park	Unknown	Native
Poaceae	<i>Festuca idahoensis</i>	40816	Present in Park	Unknown	Native
Poaceae	<i>Festuca microstachys</i>	513548	Present in Park	Unknown	Native
Liliaceae	<i>Fritillaria pudica</i>	42936	Present in Park	Unknown	Native
Rubiaceae	<i>Galium aparine</i>	34797	Present in Park	Unknown	Native
Rubiaceae	<i>Galium multiflorum</i>	34892	Present in Park	Unknown	Native
Chenopodiaceae	<i>Grayia spinosa</i>	20690	Present in Park	Unknown	Native
Asteraceae	<i>Grindelia nana</i>	37465	Present in Park	Unknown	Native
Asteraceae	<i>Gutierrezia sarothrae</i>	37483	Present in Park	Unknown	Native
Asteraceae	<i>Helianthus nuttallii</i>	36662	Present in Park	Unknown	Native
Saxifragaceae	<i>Heuchera cylindrica</i>	24347	Present in Park	Unknown	Native
Juncaceae	<i>Juncus balticus</i>	39223	Present in Park	Unknown	Native
Juncaceae	<i>Juncus bufonius</i>	39227	Present in Park	Unknown	Native
Cupressaceae	<i>Juniperus occidentalis</i>	194855	Present in Park	Unknown	Native
Poaceae	<i>Koeleria macrantha</i>	503284	Present in Park	Unknown	Native
Asteraceae	<i>Lagophylla ramosissima</i>	37827	Present in Park	Unknown	Native
Asteraceae	<i>Layia glandulosa</i>	37863	Present in Park	Unknown	Native
Polemoniaceae	<i>Leptodactylon pungens</i>	31233	Present in Park	Unknown	Native
Brassicaceae	<i>Lesquerella occidentalis</i>	23212	Present in Park	Unknown	Native

Portulacaceae	<i>Lewisia rediviva</i>	20490	Present in Park	Unknown	Native
Poaceae	<i>Leymus cinereus</i>	503433	Present in Park	Unknown	Native
Saxifragaceae	<i>Lithophragma glabrum</i>	24395	Present in Park	Unknown	Native
Boraginaceae	<i>Lithospermum ruderales</i>	31953	Present in Park	Unknown	Native
Apiaceae	<i>Lomatium grayi</i>	29707	Present in Park	Unknown	Native
Apiaceae	<i>Lomatium hendersonii</i>	29710	Present in Park	Unknown	Native
Apiaceae	<i>Lomatium macrocarpum</i>	29719	Present in Park	Unknown	Native
Apiaceae	<i>Lomatium triternatum</i>	29754	Present in Park	Unknown	Native
Asteraceae	<i>Machaeranthera canescens</i>	37984	Present in Park	Unknown	Native
Asteraceae	<i>Madia gracilis</i>	38030	Present in Park	Unknown	Native
Loasaceae	<i>Mentzelia albicaulis</i>	503757	Present in Park	Unknown	Native
Loasaceae	<i>Mentzelia laevicaulis</i>	503779	Present in Park	Unknown	Native
Scrophulariaceae	<i>Mimulus cusickii</i>	33305	Present in Park	Unknown	Native
Scrophulariaceae	<i>Mimulus floribundus</i>	33311	Present in Park	Unknown	Native
Scrophulariaceae	<i>Mimulus guttatus</i>	33236	Present in Park	Unknown	Native
Scrophulariaceae	<i>Mimulus nanus</i>	33263	Present in Park	Unknown	Native
Portulacaceae	<i>Montia perfoliata</i>	517308	Present in Park	Unknown	Native
Poaceae	<i>Muhlenbergia asperifolia</i>	41899	Present in Park	Unknown	Native
Solanaceae	<i>Nicotiana attenuata</i>	30571	Present in Park	Unknown	Native
Asteraceae	<i>Nothocalais troximoides</i>	38134	Present in Park	Unknown	Native
Onagraceae	<i>Oenothera caespitosa</i>	565328	Present in Park	Unknown	Native
Onagraceae	<i>Oenothera tanacetifolia</i>	517743	Present in Park	Unknown	Native
Cactaceae	<i>Opuntia polyacantha</i>	19726	Present in Park	Unknown	Native
Orobanchaceae	<i>Orobanche fasciculata</i>	34290	Present in Park	Unknown	Native
Asteraceae	<i>Packera cana</i>	518142	Present in Park	Unknown	Native
Cactaceae	<i>Pediocactus simpsonii</i>	19776	Present in Park	Unknown	Native
Scrophulariaceae	<i>Penstemon deustus</i>	33876	Present in Park	Unknown	Native
Scrophulariaceae	<i>Penstemon eriantherus</i> var. <i>argillosus</i>	529476	Present in Park	Unknown	Native
Scrophulariaceae	<i>Penstemon richardsonii</i>	33759	Present in Park	Unknown	Native
Hydrophyllaceae	<i>Phacelia hastata</i>	31529	Present in Park	Unknown	Native
Hydrophyllaceae	<i>Phacelia linearis</i>	31514	Present in Park	Unknown	Native
Hydrophyllaceae	<i>Phacelia lutea</i>	31444	Present in Park	Unknown	Native
Hydrophyllaceae	<i>Phacelia ramosissima</i>	31585	Present in Park	Unknown	Native
Hydrangeaceae	<i>Philadelphus lewisii</i>	24430	Present in Park	Unknown	Native
Polemoniaceae	<i>Phlox longifolia</i>	30956	Present in Park	Unknown	Native
Polemoniaceae	<i>Phlox muscoides</i>	30965	Present in Park	Unknown	Native
Polemoniaceae	<i>Phlox viscida</i>	30996	Present in Park	Unknown	Native
Pinaceae	<i>Pinus ponderosa</i>	183365	Present in Park	Unknown	Native
Plantaginaceae	<i>Plantago patagonica</i>	32907	Present in Park	Unknown	Native
Valerianaceae	<i>Plectritis macrocera</i>	35383	Present in Park	Unknown	Native
Poaceae	<i>Poa secunda</i>	41103	Present in Park	Unknown	Native
Polemoniaceae	<i>Polemonium micranthum</i>	31017	Present in Park	Unknown	Native
Polygonaceae	<i>Polygonum hydropiper</i>	20856	Present in Park	Unknown	Native
Salicaceae	<i>Populus trichocarpa</i>	195735	Present in Park	Unknown	Native
Portulacaceae	<i>Portulaca oleracea</i>	20422	Present in Park	Unknown	Native
Rosaceae	<i>Potentilla glandulosa</i> var. <i>campanulata</i>	539204	Present in Park	Unknown	Native
Rosaceae	<i>Prunus virginiana</i>	24806	Present in Park	Unknown	Native
Poaceae	<i>Puccinellia lemmonii</i>	41213	Present in Park	Unknown	Native
Rosaceae	<i>Purshia tridentata</i>	25290	Present in Park	Unknown	Native

Ranunculaceae	Ranunculus aquatilis	18581	Present in Park	Unknown	Native
Ranunculaceae	Ranunculus glaberrimus	18606	Present in Park	Unknown	Native
Ranunculaceae	Ranunculus sceleratus	18576	Present in Park	Unknown	Native
Anacardiaceae	Rhus radicans	28776	Present in Park	Unknown	Native
Grossulariaceae	Ribes aureum	24452	Present in Park	Unknown	Native
Grossulariaceae	Ribes cereum	24457	Present in Park	Unknown	Native
Grossulariaceae	Ribes cognatum	24458	Present in Park	Unknown	Native
Brassicaceae	Rorippa nasturtium-aquaticum	22993	Present in Park	Unknown	Native
Rosaceae	Rosa woodsii	24847	Present in Park	Unknown	Native
Lamiaceae	Salvia dorrii	32683	Present in Park	Unknown	Native
Caprifoliaceae	Sambucus cerulea	35320	Present in Park	Unknown	Native
Chenopodiaceae	Sarcobatus vermiculatus	20707	Present in Park	Unknown	Native
Cyperaceae	Schoenoplectus tabernaemontani	507797	Present in Park	Unknown	Native
Lamiaceae	Scutellaria angustifolia	32783	Present in Park	Unknown	Native
Crassulaceae	Sedum lanceolatum	24126	Present in Park	Unknown	Native
Asteraceae	Senecio serra	36182	Present in Park	Unknown	Native
Poaceae	Sitanion hystrix	42097	Present in Park	Unknown	Native
Asteraceae	Solidago canadensis	36224	Present in Park	Unknown	Native
Malvaceae	Sphaeralcea munroana	21949	Present in Park	Unknown	Native
Poaceae	Sporobolus cryptandrus	42132	Present in Park	Unknown	Native
Asteraceae	Stephanomeria tenuifolia	38455	Present in Park	Unknown	Native
Poaceae	Stipa comata	42172	Present in Park	Unknown	Native
Poaceae	Stipa thurberana	42197	Present in Park	Unknown	Native
Asteraceae	Tetradymia canescens	38494	Present in Park	Unknown	Native
Brassicaceae	Thelypodium laciniatum	23403	Present in Park	Unknown	Native
Typhaceae	Typha latifolia	42326	Present in Park	Unknown	Native
Ulmaceae	Ulmus pumila	19057	Present in Park	Unknown	Native
Urticaceae	Urtica dioica	19152	Present in Park	Unknown	Native
Valerianaceae	Valerianella locusta	35392	Present in Park	Unknown	Native
Scrophulariaceae	Veronica anagallis-aquatica	565594	Present in Park	Unknown	Native
Scrophulariaceae	Veronica peregrina	33421	Present in Park	Unknown	Native
Asteraceae	Xanthium strumarium	38692	Present in Park	Unknown	Native
Poaceae	Agropyron caninum var. latiglume	501906	Present in Park	Unknown	Non-Native
Poaceae	Agropyron cristatum	182478	Present in Park	Unknown	Non-Native
Brassicaceae	Alyssum alyssoides	23030	Present in Park	Unknown	Non-Native
Apiaceae	Anthriscus scandicina	184758	Present in Park	Unknown	Non-Native
Asteraceae	Arctium minus	36546	Present in Park	Unknown	Non-Native
Poaceae	Arrhenatherum elatius	41443	Present in Park	Unknown	Non-Native
Boraginaceae	Asperugo procumbens	31723	Present in Park	Unknown	Non-Native
Chenopodiaceae	Bassia hyssopifolia	20588	Present in Park	Unknown	Non-Native
Poaceae	Bromus briziformis	40495	Present in Park	Unknown	Non-Native
Poaceae	Bromus commutatus	40497	Present in Park	Unknown	Non-Native

Poaceae	<i>Bromus mollis</i>	40508	Present in Park	Unknown	Native
Poaceae	<i>Bromus rubens</i>	40518	Present in Park	Unknown	Non-Native
Poaceae	<i>Bromus tectorum</i>	40524	Present in Park	Unknown	Non-Native
Brassicaceae	<i>Camelina microcarpa</i>	22599	Present in Park	Unknown	Non-Native
Brassicaceae	<i>Capsella bursa-pastoris</i>	22766	Present in Park	Unknown	Non-Native
Caryophyllaceae	<i>Cerastium glomeratum</i>	19955	Present in Park	Unknown	Non-Native
Ranunculaceae	<i>Ceratocephala testiculata</i>	501365	Present in Park	Unknown	Non-Native
Chenopodiaceae	<i>Chenopodium album</i>	20592	Present in Park	Unknown	Non-Native
Chenopodiaceae	<i>Chenopodium botrys</i>	20596	Present in Park	Unknown	Non-Native
Asteraceae	<i>Cichorium intybus</i>	36763	Present in Park	Unknown	Non-Native
Poaceae	<i>Dactylis glomerata</i>	193446	Present in Park	Unknown	Non-Native
Brassicaceae	<i>Descurainia pinnata</i>	22826	Present in Park	Unknown	Non-Native
Dipsacaceae	<i>Dipsacus sylvestris</i>	35406	Present in Park	Unknown	Non-Native
Poaceae	<i>Echinochloa crusgalli</i>	40668	Present in Park	Unknown	Non-Native
Geraniaceae	<i>Erodium cicutarium</i>	29147	Present in Park	Unknown	Non-Native
Asteraceae	<i>Helianthus annuus</i>	36616	Present in Park	Unknown	Non-Native
Caryophyllaceae	<i>Holosteum umbellatum</i>	503057	Present in Park	Unknown	Non-Native
Poaceae	<i>Hordeum leporinum</i>	40879	Present in Park	Unknown	Non-Native
Asteraceae	<i>Lactuca serriola</i>	36608	Present in Park	Unknown	Non-Native
Brassicaceae	<i>Lepidium perfoliatum</i>	22974	Present in Park	Unknown	Noxious
Malvaceae	<i>Malva neglecta</i>	21836	Present in Park	Unknown	Non-Native
Lamiaceae	<i>Marrubium vulgare</i>	32561	Present in Park	Unknown	Non-Native
Fabaceae	<i>Medicago lupulina</i>	503721	Present in Park	Unknown	Non-Native
Fabaceae	<i>Medicago sativa</i>	183623	Present in Park	Unknown	Non-Native
Fabaceae	<i>Melilotus alba</i>	26149	Present in Park	Unknown	Non-Native
Lamiaceae	<i>Mentha spicata</i>	32272	Present in Park	Unknown	Non-Native
Poaceae	<i>Panicum capillare</i>	40914	Present in Park	Unknown	Non-Native

Poaceae	Pennisetum glaucum	565385	Present in Park	Unknown	Non-Native
Poaceae	Phalaris arundinacea	41335	Present in Park	Unknown	Non-Native
Plantaginaceae	Plantago lanceolata	32874	Present in Park	Unknown	Non-Native
Poaceae	Poa bulbosa	41116	Present in Park	Unknown	Non-Native
Poaceae	Poa pratensis	41088	Present in Park	Unknown	Non-Native
Poaceae	Polypogon monspeliensis	41171	Present in Park	Unknown	Non-Native
Polygonaceae	Rumex crispus	20937	Present in Park	Unknown	Non-Native
Chenopodiaceae	Salsola kali	20655	Present in Park	Unknown	Non-Native
Caryophyllaceae	Saponaria officinalis	20039	Present in Park	Unknown	Non-Native
Brassicaceae	Sisymbrium altissimum	23312	Present in Park	Unknown	Non-Native
Solanaceae	Solanum dulcamara	30414	Present in Park	Unknown	Non-Native
Poaceae	Thinopyrum ponticum	522542	Present in Park	Unknown	Non-Native
Asteraceae	Tragopogon dubius	38564	Present in Park	Unknown	Non-Native
Zygophyllaceae	Tribulus terrestris	29057	Present in Park	Unknown	Non-Native
Fabaceae	Trifolium pratense	26313	Present in Park	Unknown	Non-Native
Fabaceae	Trifolium repens	26206	Present in Park	Unknown	Non-Native
Scrophulariaceae	Verbascum thapsus	33394	Present in Park	Unknown	Non-Native
Asteraceae	Centaurea repens	510530	Present in Park	Unknown	Noxious
Asteraceae	Centaurea solstitialis	36972	Present in Park	Unknown	Noxious
Asteraceae	Cirsium vulgare	36428	Present in Park	Unknown	Noxious
Convolvulaceae	Convolvulus arvensis	30705	Present in Park	Unknown	Noxious
Asteraceae	Artemisia tridentata ssp. tridentata	35499	Present in Park	Unknown	Unknown
Asteraceae	Artemisia tridentata ssp. wyomingensis	183741	Present in Park	Unknown	Unknown
Chenopodiaceae	Atriplex confertifolia	20519	Present in Park	Unknown	Unknown

Appendix F – Photo Interpretation Mapping Conventions and Visual Key

John Day Fossil Beds National Monument - Map Units

This appendix describes the map units for the John Day Fossil Beds (JODA) Vegetation Inventory Project. Its purpose is to:

- Describe the vegetation of each map unit;
- Provide a representative ground photograph/image for each map unit;
- Describe the link between each map unit and the U.S. National Vegetation Classification;
- Provide visual examples of each map unit with digital overhead images and delineated overlays.

The map units for JODA were based on a combination of NVCS plant associations/alliances, local requests (i.e. Park Specials), the limitations of the digital imagery, and land use / land cover classes. The vegetation described in this section reflects the classification designed specifically for this project. Non-vegetated and land-use map units are not described in this key. For more information on the development of the mapping scheme for JODA please reference the mapping sections of this report and the digital information (i.e. lookup tables, metadata) included on the project DVD.

This key follows the physiognomic grouping of each map unit starting with woodland and forest types. Each map unit is fully described by a variety of characteristics and features. First the NVC crosswalk to associations and the common plant species for each association is presented. Next is a description of the mapping concept and a representative ground photograph. A map of the distribution for each mapping unit across the study area follows along with an example of the NAIP 2009 digital basemap ortho-imagery (true-color bands). The imagery snapshot examples also include representative polygon outlines that highlight the map unit signatures. Many of the map unit descriptions rely heavily on the vegetation plot data collected in 2008. The sample ground photographs were taken during the 2008 plot data collection or during the 2009 accuracy assessment by Northwest Management, Incorporated.

Forests and Woodlands

Map Code *Juniperus occidentalis* / *Artemisia tridentata* Woodland Complex
JUOC/ARTR Western juniper / Big Sagebrush Woodland Complex

Common Species

Juniperus occidentalis, *Artemisia tridentata*,
Purshia tridentata, *Pseudoroegneria spicata*,
Festuca idahoensis

NVCS Associations

-*Juniperus occidentalis* / *Artemisia tridentata* - *Purshia tridentata* Wooded Herbaceous Vegetation
-*Juniperus occidentalis* / *Artemisia tridentata* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation

Representative Ground Photo



Description

Western juniper with predominately big sagebrush and bitterbrush in the understory was fairly common in all three units of JODA. Stands of this type usually occurred on hillslopes and alluvial fans intermixed with Wyoming big sagebrush and grassland polygons. The western juniper was mostly moderate to sparse with sufficient space for sagebrush/bitterbrush to occur in the openings. This map unit was expressed as dark green to black dots with a coarse, pebbly, gray photo signature due to the sagebrush on the imagery. Very sparse stands supported high understory cover with a resulting photo signature of thick gray (shrubs) on tan (herbaceous) background color. Stands of this type may have been confused with the other western juniper types especially if the sagebrush was sparse.

Range and Distribution

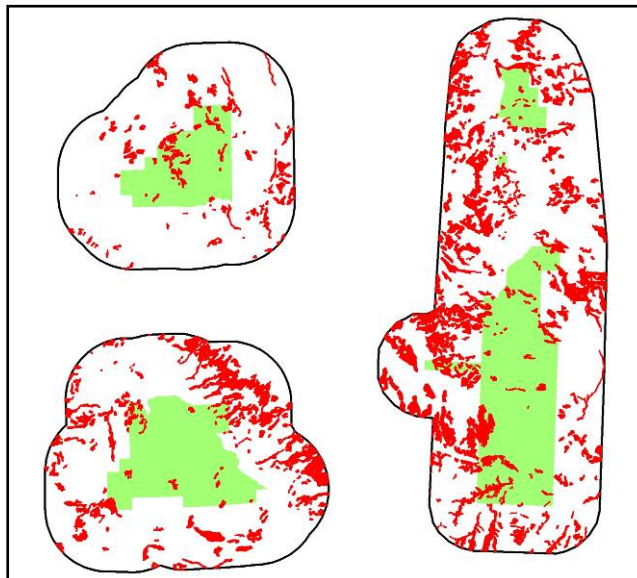
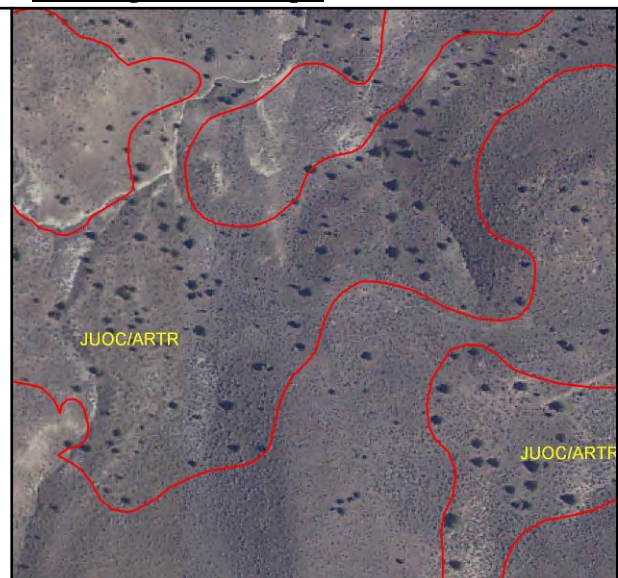
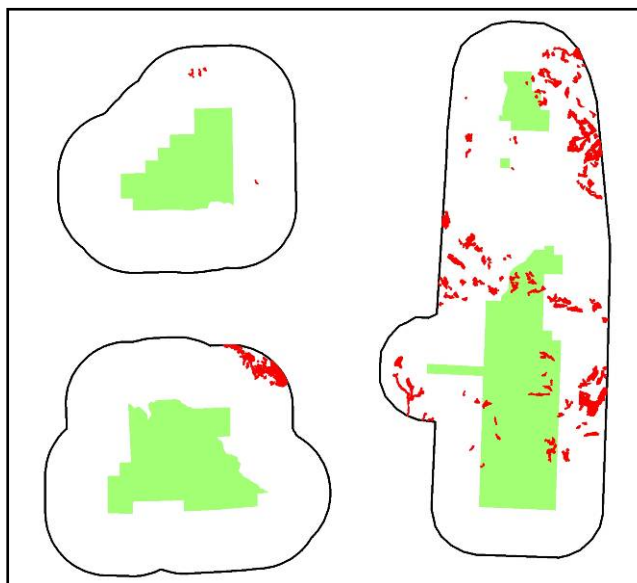
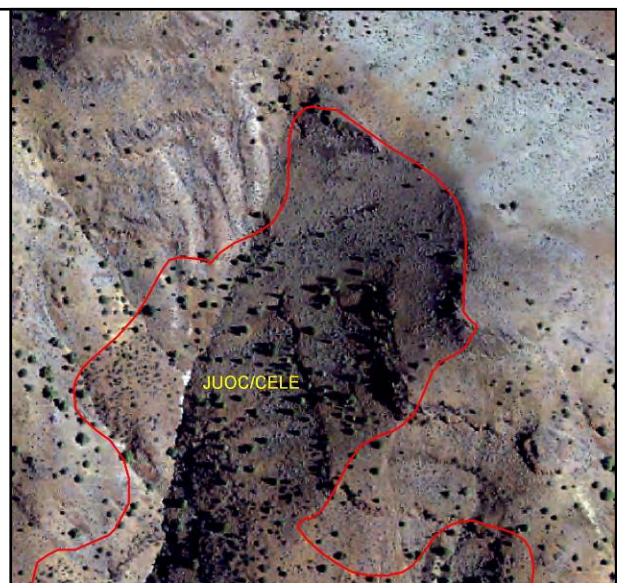


Photo Signature Example



Map Code***Cercocarpus ledifolius* / *Pseudoroegneria spicata****Juniperus occidentalis* –**JUOC/CELE Woodland****Western Juniper / Curl-leaf Mountain-mahogany / Bluebunch Wheatgrass
Woodland****Common Species***Juniperus occidentalis*, *Cercocarpus ledifolius*, *Pseudoroegneria spicata*,
*Festuca idahoensis***NVCS Association***-Juniperus occidentalis* / *Cercocarpus ledifolius* / *Pseudoroegneria spicata*
Woodland**Representative Ground Photo****Description**

Western juniper with curl-leaf mountain-mahogany in the understory was fairly common in the Sheeprock Unit but sparse to rare in the other two units. This type occurred primarily on rocky canyon walls, cliffs, and steep outcrops and was intermixed with the other western juniper and curl-leaf mountain-mahogany map units. This type was expressed on the imagery as dark-green colored trees on a tan or brown matrix with large gray pebbles representing the mountain-mahogany shrubs (larger than similar sagebrush shrubs) in the understory. Mapping of this type was based primarily on its signature and secondarily on topographic position.

Range and Distribution**Photo Signature Example**

Map Unit *Juniperus occidentalis* Wooded Herbaceous Alliance
JUOC/HERB **Western Juniper Wooded Herbaceous Alliance**

Common Species

Juniperus occidentalis, *Pseudoroegneria spicata*, *Festuca idahoensis*, *Achnatherum thurberianum*

NVCS Associations

-*Juniperus occidentalis* / *Achnatherum thurberianum* Wooded Herbaceous Vegetation

-*Juniperus occidentalis* / *Festuca idahoensis* Wooded Herbaceous Vegetation

-*Juniperus occidentalis* / *Pseudoroegneria spicata* Wooded Herbaceous Vegetation

Representative Ground Photo



Description

Western juniper with a native grass understory was very common in all three units of JODA, occurring on hilltops, dry slopes, alluvial fans and as encoachments on toeslopes and floodplains. Western juniper trees were usually sparse in cover with large canopy openings devoid of shrubs. The photo signature for this type was fairly unique containing large dark-green dots (junipers) on a tan, brown, or gray background. The obvious absence of shrubs (sagebrush, mountain-mahogany) and cheatgrass was critical to mapping this type. The closeness of this type to the other western juniper mapping units likely resulted in some confusion during map attribution.

Range and Distribution

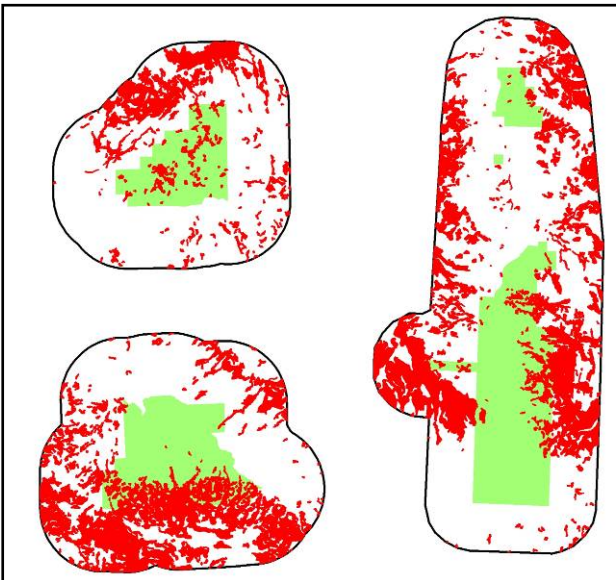
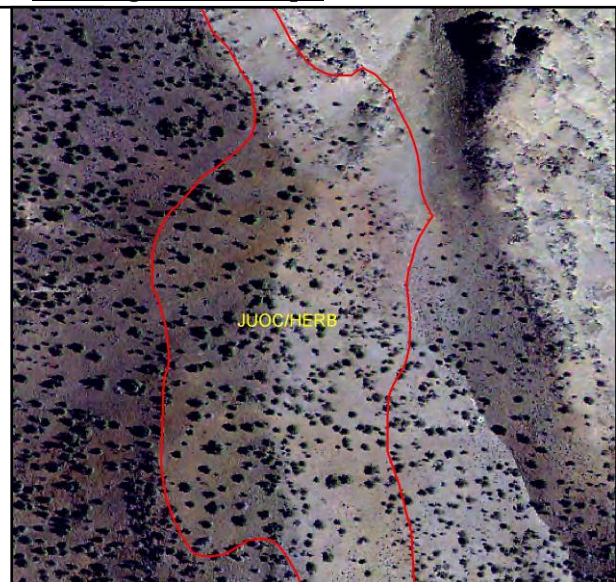


Photo Signature Example



Map Unit	<i>Juniperus occidentalis</i> Sparse Ash Bed Woodland
JUOC/ASH	Western Juniper Sparse Ash Bed Woodland

Common Species

Juniperus occidentalis, *Helianthus nuttallii*, *Cleome platycarpa*,
Eriogonum strictum, *Poa secunda*,
Salvia dorrii, *Pseudoroegneria spicata*,
Artemisia rigida

NVCS Association

-*Juniperus occidentalis* / *Artemisia rigida*
 / *Poa secunda* Wooded Herbaceous
 Vegetation

Representative Ground Photo



Description

Western juniper stands occurring on ash and tuff exposures were fairly rare throughout the entire study area. Typically this type was associated with a very sparse understory represented by smooth, bright white, gray or redish soils. Understory composition varies greatly depending on the location; either containing many of the shrubs and grasses common to these geologic exposures or other common shrubs and grasses where the soil is more developed. This species overlap likely resulted in confusion with the other vegetated ash and juniper mapping units. *Artemisia rigida* was unique to this type, primarily in the Sheeprock Unit, but the small stature of this shrub coupled with the high soil reflectance made it impossible to delineate it from the other understory species. On the imagery the western juniper appeared as dark-green dots.

Range and Distribution

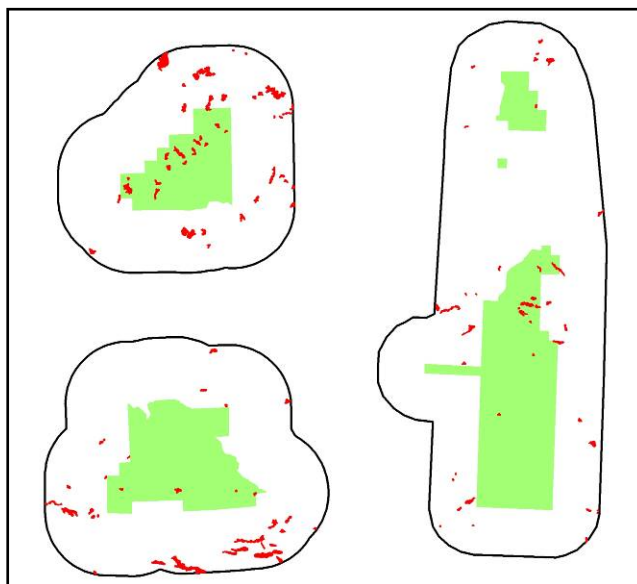


Photo Signature Example



Map Unit *Juniperus occidentalis* / *Bromus tectorum* Woodland
JUOC/BRTE **Western Juniper / Cheatgrass Woodland**

Common Species

Juniperus occidentalis, *Bromus tectorum*,
Gutierrezia sarathae, *Taeniatherum*
caput-medusae, *Poa bulbosa*

Representative Ground Photo



NVCS Association

Local Stand (no NVCS Association at this time)

Description

Stands of western juniper associated with mixed weedy herbaceous vegetation were found in scattered, disturbed areas across all three units and in the surrounding environs. In all locations western juniper trees were often found encroaching onto floodplains, toeslopes, benches and other flat areas. Cheatgrass was the dominant understory species but it often intermixed with other non-native grasses, forbs and some native bunchgrasses. This type is not currently in the NVC but due to management considerations it was split out from the other western juniper types, likely resulting in some mapping confusion. On the NAIP imagery the western juniper trees appeared as sparse dark-green dots with a mottled orangish brown background (little to no shrubs) and evidence of fire, clearing, or downed trees often aided in the delineation.

Range and Distribution

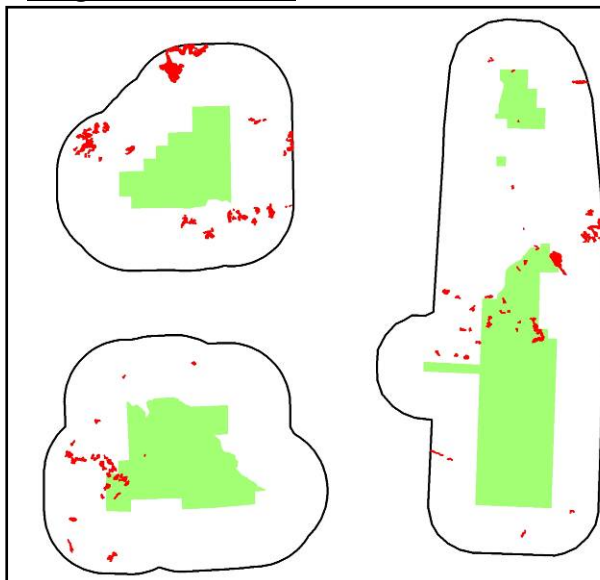
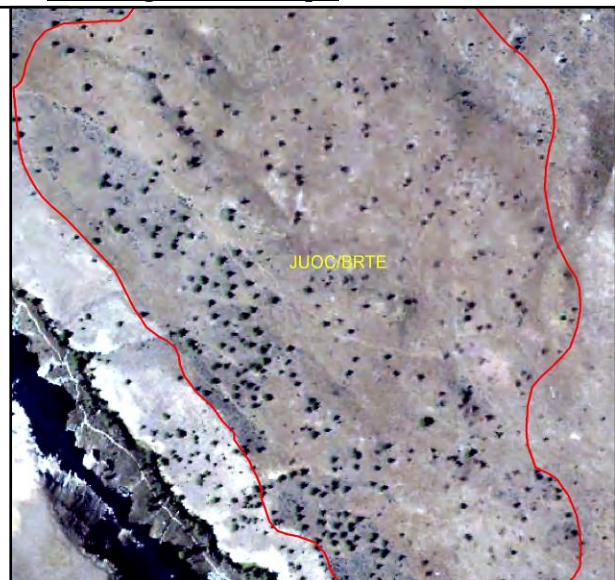


Photo Signature Example



Map Unit	<i>Celtis laevigata</i> var. <i>reticulata</i> / <i>Pseudoroegneria spicata</i> Woodland
CELA	Netleaf Hackberry / Bluebunch Wheatgrass Woodland

Common Species

Celtis laevigata var. *reticulata*,
Pseudoroegneria spicata, *Bromus*
tectorum, *Artemisia tridentata* ssp.
wyomingensis

NVCS Association

- *Celtis laevigata* var. *reticulata* /
Pseudoroegneria spicata Woodland

Representative Ground Photo



Description

Netleaf hackberry only occurred in one mappable stand in the Clarno Unit of JODA. Here it was represented by small, scattered trees located on a cobble slope below a rock outcrop. Other hackberry trees are likely present in JODA but are minor associates in other plant communities. On the imagery this type appeared as sparse, green flecks intermixed with large rocks. Mapping of this type was based on previous known locations and more field work could be done to better determine the distribution of this type.

Range and Distribution

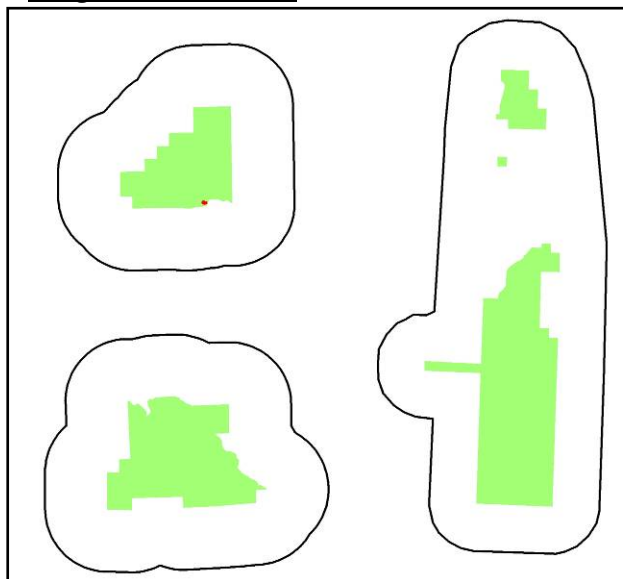


Photo Signature Example



Map Unit	<i>Alnus rhombifolia</i> Temporarily Flooded Forest Alliance
ALRH	White Alder Temporarily Flooded Forest Alliance

Common Species

Alnus incana, *Prunus virginiana*,
Leymus cinereus, *Populus balsamifera*
 ssp. *trichocarpa*, *Alnus rhombifolia*,
Salix exigua, *Rosa woodsii*,
Schoenoplectus americanus, *Eleocharis*
palustris, *Populus balsamifera* ssp.
trichocarpa, *Typha latifolia*, *Typha*
angustifolia

NVCS Associations

-*Alnus rhombifolia* / *Philadelphus lewisii*
 Forest
 -*Alnus rhombifolia* / *Rosa woodsii* Forest

Representative Ground Photo



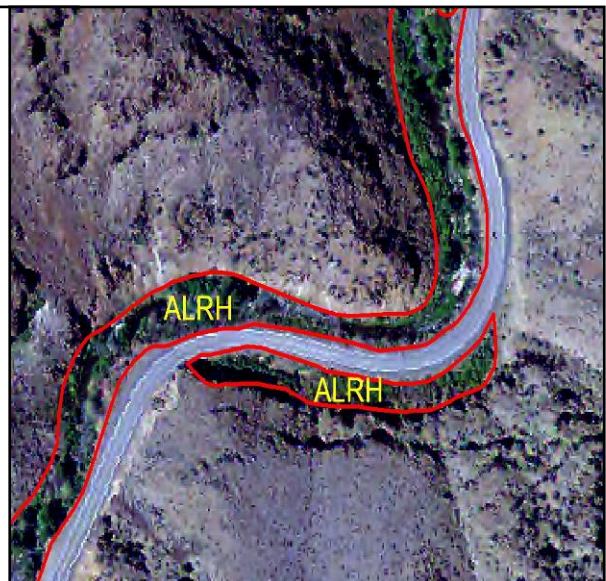
Description

White alder was a common riparian species along the John Day River and its major tributaries in the Sheeprock Unit. It also occurred in a few small stands in the riparian corridor of the Painted Hills Unit. White alder often intermixed or occurred adjacent to the cottonwood, willow and cattail map units. This map unit is characterized by small to medium-size shrubs located in long bands next to streams and rivers. When small, white alder shrubs exhibited a smooth dark green signature changing to a coarser green signature when larger shrubs occurred on the ortho-imagery. Due to the close similarity of signatures and intermixing of common species, this map unit may have been confused with the cottonwood, willow and other riparian types.

Range and Distribution



Photo Signature Example



Map Unit	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i> Temporarily Flooded Forest Alliance
POBA	Black Cottonwood Temporarily Flooded Forest Alliance

Common Species

Populus balsamifera ssp. *trichocarpa*,
Alnus rhombifolia, *Salix exigua*, *Rosa*
woodsii, *Schoenoplectus americanus*,
Eleocharis palustris, *Typha latifolia*,
Typha angustifolia, *Leymus cinereus*

NVCS Associations

-*Populus balsamifera* ssp. *trichocarpa* /
Alnus incana Forest
-*Populus balsamifera* ssp. *trichocarpa* /
Salix exigua Forest

Representative Ground Photo



Description

Black cottonwood woodlands were common in the riparian areas of all three units at JODA. This map unit often occurred in close proximity to the white alder, willow, and cattail map units sharing similar species. This combination of deciduous trees and shrubs presented itself as bright blue-green bands with a coarse signature on the imagery. It is likely that some minor confusion exists in the mapping of this type and the other riparian units. This map unit was also used to attribute larger more mature trees located in and around agricultural lands and maintained sites. In these areas the individual black cottonwood trees appeared as large green spots and the understory signature was typically bright green (lawn). It is likely that in these settings this map unit may have inadvertently been used to delineate other planted deciduous trees.

Range and Distribution

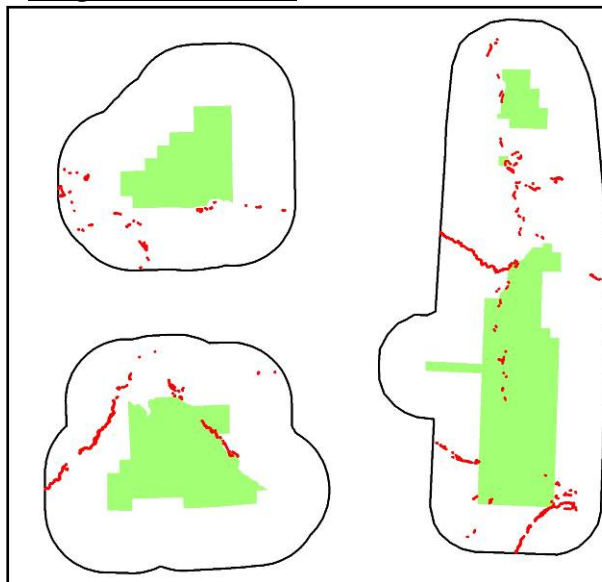


Photo Signature Example



Map Unit	<i>Elaeagnus angustifolia</i> Semi-natural Woodland Alliance
ELAN	Russian-olive Semi-natural Woodland Alliance

Common Species

Elaeagnus angustifolia

NVCS Alliance

-*Elaeagnus angustifolia* Semi-natural Woodland Alliance

Representative Ground Photo



Description

Russian olive trees were rare in the study area and were only found primarily outside of the Monument in the environs. Polygons of this map unit occurred along stream and river corridors where they were likely intermixed with other riparian species such as alders, willows and cottonwoods. This map unit had a very distinct pale, blue-green signature and individual trees could be discerned on the 2009 imagery

Range and Distribution

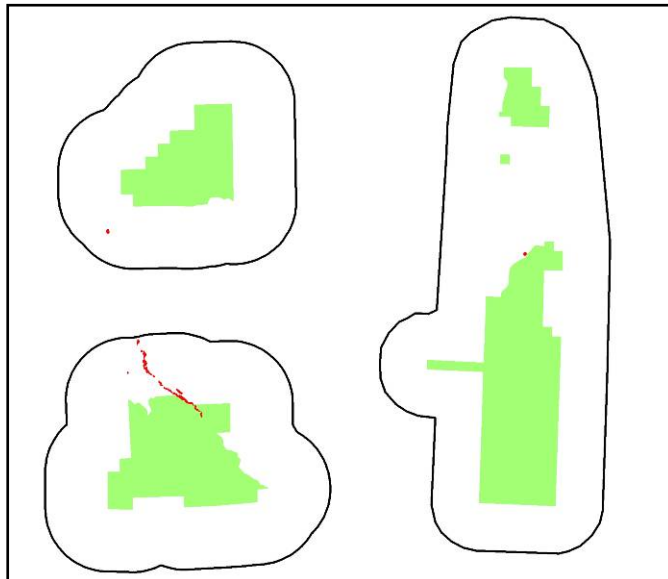
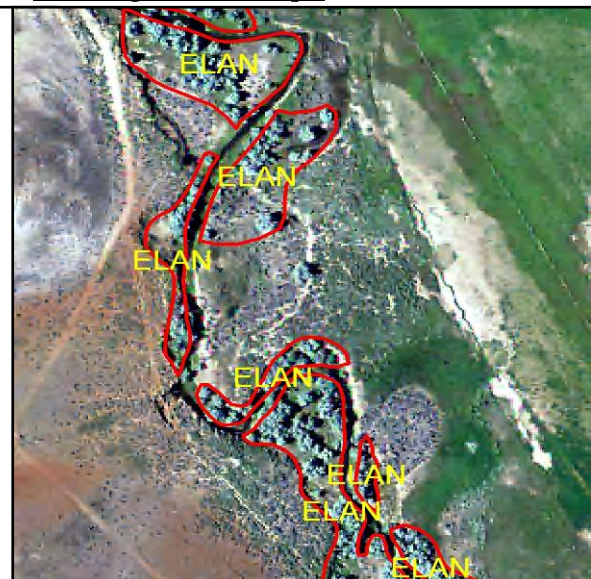


Photo Signature Example



Shrublands

Map Unit	<i>Cercocarpus ledifolius</i> Shrubland Alliance
CELE	Curl-leaf Mountain-mahogany Shrubland Alliance

Common Species

Cercocarpus ledifolius, *Purshia tridentata*, *Artemisia tridentata*, *Juniperus occidentalis*, *Pseudoroegneria spicata*, *Festuca idahoensis*, *Achnatherum thurberianum*

NVCS Associations

-*Cercocarpus ledifolius* - *Artemisia tridentata* Shrubland
 - *Cercocarpus ledifolius* / *Pseudoroegneria spicata* Shrubland

Representative Ground Photo



Description

Curl-leaf mountain-mahogany shrubs were common in the Sheeprock Unit and rare in the other two units. In the Sheeprock Unit it occurred on steep slopes, ridges and canyon outcrops, often surrounded by western juniper stands. The understory of this type was mostly dominated by a mix of native grasses. This type had an unique signature that included large gray spots indicating individual curl-leaf mountain mahogany shrubs against a tan or brown background. Curl-leaf mountain-mahogany stands had a similar appearance to short juniper trees and some confusion may have occurred between this map unit and the western juniper / curl-leaf mountain-mahogany type during delineation.

Range and Distribution

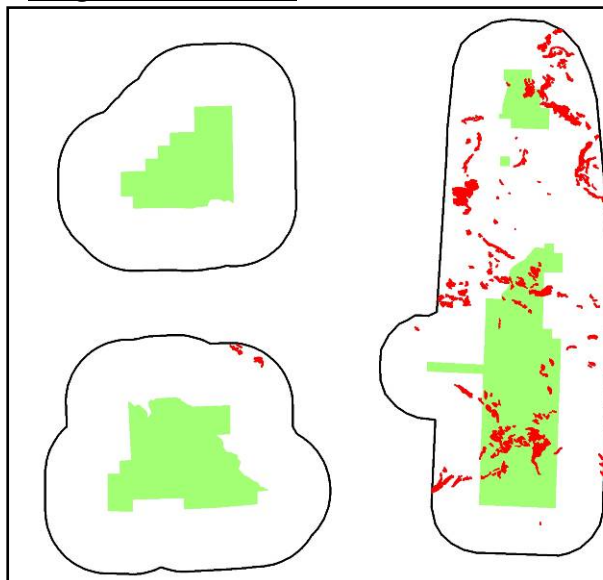
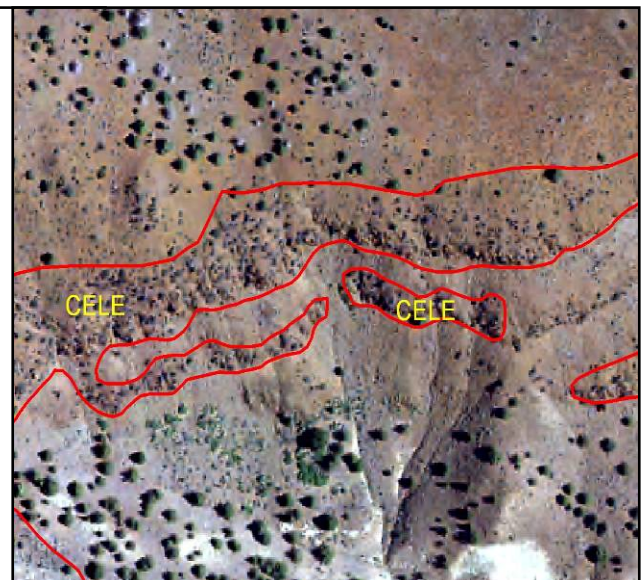


Photo Signature Example



Map Unit	<i>Artemisia arbuscula</i> ssp. <i>arbuscula</i> - (<i>Artemisia rigida</i>) Shrub Herbaceous
ARAR	Complex
	Dwarf Sagebrush - (Scabland Sagebrush) Shrub Herbaceous Complex

Common Species

Artemisia arbuscula ssp. *arbuscula*,
Pseudoroegneria spicata, *Artemisia*
rigida, *Festuca idahoensis*

NVCS Associations

-*Artemisia arbuscula* ssp. *arbuscula* /
Pseudoroegneria spicata Shrub
Herbaceous Vegetation
-Artemisia rigida / *Pseudoroegneria*
spicata Shrub Herbaceous Vegetation

Representative Ground Photo



Description

Dwarf and scabland sagebrush are likely prevalent in the study area but were rarely found in large, homogenous stands. Instead, they likely occur as associates with the other sagebrush and the ash/tuff map units. Two polygons were documented and subsequently mapping in the Sheeprock Unit where they occurred on ridgetops and arid slopes. This map unit contained a primarily native grass understory and was found adjacent to western juniper stands. Overall, both sagebrushes in this type exhibited a light gray, barren or smooth-textured signature on the imagery due to the high percentage of bare ground and short stature of this plant community.

Range and Distribution

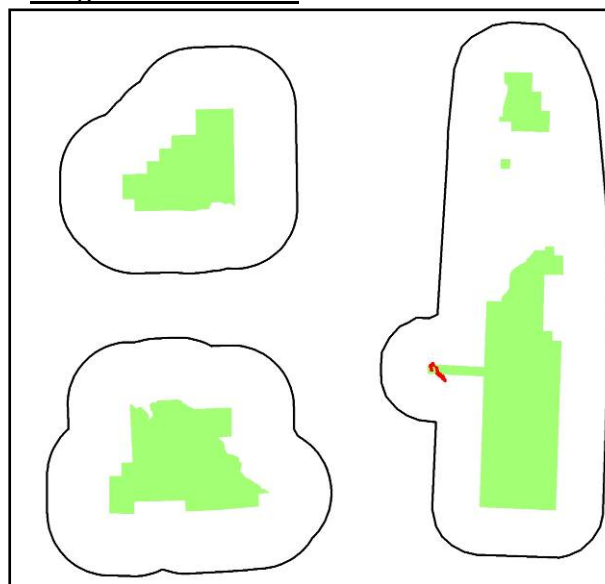
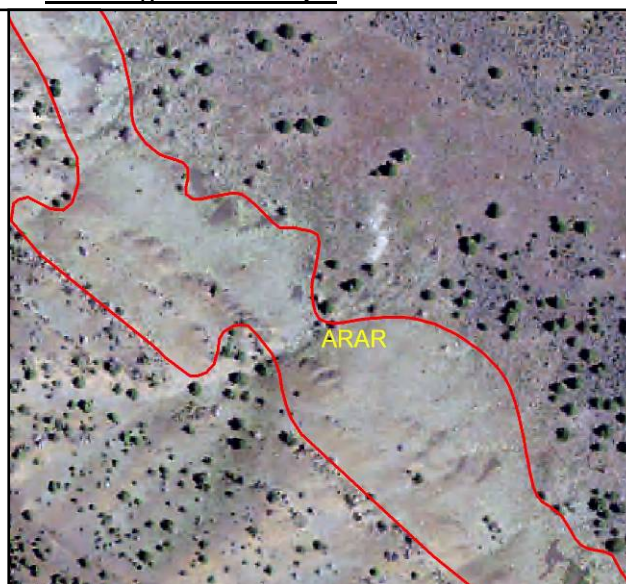


Photo Signature Example



Map Unit	<i>Artemisia tridentata</i> ssp. <i>tridentata</i> - (<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>) -
ARTR/SAVE	<i>Sarcobatus vermiculatus</i> Shrubland Complex
	Basin Big Sagebrush - (Wyoming Big Sagebrush) - Greasewood Shrubland Complex

Common Species

Artemisia tridentata ssp. *tridentata*,
Artemisia tridentata ssp. *wyomingensis*,
Sarcobatus vermiculatus,
Atriplex confertifolia,
Pseudoroegneria spicata, *Leymus*
cinereus, *Festuca idahoensis*, *Bromus*
tectorum

NVCS Associations

-*Artemisia tridentata* ssp. *wyomingensis* -
Atriplex confertifolia - *Sarcobatus*
vermiculatus Shrubland
-*Artemisia tridentata* ssp. *tridentata* /
Leymus cinereus Shrubland

Representative Ground Photo



Description

Basin big sagebrush has a scattered distribution on deep floodplain soils around the John Day River and its tributaries. In all three units basin big sagebrush often intermixed with Wyoming big sagebrush and the possible hybridization may have resulted in confusion in interpretation, delineation, and plant identification. This map unit appeared to have robust shrubs yielding a very characteristic mottled or broken signature. This signature often included patches of brown representing grass-dominated patches and white specks indicating bare ground or rocks. Greasewood was a common associate appearing as dark green dots. This type often contained cheatgrass in the understory along with similar species found in the other sagebrush map units.

Range and Distribution

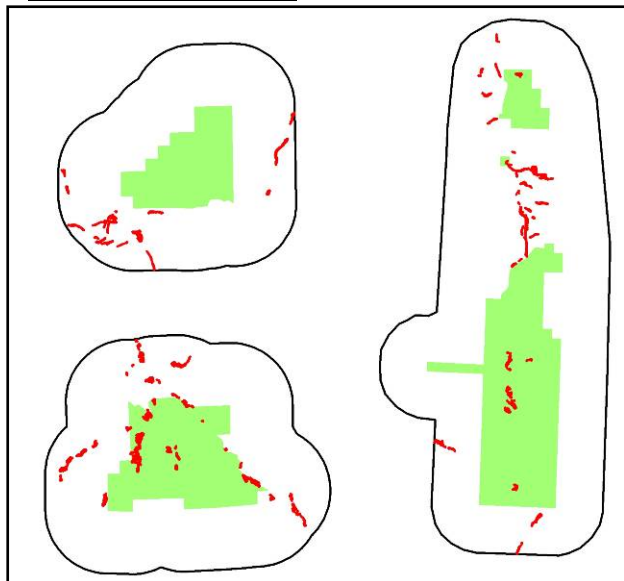
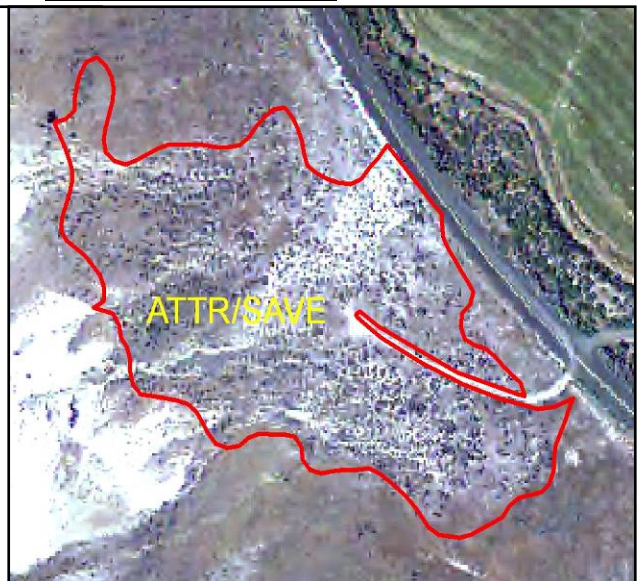


Photo Signature Example



Map Unit	<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i> Shrubland Complex
ARTRW	Wyoming Big Sagebrush Shrubland Complex

Common Species

Artemisia tridentata ssp. *wyomingensis*,
Purshia tridentata, *Achnatherum*
thurberianum, *Festuca idahoensis*,
Bromus tectorum, *Pseudoroegneria*
spicata, *Poa secunda*

NVCS Associations

-*Artemisia tridentata* ssp. *wyomingensis* -
Purshia tridentata / *Pseudoroegneria*
spicata Shrubland
-*Artemisia tridentata* ssp. *wyomingensis* /
Poa secunda Shrubland
-*Artemisia tridentata* ssp. *wyomingensis* /
Achnatherum thurberianum –
Pseudoroegneria spicata Steppe
-*Artemisia tridentata* ssp. *wyomingensis* /
Festuca idahoensis Shrub Herbaceous
-*Artemisia tridentata* ssp. *wyomingensis* /
Pseudoroegneria spicata Shrub
Herbaceous Vegetation

Representative Ground Photo



Description

Wyoming big sagebrush was very common across the upland plains, slopes, and terraces throughout the project area. Native grasses, varying in composition and density were common in the understory. On the 2009 imagery this map unit varied in appearance from dispersed medium-sized gray dots against a white or gray background to a homogenous gray mottled texture on a light tan background. Due to its similarity in size, shape, and color to shadescale, bitterbrush, horsebrush, and other shrubs this map unit may have been confused with these types during delineation.

Range and Distribution

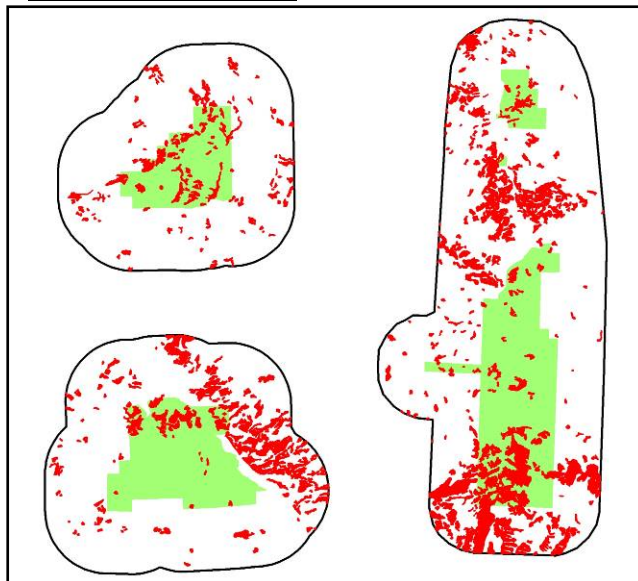
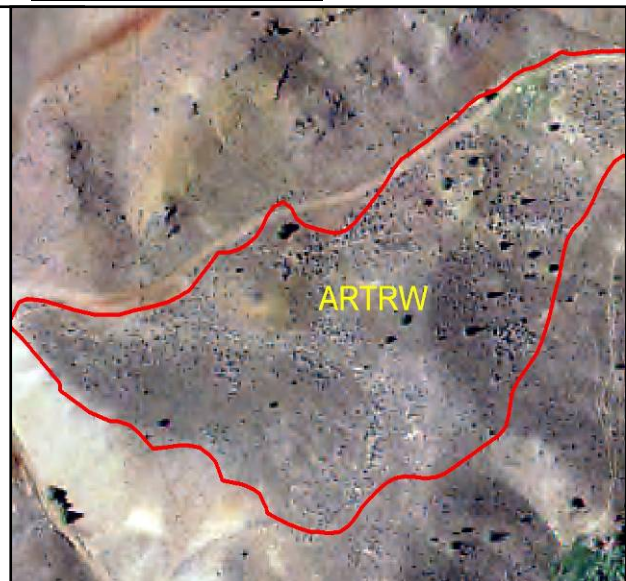


Photo Signature Example

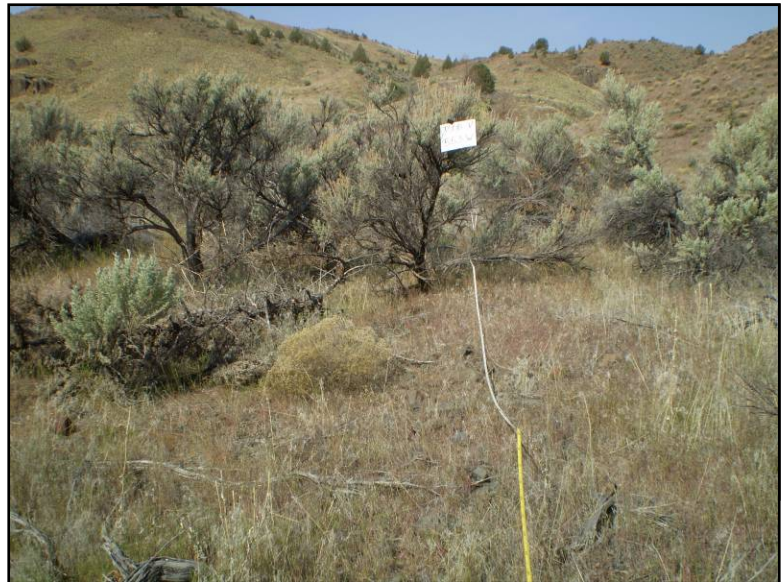


Map Unit *Artemisia tridentata ssp. wyomingensis* / *Bromus tectorum* Shrubland
ARTRW/BRTE **Wyoming Big Sagebrush / Cheatgrass Shrubland**

Common Species

Artemisia tridentata ssp. wyomingensis,
Poa secunda, *Atriplex canescens*,
Gutierrezia sarathae, *Bromus tectorum*,
Taeniatherum caput-medusae,
Poa bulbosa

Representative Ground Photo



NVCS Associations

-*Artemisia tridentata ssp. wyomingensis* /
Bromus tectorum Shrubland

Description

This map unit was widespread throughout the project area occurring on upland terraces, slopes and valleys. Much like the other Wyoming big sagebrush map classes, this type occurred as both dense shrublands on flat plains and as sparse shrublands on eroding slopes. This unit is characterized by the high cover of cheatgrass in the understory, often excluding all other vegetation except the sagebrush. In some areas the sagebrush appeared nearly dead due to fire or insect infestations. On the 2009 imagery this unit appeared as gray, mottled dots on a orange-yellow (slightly hazy) background color. Since this map unit contained many of the same species as the other sagebrush map units, some confusion likely occurred when trying to delineate between them.

Range and Distribution

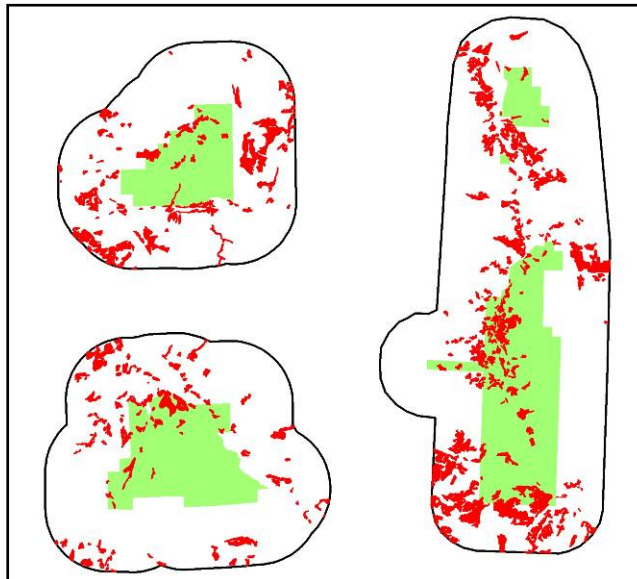
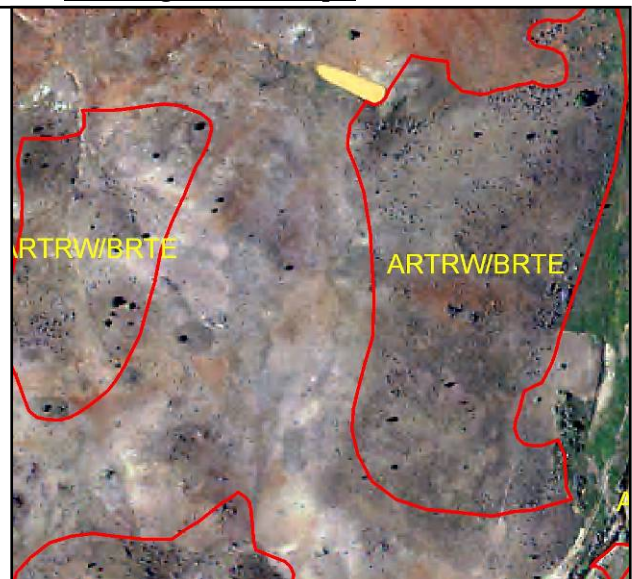


Photo Signature Example



Map Unit	<i>Atriplex confertifolia</i> Shrubland Alliance
ATCO	Shadscale Shrubland Alliance

Common Species

Atriplex confertifolia, *Bromus tectorum*,
Elymus elymoides, *Pseudoroegneria*
spicata, *Gutierrezia sarathae*,
Chrysothamnus viscidiflorus

Representative Ground Photo



NVCS Association

-*Atriplex confertifolia* / *Bromus tectorum*
Shrubland
-Atriplex confertifolia / *Elymus elymoides*
Shrubland
-Atriplex confertifolia / *Pseudoroegneria*
spicata Shrubland
-Atriplex confertifolia Sparse Shrubland

Description

Shadscale was found throughout JODA occurring on thin, alkali soils associated with erosion fans and badland formations. This map unit was particularly common in the Painted Hills unit and less so in the other two units. Where it occurred this type usually contained sparse, short shrubs with a mix of native grasses and cheatgrass. Originally this map unit was split into two units (one with cheatgrass and one without) that were later combined as a result of accuracy assessment. For the most part, the original linework for these two types was retained and the presence of cheatgrass as the dominant is stored in the polygon comments field. This type varied greatly in appearance ranging from dark gray dots (taller shrubs) to smooth, solid white, red, or tan stands (dwarf shrubs) depending on soil color and the presence of grasses. On the imagery shadscale was visible as gray smudges and dots and this characteristic was used to separate this map unit from the other ash/tuff shrubland types

Range and Distribution

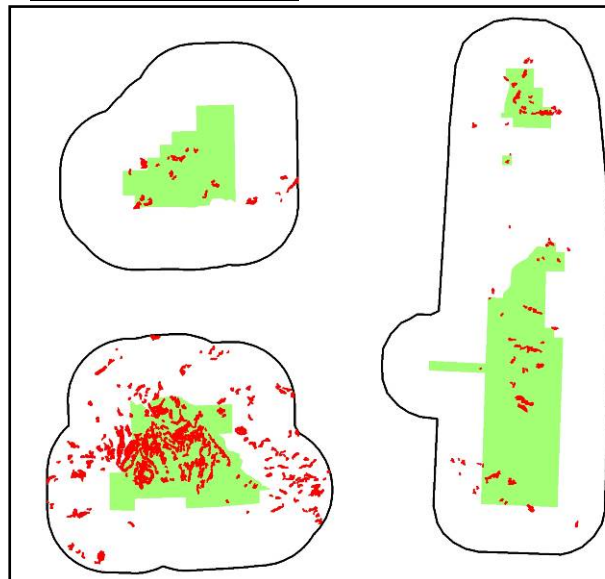
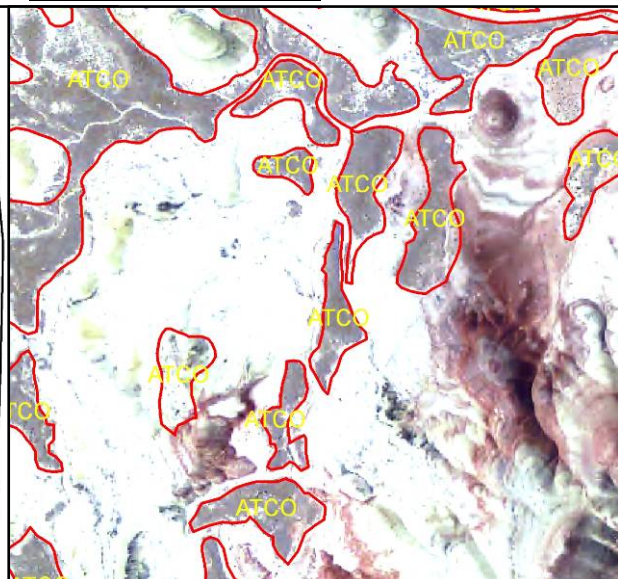


Photo Signature Example



Map Unit *Chrysothamnus viscidiflorus* / *Bromus tectorum* Shrubland
CHVI/BRTE **Green Rabbitbrush / Cheatgrass Shrubland**

Common Species

Chrysothamnus viscidiflorus, *Bromus tectorum*, *Atriplex confertifolia*, *Pseudoroegneria spicata*, *Gutierrezia sarathae*, *Artemisia tridentata* ssp. *wyomingensis*, *Pseudoroegneria spicata*, *Festuca idahoensis*

NVCS Association

-*Chrysothamnus viscidiflorus* / *Bromus tectorum* Shrubland

Representative Ground Photo



Description

Stands of green rabbitbrush were rare throughout the project area, although individual shrubs were found associated with many of the other shrubland map units. Where it did occur this type was usually on disturbed, flat uplands and floodplains. This map unit often intermixed with the sagebrush map units and often contained similar associated species including cheatgrass. On the imagery, green rabbitbrush was seen as olive-green flecks with an orange-brown background color.

Range and Distribution

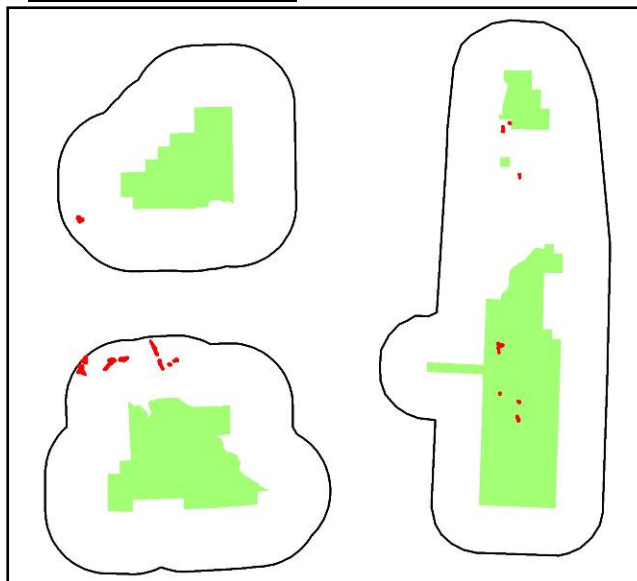


Photo Signature Example



Map Unit	<i>Tetradymia canescens</i> / <i>Poa secunda</i> Shrubland
TECA	Gray Horsebrush / Curly bluegrass Shrubland

Common Species

Tetradymia canescens, *Poa secunda*,
Chrysothamnus viscidiflorus, *Bromus*
tectorum, *Pseudoroegneria spicata*,
Artemisia tridentata ssp. *wyomingensis*,
Pseudoroegneria spicata, *Festuca*
idahoensis

NVCS Association

- *Tetradymia canescens* / *Poa secunda*
Shrubland

Representative Ground Photo



Description

Gray horsebrush only occurred in two mappable stands in the Sheeprock unit (locations are based on the classification plot data). Because horsebrush is similar in growth-form to species of sagebrush it is likely that other stands exist and were not mapped. On the 2009 imagery this type exhibited an olive-green mottled signature against a tan background. The shrubs appeared short in stature.

Range and Distribution

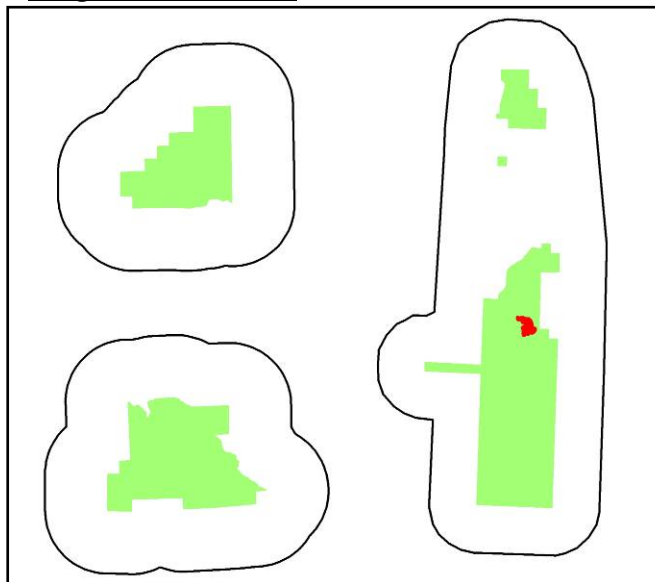
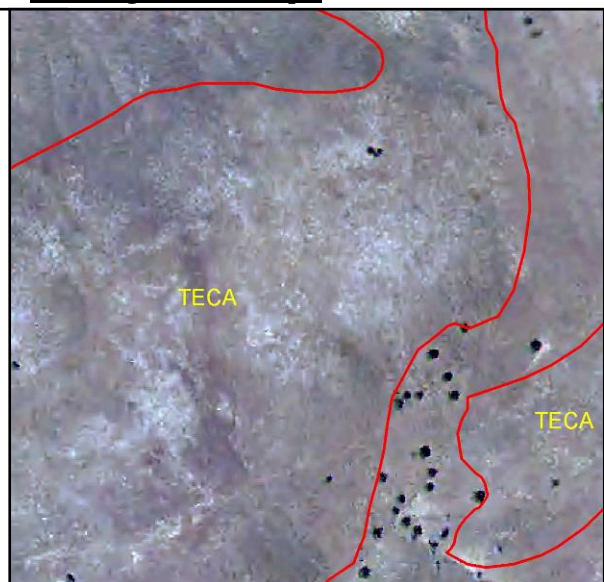


Photo Signature Example



Map Unit	<i>Sarcobatus vermiculatus</i> Intermittently Flooded Shrubland Alliance
SAVE	Greasewood Intermittently Flooded Shrubland Alliance

Common Species

Sarcobatus vermiculatus,
Leymus cinereus, *Bromus tectorum*,
Festuca idahoensis, *Pseudoroegneria*
spicata, *Atriplex confertifolia*

NVCS Associations

-*Sarcobatus vermiculatus* / *Leymus*
cinereus Shrubland
 -*Sarcobatus vermiculatus* / *Bromus*
tectorum Shrubland

Representative Ground Photo



Description

Greasewood was a common map unit throughout the floodplains along the John Day River and its tributaries. Polygons of this type often contained cheatgrass in the understory along with similar species found in the sagebrush map units. On the 2009 imagery this type appeared as dark, olive-green dots against a tan or brown background. When greasewood occurred in higher densities it often had a rougher signature and was less brown and grayer in appearance. This type differed from the sagebrush/greasewood map unit due to the obvious absence of sagebrush. Species overlap between these two types may have led to some confusion in the mapping.

Range and Distribution

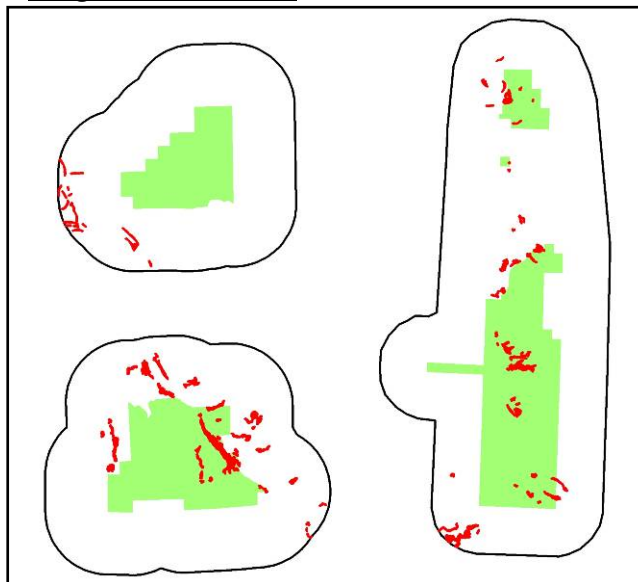


Photo Signature Example



Map Unit	<i>Salix exigua</i> - (<i>Rosa woodsii</i>) Temporarily Flooded Shrubland Complex
SALX	Coyote Willow - (Woods' Rose) Temporarily Flooded Shrubland Complex

Common Species

Salix exigua, *Rosa woodsii*,
Schoenoplectus americanus, *Eleocharis palustris*, *Populus balsamifera* ssp. *trichocarpa*, *Typha latifolia*, *Typha angustifolia*, *Leymus cinereus*

NVCS Associations

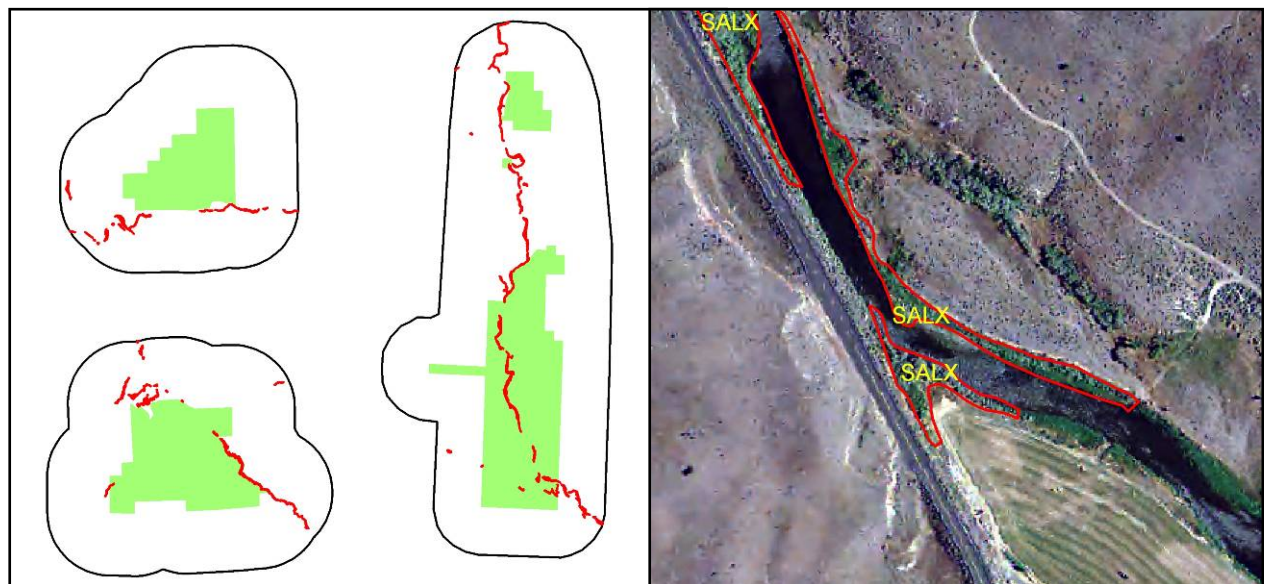
-*Rosa woodsii* Shrubland
 -*Salix exigua* / Barren Shrubland
 -*Salix exigua* / *Eleocharis palustris* -
Schoenoplectus americanus Shrubland
 -*Salix exigua* - *Rosa woodsii* Shrubland

Representative Ground Photo



Description

Long bands of coyote willow and Wood's rose were observed in riparian and mesic sites throughout the project area, often intermixed or occurring adjacent to the cottonwood and alder map units. This type is characterized by having small to medium-sized willow and rose shrubs often with associated trees. When the willows and roses were small they appeared as a slightly mottled to smooth light green signature changing to a more dark green when the willows became more dominant than the rose. Due to the close similarity of their signatures and their intermixing, this type was likely confused with the cottonwood, cattail, and alder map units during the mapping.



Map Unit	<i>Prunus virginiana</i> - (<i>Prunus americana</i>) Shrubland
PRVI	Chokecherry - (American Plum) Shrubland

Common Species

Prunus virginiana, *Prunus americana*
Leymus cinereus, *Festuca idahoensis*,
Pseudoroegneria spicata

NVCS Association

- *Prunus virginiana* - (*Prunus americana*)
Shrubland

Representative Ground Photo



Description

Small stands of chokecherry shrubs were observed in mesic drainages, small canyons and draws in the Sheeprock and Painted Hills Units. Chokecherry and plum shrubs were also likely present in the riparian corridors but were never found to be the dominate species. The chokecherry map unit was characterized by small to medium-sized shrubs occurring in thick, dense stands with few associated species. On the ortho-imagery this map unit appeared as an olive green color with a smooth-texture when small in stature and as a coarser olive-green when the shrubs were taller.

Range and Distribution



Photo Signature Example



Herbaceous Vegetation

Map Unit	<i>Pseudoroegneria spicata</i> - <i>Festuca idahoensis</i> Canyon Herbaceous Vegetation
FEID	Bluebunch Wheatgrass - Idaho Fescue Canyon Herbaceous Vegetation

Common Species

Festuca idahoensis, *Pseudoroegneria spicata*, *Sporobolus cryptandrus*, *Artemisia tridentata* ssp. *wyomingensis*, *Purshia tridentata*, *Achnatherum thurberianum*, *Poa secunda*

NVCS Association

-*Pseudoroegneria spicata* - *Festuca idahoensis* Canyon Herbaceous Vegetation

Representative Ground Photo



Description

This widespread, native grassland type was very similar to the bluebunch wheatgrass (Map Unit PSSP) and the Thurber's needlegrass (Map Unit ACTH) map units in both appearance and composition. This type was separated from the others due to its location on steep slopes, canyon walls and ridgetops. In these locations Idaho fescue was the dominant grass often forming thick stands. The density of native grasses varied greatly from sparse communities on rocky cliffs to denser stands on loams and other established soil types. On the 2009 imagery this map unit appeared as a rich, smooth tan signature due to the lack of shrubs and juniper trees.

Range and Distribution

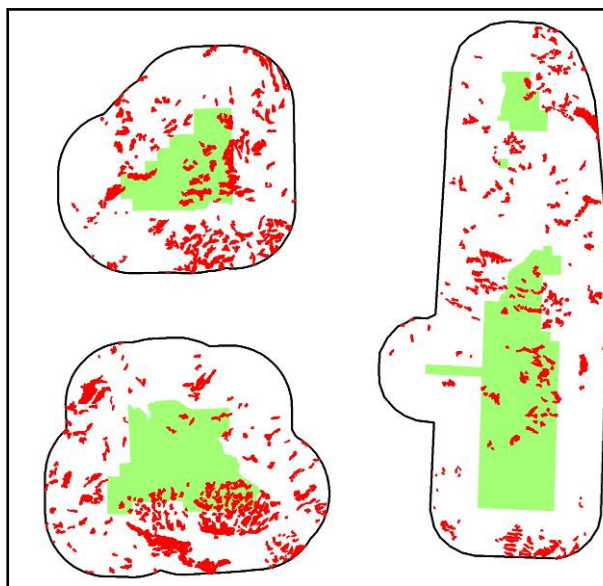
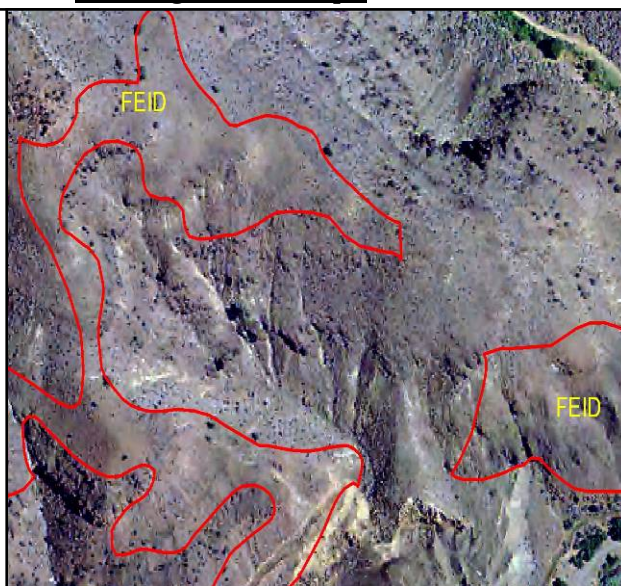


Photo Signature Example



Map Unit	<i>Pseudoroegneria spicata</i> - (<i>Sporobolus cryptandrus</i> - <i>Poa secunda</i>)
PSSP	Herbaceous Vegetation Complex
	Bluebunch Wheatgrass – (Sand Dropseed - Curly Bluegrass) Herbaceous Vegetation Complex

Common Species

Balsamorhiza sagittata, *Pseudoroegneria spicata*, *Sporobolus cryptandrus*, *Artemisia tridentata* ssp. *wyomingensis*, *Purshia tridentata*, *Achnatherum thurberianum*, *Festuca idahoensis*, *Poa secunda*

NVCS Associations

-*Pseudoroegneria spicata* - *Balsamorhiza sagittata* - *Poa secunda* Herbaceous Vegetation

-*Sporobolus cryptandrus* - *Poa secunda* Herbaceous Vegetation

Representative Ground Photo



Description

Bluebunch wheatgrass was the most dominate native grass found at JODA and this mapping unit was common throughout all three units occurring on plains, slopes, hilltops and alluvial fans. Polygons of this type represent many different types of grasslands with varying amounts of bluebunch wheatgrass, Thurber's needlegrass, Idaho fescue, and other native grasses. Although non-native species, including cheatgrass were sometimes present they did not form the monotypic stands as occur elsewhere in the mapping area. The density of native grasses varied greatly from sparse communities on thin soils to denser stands on loams and other established soil types. On the ortho-imagery this map unit appeared as a mottled, smooth signature due to the lack of shrubs and varied in color from brown to light tan to gray in eroded areas.

Range and Distribution

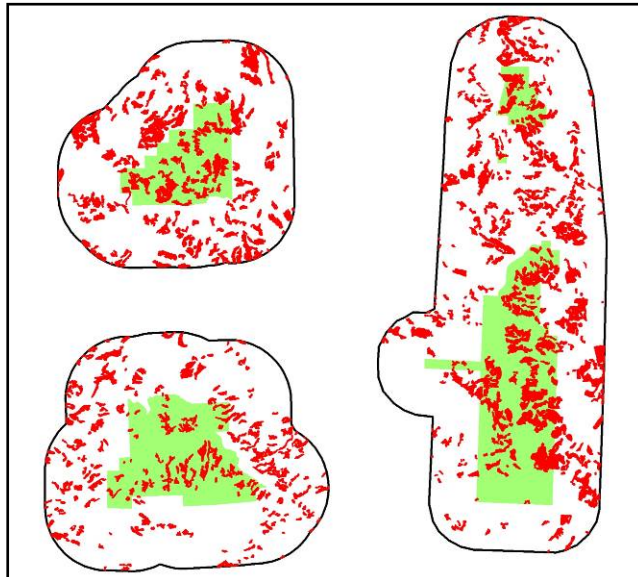


Photo Signature Example



Map Unit	<i>Achnatherum thurberianum</i> - <i>Pseudoroegneria spicata</i> Herbaceous Vegetation
ACTH	Thurber's Needlegrass – Bluebunch Wheatgrass Herbaceous Vegetated Ash

Common Species

Achnatherum thurberianum,
Pseudoroegneria spicata,
Sporobolus cryptandrus, *Artemisia*
tridentata ssp. *wyomingensis*,
Festuca idahoensis, *Poa secunda*

NVCS Association

-*Achnatherum thurberianum* -
Pseudoroegneria spicata Herbaceous
Vegetation

Representative Ground Photo



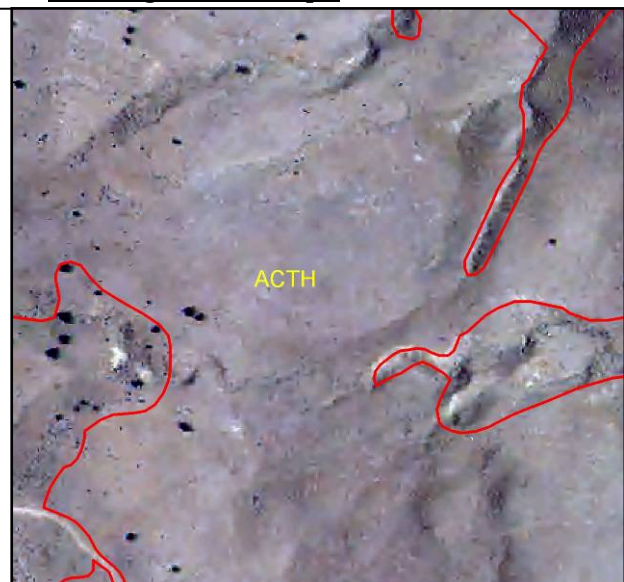
Description

Thurber's needlegrass was a fairly common grass species at JODA found associated with bluebunch wheatgrass and Idaho fescue. In some locations, Thurber's needlegrass was documented as being the dominant and effort was made to map this type separately from the other native grassland types. Most of the mapping for this type was based on previously documented locations (field plots) and observations. On the 2009 imagery this type appeared as smooth tan color with no texture.

Range and Distribution



Photo Signature Example



Map Unit	<i>Bromus tectorum</i> - (<i>Taeniatherum caput-medusae</i> - <i>Poa bulbosa</i>)
BRTE	Semi-natural Herbaceous Vegetation Complex
	Cheatgrass (Medusahead rye – Bulbous Bluegrass) Semi-natural Herbaceous Vegetation Complex

Common Species

Bromus tectorum, *Gutierrezia sarathae*,
Taeniatherum caput-medusae, *Poa bulbosa*

NVCS Alliance

-*Bromus tectorum* Semi-natural
Herbaceous Alliance

Representative Ground Photo



Description

Cheatgrass along with other non-native annual grasses occurred in nearly monotypic stands across broad plains, intermixed with other non-native grass and forb species in old pastures and occurred on rolling hills and slopes. Cheatgrass was fairly common at JODA and this map unit was used to map large areas that were likely disturbed in the past from fire or agricultural activity. Stands of this type ranged from thick, lush stands on floodplains to sparser arid areas within canyons, alluvial fans, and on hillslopes. On the 2009 imagery stands of cheatgrass with sufficient cover (>20%) had a characteristic smooth, orange-tan color.

Range and Distribution

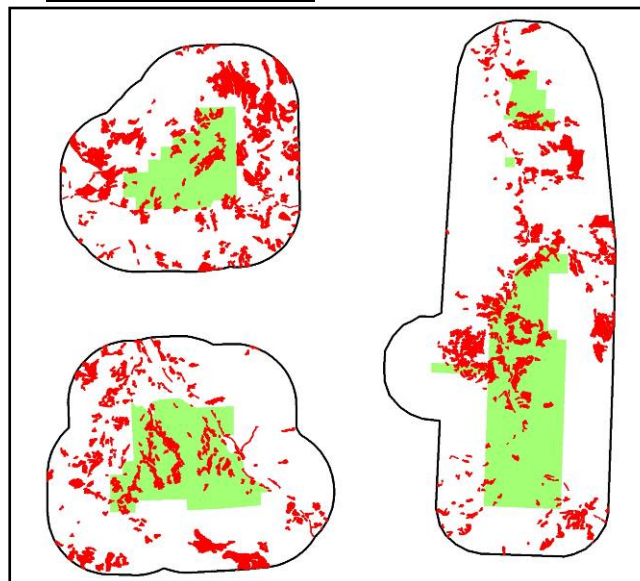
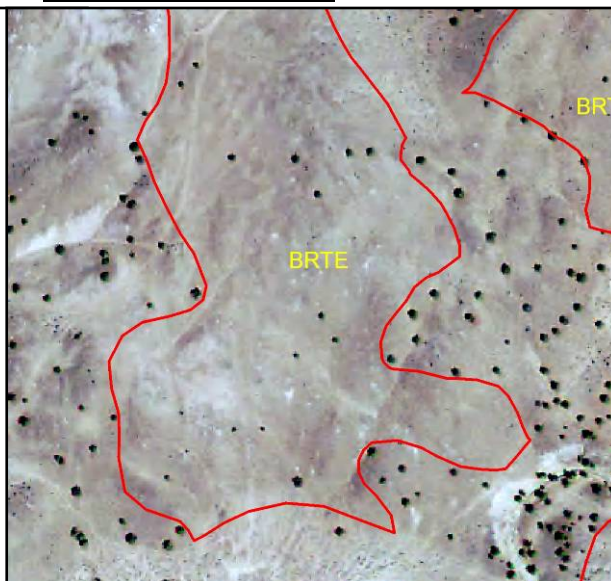


Photo Signature Example



Map Unit	<i>Thinopyrum intermedium</i> - (<i>Agropyron</i> sp.) Semi-natural Herbaceous
THIN	Vegetation Complex
	Intermediate Wheatgrass – (Wheatgrass species) Semi-natural Herbaceous
	Vegetation

Common Species

Agropyron cristatum, *Thinopyrum intermedium*,
Agropyron caninum, *Bromus tectorum*

NVCS Association1

-*Thinopyrum intermedium* Semi-natural Herbaceous Alliance
-*Agropyron cristatum* Semi-natural Herbaceous Alliance

Representative Ground Photo



Description

This map unit represents a few previously planted pastures and cultivated lands that were probably seeded at one time with non-native wheatgrasses. Planted stands occurred along the floodplain of the John Day River and usually exhibited a dark brown-tan (mocha) color. Old agricultural tillage and irrigation lines were sometimes apparent. Polygons of this map unit likely include areas with high cheatgrass cover and possibly some pockets of native grasses. Other areas with these non-native species likely exist in the study area but were not recognizable on the imagery. More ground-truthing of this type in the floodplains would greatly improve the accuracy and distribution of this type.

Range and Distribution

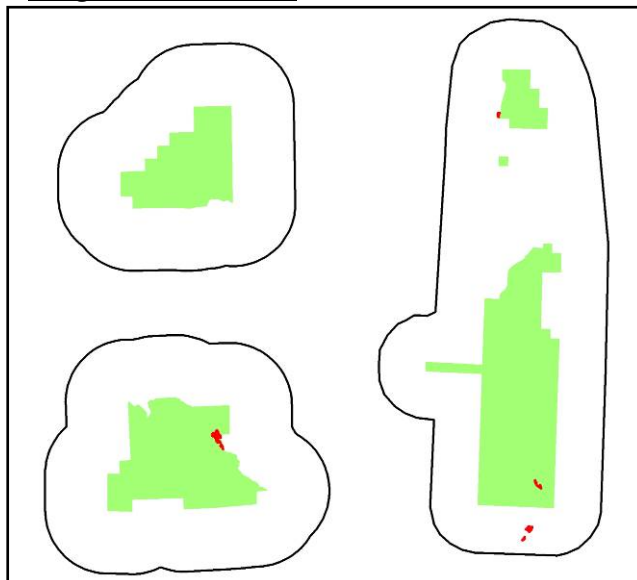


Photo Signature Example



Map Unit	<i>Typha (angustifolia, latifolia) – (Leymus cinereus) Herbaceous Vegetation Complex</i>
TYPHA	Cattail (Broadleaf, Narrowleaf) – (Great Basin Wildrye) Herbaceous Vegetation Complex

Common Species

Typha latifolia, *Typha angustifolia*, *Leymus cinereus*

NVCS Associations

-*Typha (latifolia, angustifolia)* Western Herbaceous Vegetation
 -*Leymus cinereus* Bottomland Herbaceous Vegetation

Representative Ground Photo



Description

This herbaceous wetland type was common at JODA in mesic drainage bottoms and along the edges of the John Day River and its tributaries. Polygons of this type typically contained pure stands of cattails and/or solid stands of wildrye. Stands of both types were indistinguishable from one another on the imagery and appeared to often intermix. On the 2009 imagery this type was mapped partially by its landscape position in drainage bottoms and partially by its characteristic mottled, light green color with white flecks (water). Polygons of this type may have been confused with small willow stands.

Range and Distribution

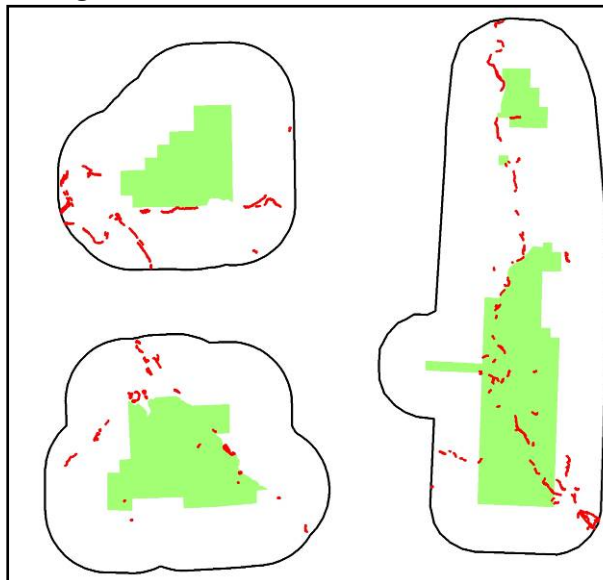
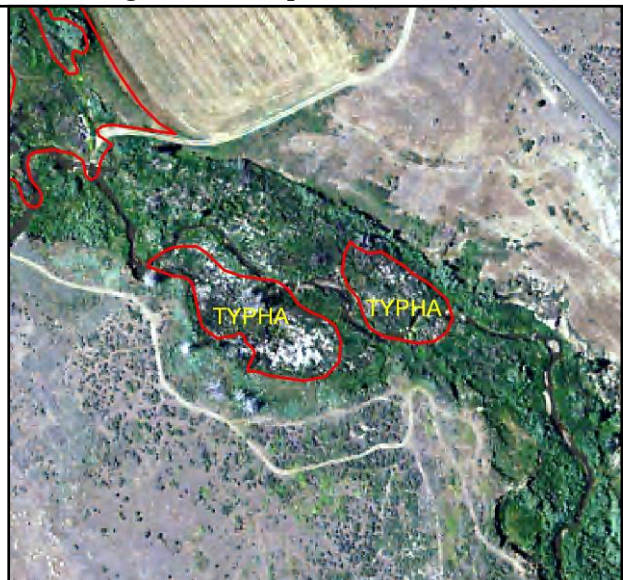


Photo Signature Example



Map Unit	Annual Forbs Mixed Weedy Herbaceous Vegetation
WEED	

Common Species

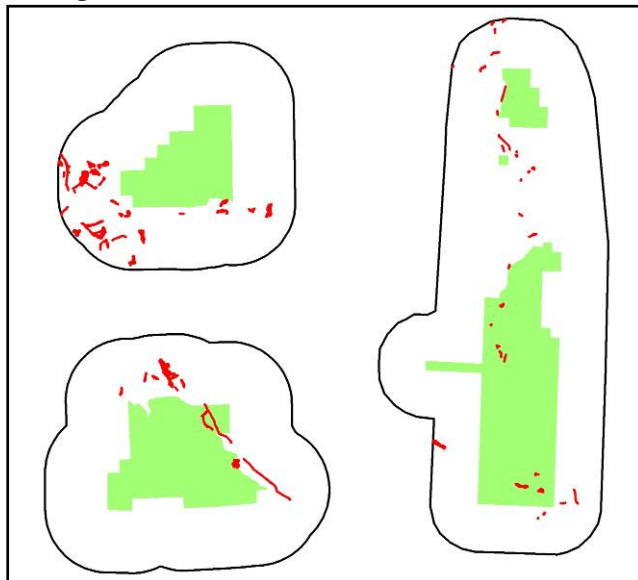
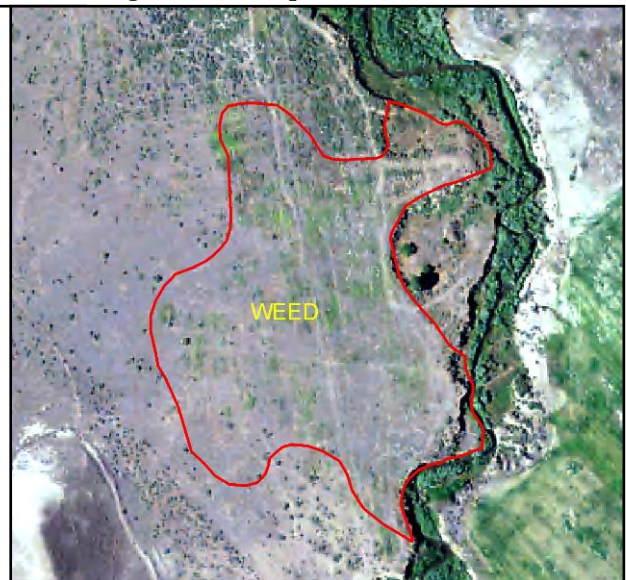
Linaria dalmatica, *Acroptilon repens*,
Centaurea spp., *Cardaria* spp.,
Onopordum acanthium, *Lepidum*
latifolium, *Agropyron cristatum*, *Bromus*
tectorum

NVCS Association

Local Stand (no NVCS Association at this time)

Representative Ground Photo**Description**

This type represents disturbed sites primarily in the environs, including fallow fields, field boundaries, road edges and old pastures. Although cheatgrass and other non-native grasses were usually present in these stands they were not the clear dominant. Other common species in this map unit were mainly weedy annuals varying greatly in composition and density from site to site. This successional type has likely replaced native grasslands or big sagebrush shrublands. At JODA this type had various signatures on the 2009 imagery ranging from mottled tans, to blotchy greens all characteristic of disturbed sites.

Range and Distribution**Photo Signature Example**

Sparse Vegetation

Map Unit	<i>Purshia tridentata</i> Ash Bed
PUTR	Bitterbrush Ash Bed

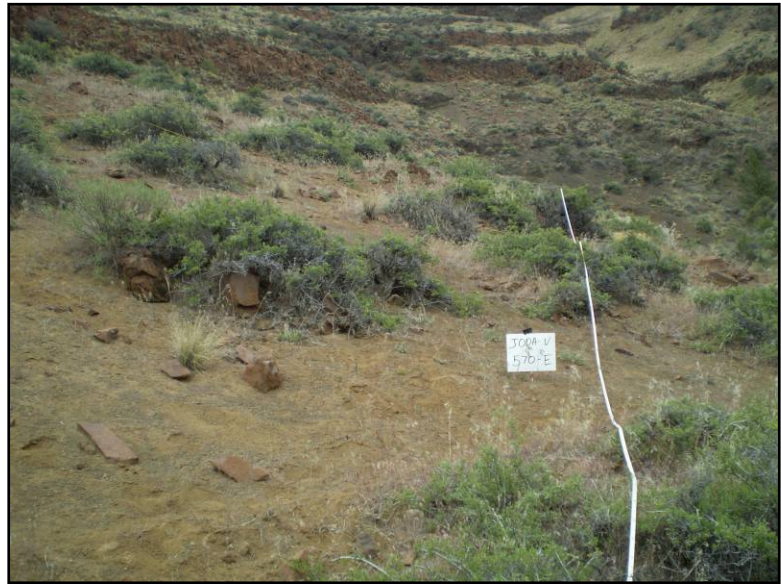
Common Species

Purshia tridentata, *Ericameria nauseosa*,
Gutierrezia sarathae, *Eriogonum*
strictum, *Poa secunda*

NVCS Associations

- *Purshia tridentata* Ash Bed

Representative Ground Photo



Description

Bitterbrush was found on a few isolated site in all three units of JODA where it was clearly the dominant vegetation. Elsewhere it was often found as an associate with the sagebrush and western juniper map units. Although it is described at JODA to be an exclusive ash type this map unit was also found on other more developed soils. More ground-truthing and sampling of this type may indicate the presence of other bitterbrush associations and would greatly assist with the mapping precision of this type. Bitterbrush's gray signature and close proximity to other sagebrush polygons may have led to some mapping confusion. On the 2009 imagery this map unit was characterized by small to medium-sized shrubs that appeared as pebbled light gray circles. Where it was dense, the bitterbrush had a mottled to smooth appearance and when it was sparse it had a tan or gray background.

Range and Distribution

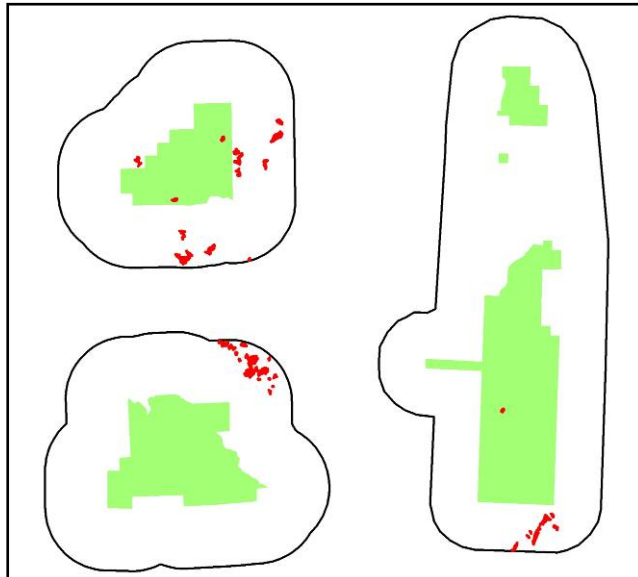
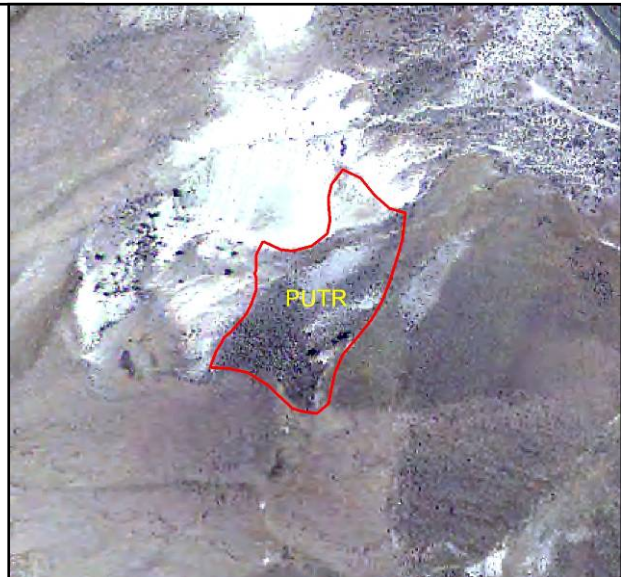


Photo Signature Example



Map Unit	<i>Ericameria nauseosa</i> Sparse Shrubland
ERNA	Rubber Rabbitbrush Sparse Shrubland

Common Species

Ericameria nauseosa, *Gutierrezia sarathae*, *Bromus tectorum*, *Poa secunda*,

Representative Ground Photo



NVCS Association

-*Ericameria nauseosa* Sparse Shrubland

Description

Stands of this type that were large enough to map were relatively rare in the project area only occurring on a few documented ash/tuff exposures and associated fans. Rubber rabbitbrush shrubs are likely more common than this at JODA but probably occur as associated species with the other ash/tuff and sagebrush map units. More ground-truthing and sampling of this type would greatly aid with the mapping precision of this type. On the 2009 imagery, this type had a characteristic smooth green signature that varied from solid green in dense stands to light green with a tan, gray background for sparser sites.

Range and Distribution

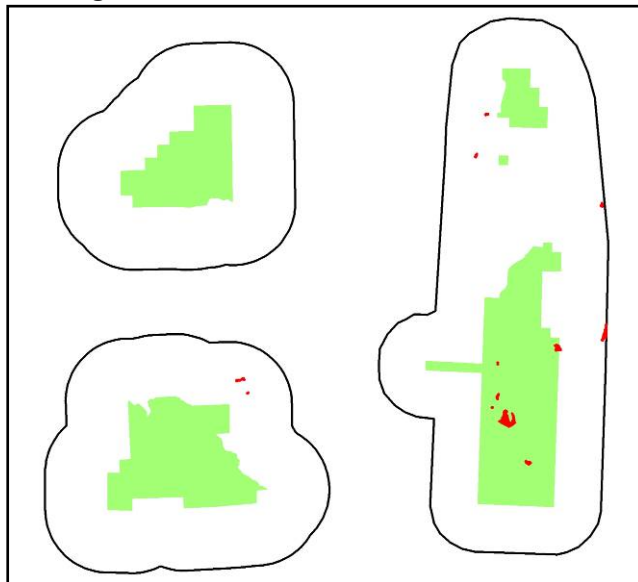
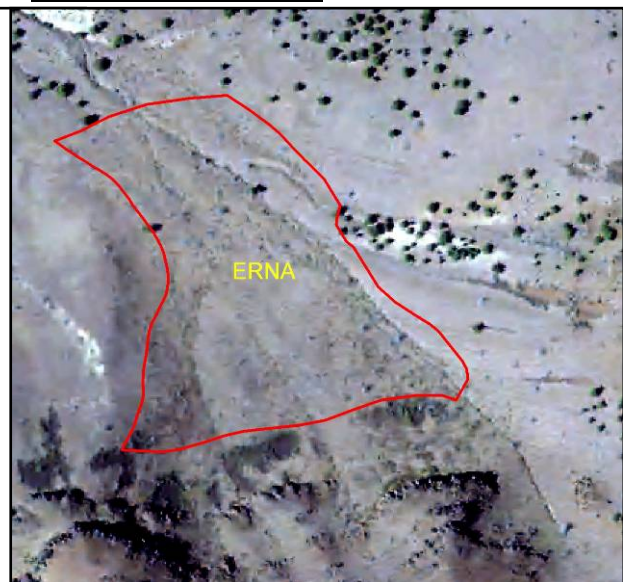


Photo Signature Example



Map Unit	<i>Gutierrezia sarathae</i> Semi-Natural Dwarf-shrubland Alliance
GUSA	Snakebrush Semi-Natural Dwarf-shrubland Alliance

Common Species

Gutierrezia sarathae, *Bromus tectorum*,
Taeniatherum caput-medusae,
Poa bulbosa

NVCS Association

-*Gutierrezia sarathae* / *Bromus tectorum*
Dwarf-shrubland
-*Gutierrezia sarathae* / *Taeniatherum*
caput-medusae Dwarf-shrubland
-*Gutierrezia sarathae* / *Poa bulbosa*
Dwarf-shrubland

Representative Ground Photo



Description

The snakebrush semi-natural map unit represents early successional sites occurring primarily on thin ash and tuff related soils throughout all three units of the project area. On these deposits snakeweed is the dominate speices although cheagrass and other non-native grasses may be quite prevalent. The overlap in species with this type and the cheatgrass type may have led to some confusion in the mapping. On the 2009 imagery this type appeared as small dark-green flecks on tan with white speckled soils. In some cases this type was mapped based on plot data and field observations.

Range and Distribution

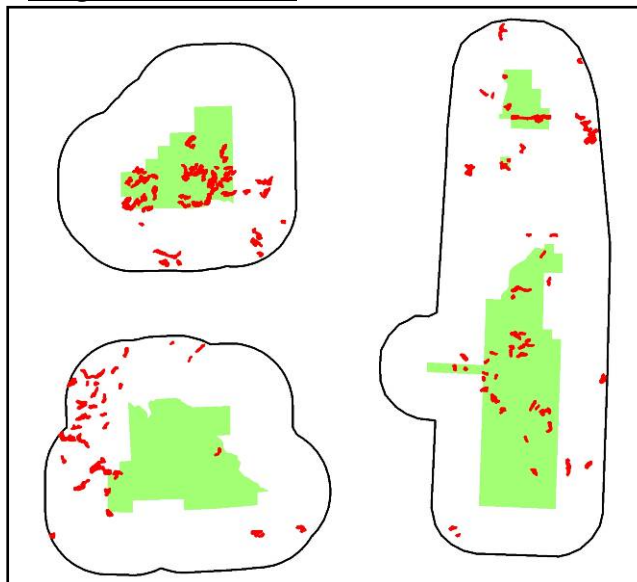
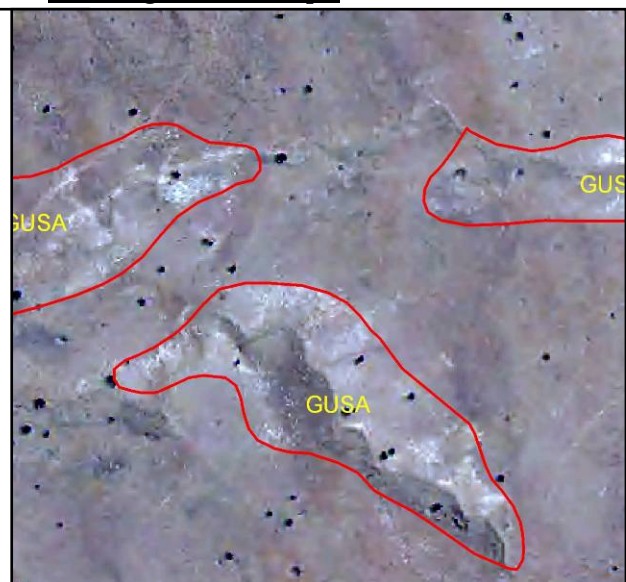


Photo Signature Example



Map Unit	Ash Beds - Mixed Shrubland Complex
ASH/SHRB	

Common Species

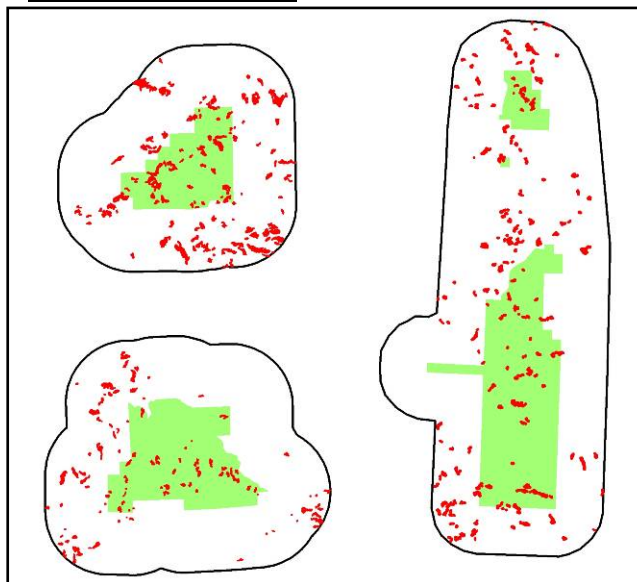
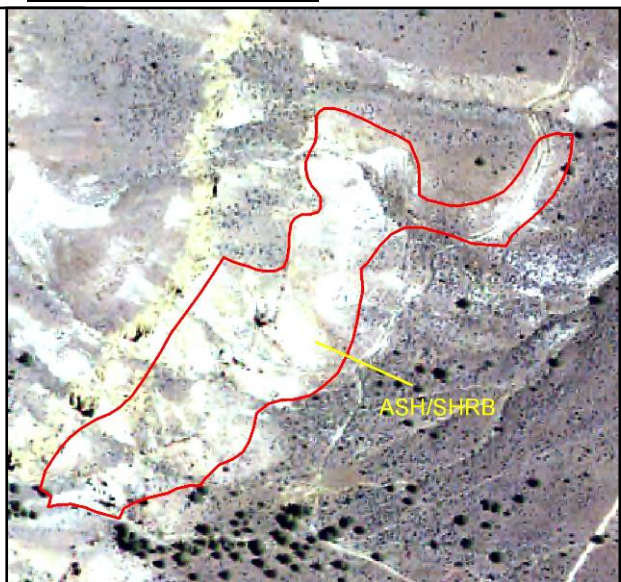
Eriogonum strictum, *Poa secunda*,
Salvia dorrii, *Pseudoroegneria spicata*

NVCS Associations

-*Eriogonum strictum* / *Poa secunda*
Dwarf-shrub Herbaceous Vegetation
-*Salvia dorrii* / *Pseudoroegneria spicata*
Dwarf-shrubland

Photo Signature Example**Description**

This was a common type throughout the project area, representing the sparse, dwarf shrub vegetation found on many of the eroding badland slopes and ash/tuff deposits characteristic of JODA. This map class combined multiple associations and likely includes other locally dominate dwarf shrubs such as shadescale and snakeweed. On the imagery this type varied from a solid white, red, tan, or brown depending on soil color. Under magnification some vegetation was visible as grey smudges and this characteristic was used to separate this map unit from the other ash/tuff types.

Range and Distribution**Photo Signature Example**

Map Unit **Ash Beds - Mixed Herbaceous Vegetation Complex**
ASH/HERB

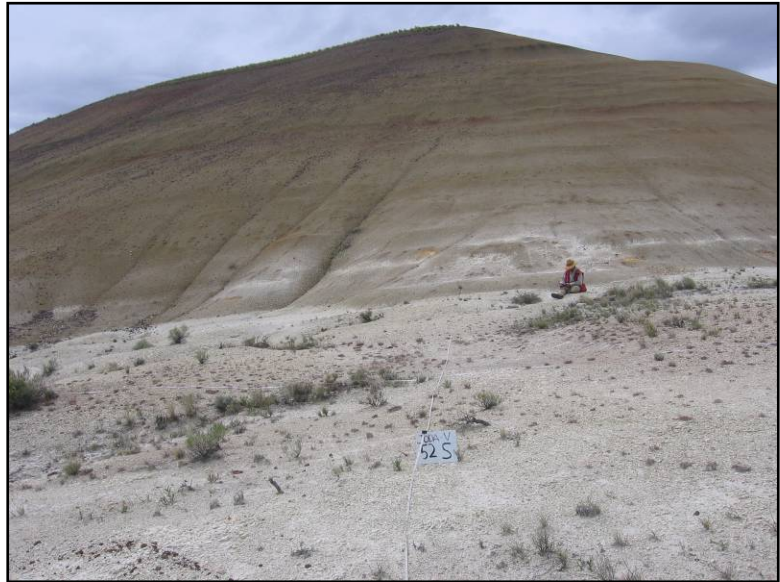
Common Species

Helianthus nuttallii, *Cleome platycarpa*,
Eriogonum strictum, *Poa secunda*,
Salvia dorrii, *Pseudoroegneria spicata*

NVCS Associations

-*Helianthus nuttallii* Ash Bed
-*Cleome platycarpa* Ash Bed

Photo Signature Example



Description

Herbaceous vegetation occurring on badland and ash beds was similar in many ways to the Ash-Bed Mixed Shrubland map unit although it characteristically lacked the dominate drawf shrub layer. Occuring throughout the study area, this type was present on many of the badland slopes and ash/tuff deposits. This map class combined multiple associations and likely includes many other locally dominate grasses and forbs such as bluebunch wheatgrass and curly bluegrass. On the 2009 imagery this type exhibited a smooth white, red or brown color with some gray haze representing the herbaceous vegetation.

Range and Distribution

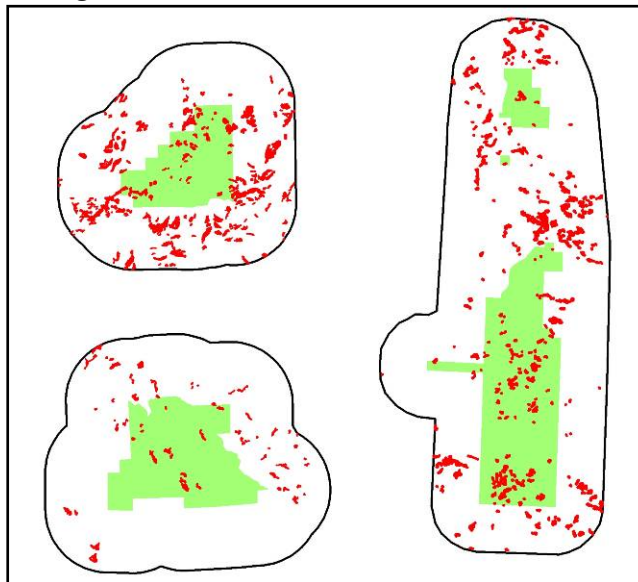
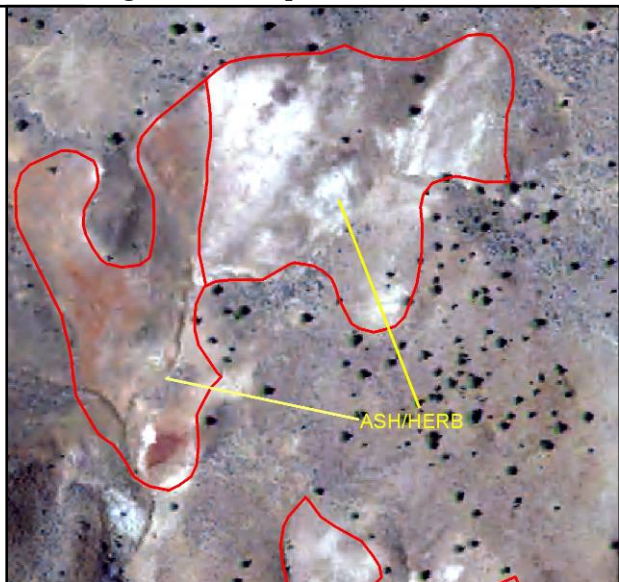


Photo Signature Example



Barren

Map Unit **Barren Streambank**
BANK

Common Species

(Geology type, no vegetation)

NVCS Association

No Vegetation

Photo Signature Example



Description

Unvegetated streambanks were common in and around the John Day River and its major tributaries. This type was used to map riverine features where the vegetation appeared to be less than 5%. The map class included sandbars, cobbles, flats, and eroding stream banks. On the imagery streambanks appeared as mostly long smooth bands that varied in color from white to gray to brown.

Range and Distribution

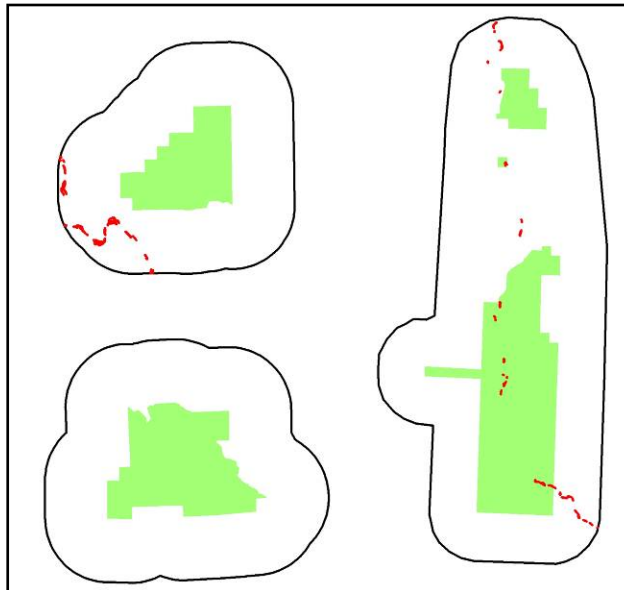


Photo Signature Example



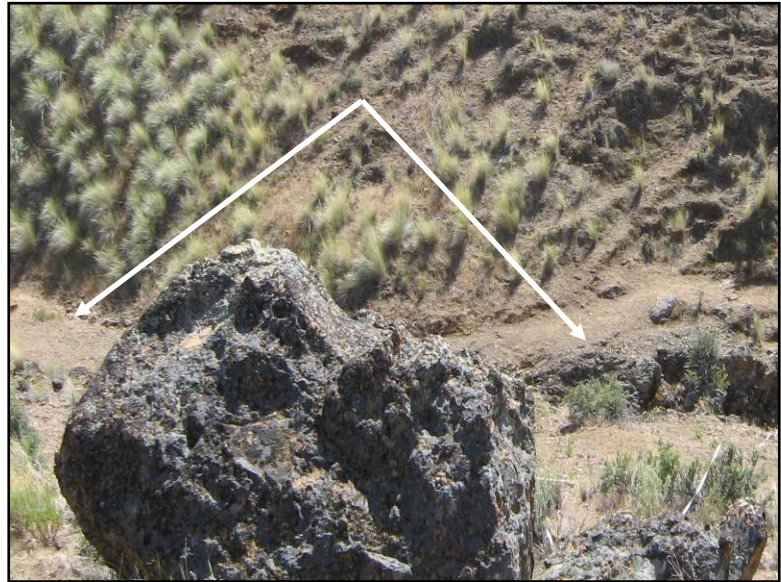
Map Unit	Unvegetated Channel
CHNL	

Common Species

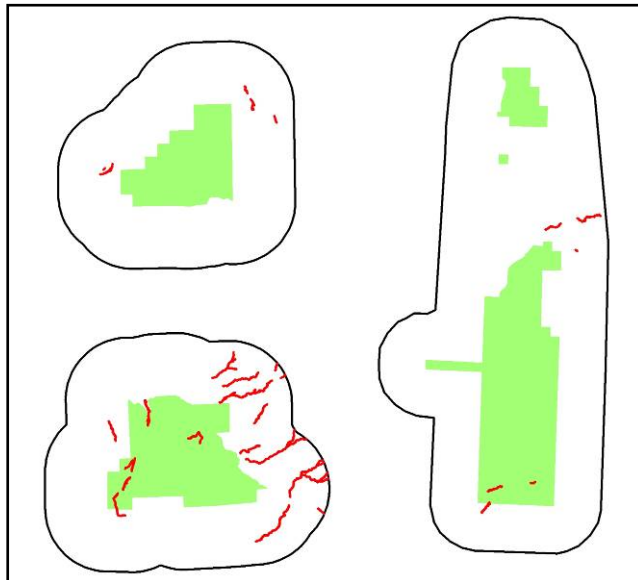
(Geology type, no vegetation)

NVCS Association

No Vegetation

Photo Signature Example**Description**

Unvegetated channels represent natural, barren erosion waterways that sporadically carry water during run-off events. Channels were relatively rare in the study area with most of them supporting some sort of vegetation. Those that were barren occurred in and around badland and ash/tuff deposits. On the imagery this type appeared long and slender, with a smooth white or tan appearance depending on the soils.

Range and Distribution**Photo Signature Example**

Map Unit CNYN	Canyon Cliffs, Scree, and Rock Outcrops
--------------------------------	--

Common Species

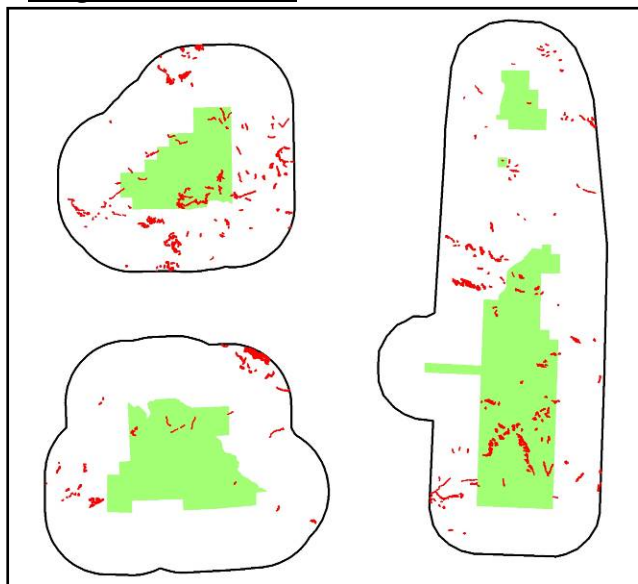
(Geology type, no vegetation)

NVCS Association

No Vegetation

Photo Signature Example**Description**

This map unit represents non-vegetated rock outcrops that supported less than 1% vegetation cover (on average). Polygons of this type occurred throughout the study site, including basalt outcrops, boulder fields, vertical canyon walls, and talus. On the imagery this type was mostly rough and cobbely in appearance and ranged in color from black to red to white depending on the geologic parent material.

Range and Distribution**Photo Signature Example**

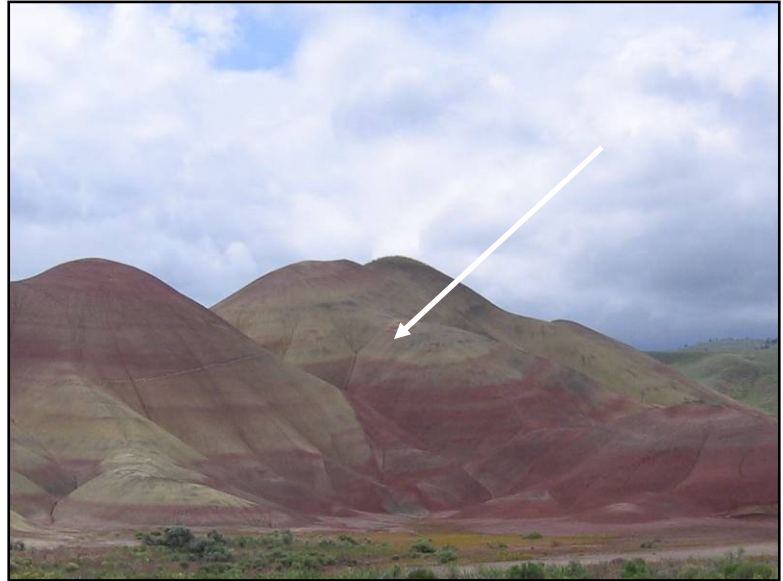
Map Unit	Ash, Tuff, and Badland Bare Ground
ASH	

Common Species

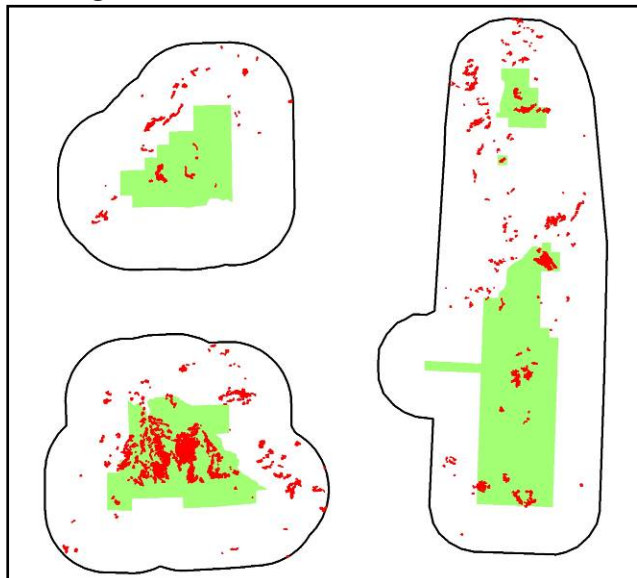
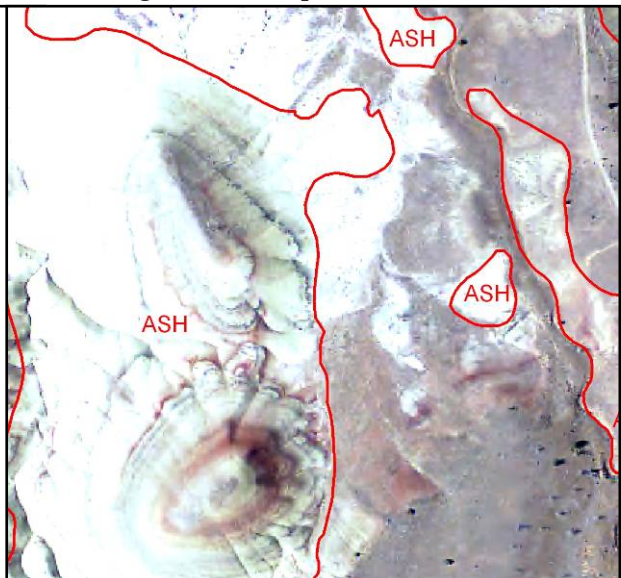
(Geology type, no vegetation)

NVCS Association

No Vegetation

Photo Signature Example**Description**

This unique map unit was used to map non-vegetated badlands and ash/tuff deposits within, and adjacent to all three Units of JODA. This type differed from the sparsely vegetated map units due to its location on the steepest slopes, active erosion and lack of vegetation. In contrast, the Canyon map unit was used to map bare rock outcrops that were not badland formations. On the 2009 imagery this type had very smooth bright white, tan, and red signature with no gray or green specks indicating vegetation. Unique formations that were red in color were noted in the polygon comments field.

Range and Distribution**Photo Signature Example**

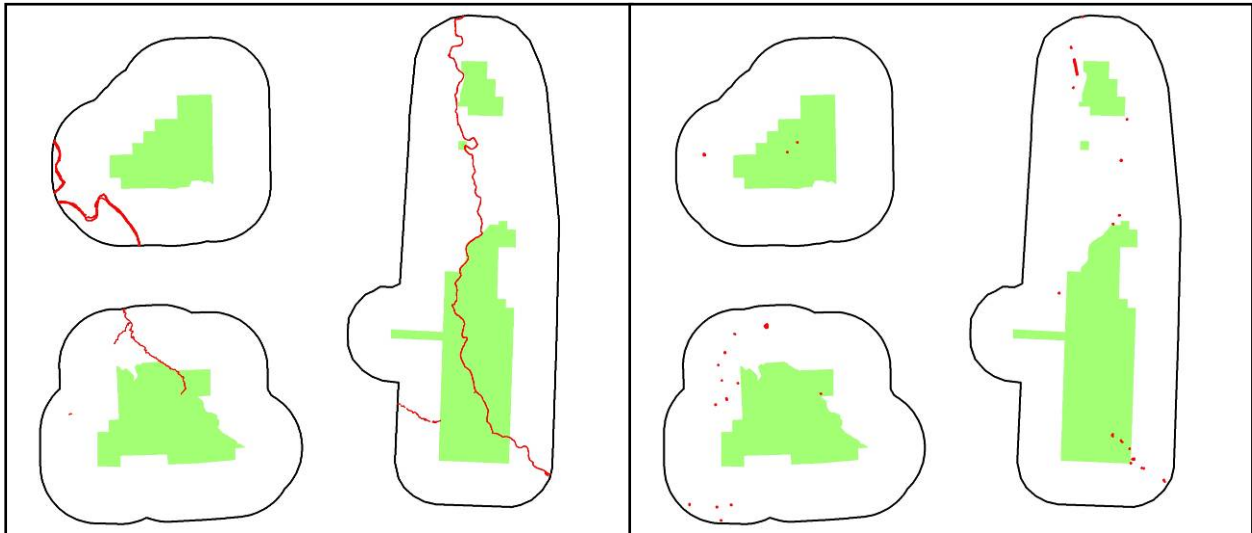
LAND COVER – LAND USE

MAP CODE
STRM

Stream / River

MAP CODE
POND

Lake / Pond

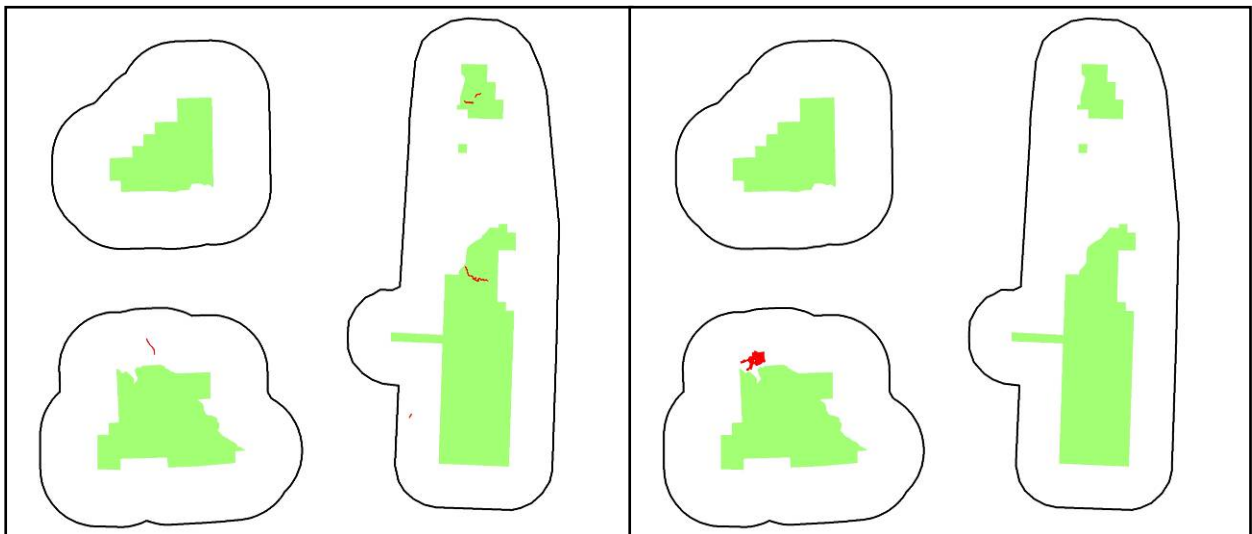


MAP CODE
CANL

Canal / Ditch

MAP CODE
RESV

Reservoir

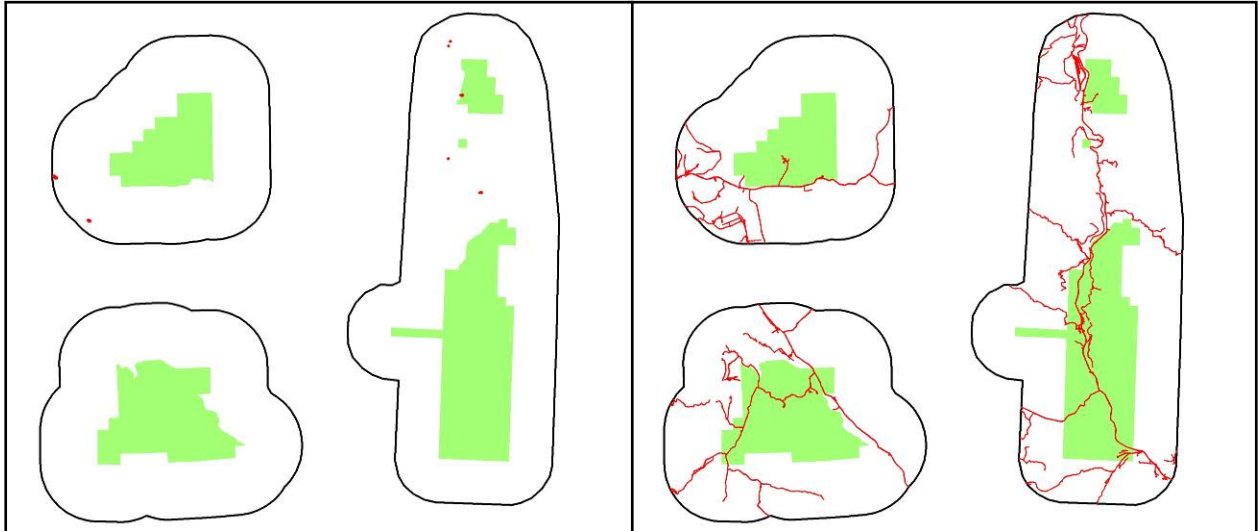


**MAP CODE
AGRI**

**Agricultural
Business**

**MAP CODE
ROAD**

Transportation

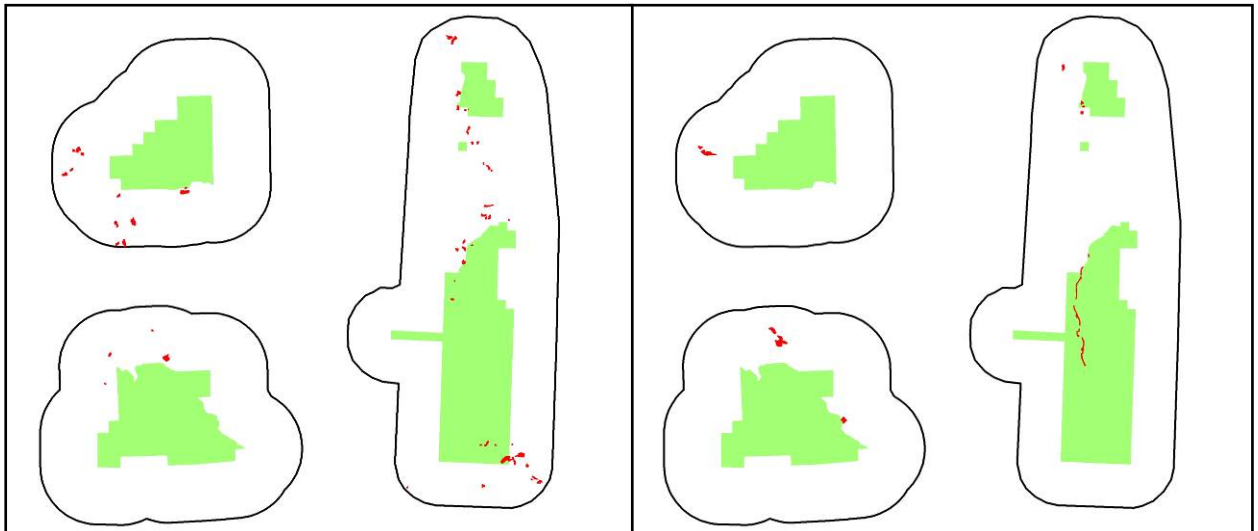


**MAP CODE
AGRI**

**Agricultural
Business**

**MAP CODE
TRANS**

Transistional

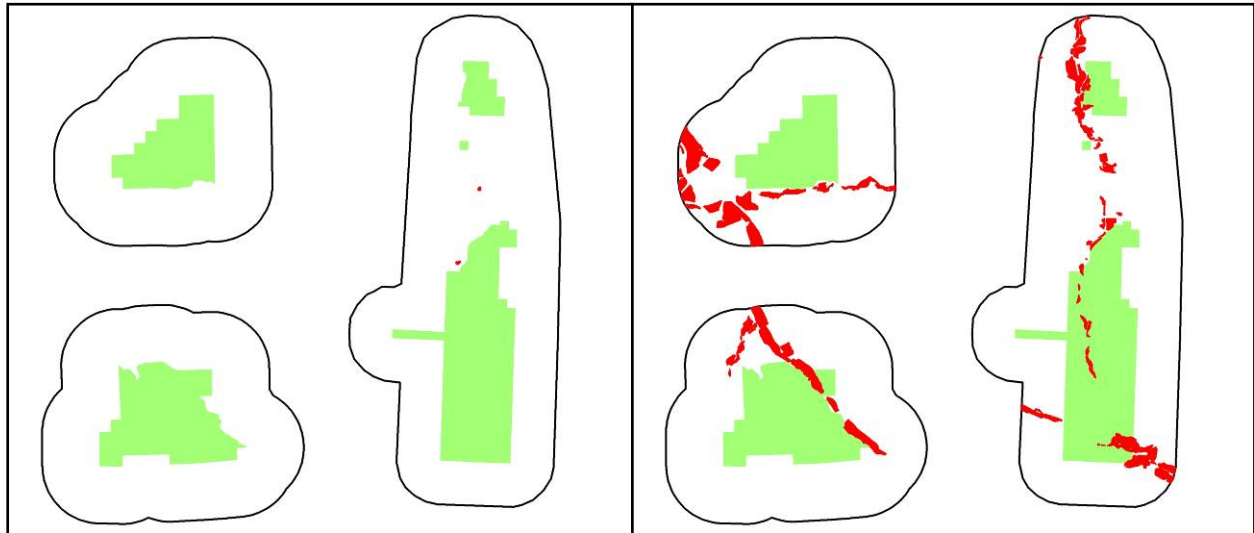


**MAP CODE
MINE**

**Quarries / Strip
Mines / Gravel Pits**

**MAP CODE
FIELD**

Planted / Cultivated

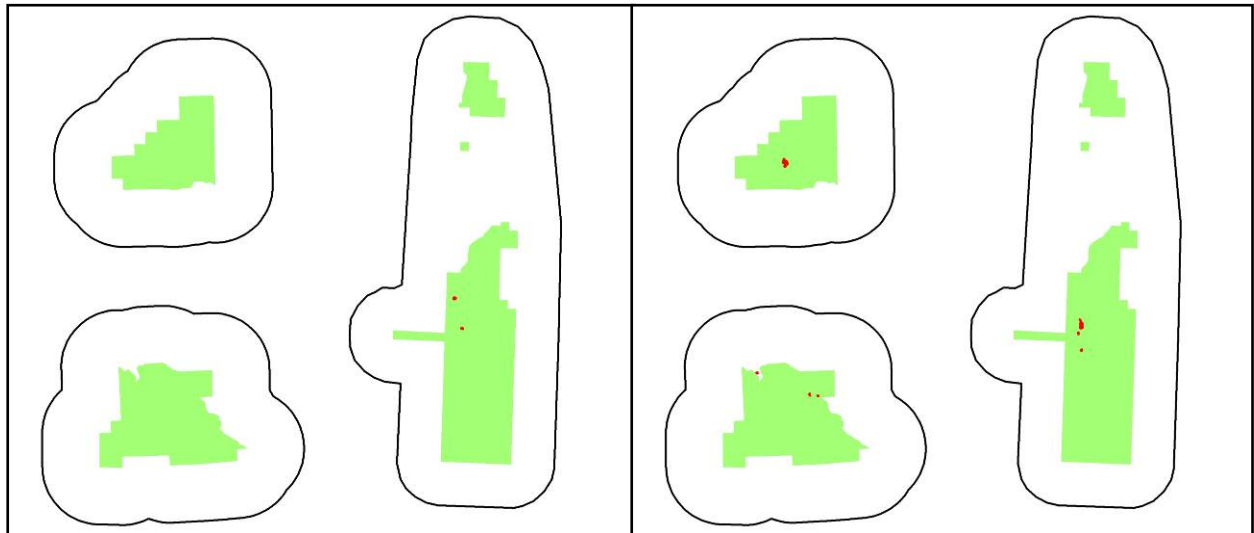


**MAP CODE
ORCH**

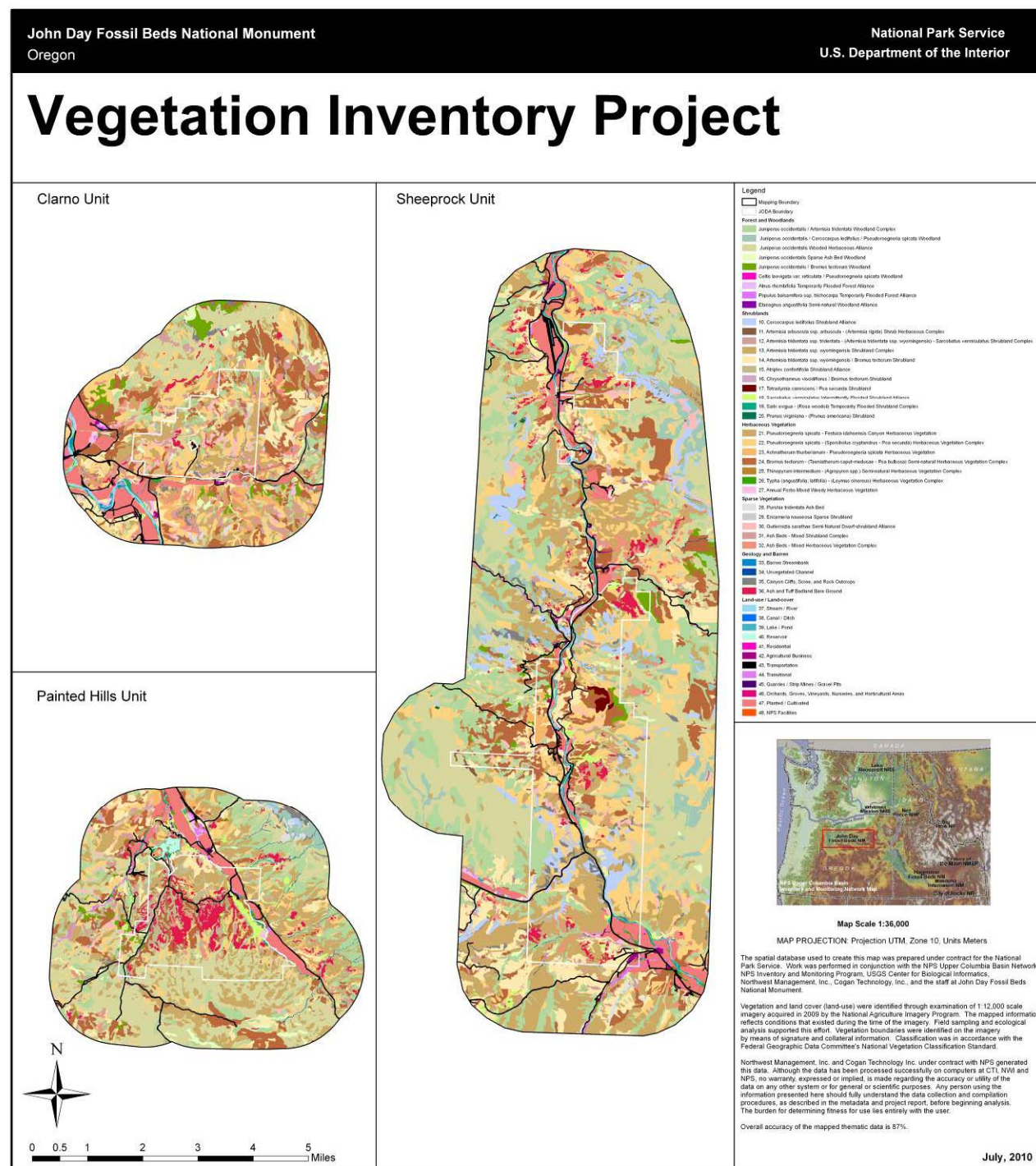
**Orchards, Groves
Vineyards,
Nurseries, and
Horticultural Areas**

**MAP CODE
NPS**

NPS Facilities



Appendix G – Final JODA Vegetation Map



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 108/106478, January 2011

National Park Service
U.S. Department of the Interior



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Fort Collins, CO 80525

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