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Vegetation Classification and Mapping Project Report, Pipe Spring National Monument

Natural Resource Technical Report NPS/NCPN/NRTR—2008/122

ON THE COVER
Winsor Castle (The Fort), Pipe Spring National Monument (Photograph by Janet Coles)

Vegetation Classification and Mapping Project Report, Pipe Spring National Monument

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Acronyms and Abbreviations

AA	Accuracy Assessment
CCC	Civilian Conservation Corps
CEGL	Community Element Code
DBH	Diameter At Breast Height (4.5 feet)
DEM	Digital Elevation Model
DOQQ	Digital Orthophotograph Quarter Quadrangle
DRC	Diameter At Root Crown
e^2M	engineering-environmental Management, Incorporated
ES	Ecological System
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
GPS	Global Positioning System
Ha	Hectares
I&M	Inventory and Monitoring Program
ITIS	Integrated Taxonomic Information System
LC/LU	Land Cover/Land Use
MMU	Minimum Mapping Unit
NAD	North American Datum
NBII	National Biological Information Infrastructure Program
NCPN	Northern Colorado Plateau Network
NPS	National Park Service
NPS FirePro	National Park Service Fire Program
NRCS	Natural Resource Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification Standard
PISP	Pipe Spring National Monument
QA/QC	Quality Assurance/Quality Control
SCS	Soil Conservation Service
TNC	The Nature Conservancy
TSN	Taxonomic Serial Number
UNESCO	United Nations Education, Science, and Cultural Organization
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WRCC	Western Region Climate Center

Summary

The Northern Colorado Plateau Inventory and Monitoring Network (NCPN) worked with the U.S. Geological Survey (USGS) and National Park Service (NPS) Vegetation Mapping Program to describe and map vegetation at Pipe Spring National Monument (PISP). This collaborative effort involved project partners engineering-environmental Management, Inc. (e^2M), the Western Region office of NatureServe, and their cooperators.

The mapping area is 35.4 hectares (87.4 acres), encompassing the lands within the Monument boundary (16.2 ha / 40 acres) and an environs extending 100 m (330 feet) into the surrounding Kaibab Paiute Reservation (19.2 ha / 47.4 acres). Project partners identified plant associations for PISP and determine how best to map them using 1:12,000-scale, true color orthophotography. The team collected vegetation and environmental data from three vegetation classification plots and four observation points. No supplemental fuels data were collected during the project. Fieldwork and mapping were completed in 2008.

Analysis of the plot data revealed six National Vegetation Classification plant associations within the Monument and environs. Two additional native vegetation communities were described from field notes. Six unvegetated land use types were delineated, including roads and NPS facilities, as well as eight types representing introduced or cultivated vegetation.

Vegetation and land use were delineated in the field on base maps of 1:12,000 true-color orthophotography acquired in 2006. This was possible because of the small size of the Monument and because every part of the unit is accessible on foot. Because PISP is a relatively small park unit, the program standard minimum mapping unit of 0.5 ha was discarded and polygons were delineated to approximately 0.1 ha. In addition, the park requested that all occurrences of wetland plant species be recorded.

Thirty-eight map polygons representing 12 natural vegetation map classes were developed for the PISP mapping project; these describe 86% of the mapping area. Six developed land use map classes describe 22 polygons covering 8% of the mapping area. Thirteen polygons covering 6% of the mapping area represent the eight introduced or cultivated vegetation map classes. Average polygon size across all map classes is 0.5 ha (1.2 acres). The most frequent vegetation mapping unit is Fourwing Saltbush Shrubland (Map Class # 31) with 11 polygons covering 15.8 ha (39 acres) or 45% of the mapping area.

Because each polygon was visited, verified, and delineated in the field, a traditional thematic accuracy assessment of the vegetated map classes was not employed.

Products resulting from the PISP vegetation mapping project include:

Available in this report:

- project summary of methods and results
- illustrated dichotomous field key to the vegetation associations
- illustrated guide to the map classes

- detailed descriptions of vegetation associations
- samples of completed field forms
- field manual used to guide plot and observation point data collection

Available elsewhere:

- geodatabase containing map polygon attribute, land use, plot data and Monument and project boundaries
- ground photography of vegetation plots and observation points in hard copy and digital formats
- all field data (plots and observation points) stored in a Microsoft Access database
- hard copy vegetation maps
- metadata for all digital products

Geospatial products are in Universal Transverse Mercator (UTM) projection, Zone 12, using the North American datum of 1983.

Acknowledgements

This project was completed through the effort and dedication of numerous individuals and organizations. Angela Evenden coordinated the NCPN Vegetation Mapping Program in its early years and guided the development of the methodologies used to map the vegetation of Pipe Spring NM. Karl Brown and Tammy Hamer (USGS/NPS) and Mike Mulligan (USGS) provided program oversight and coordination. Funding for this project was provided through the USGS-NPS National Vegetation Mapping Program and the Northern Colorado Plateau Inventory and Monitoring Network.

Keith Schulz of the Western Region office of NatureServe prepared the final vegetation classification. Jim Von Loh, Senior Biologist with engineering-environmental Management, Inc. helped write the report. Database management and support were skillfully performed by Helen Thomas and Russ DenBleyker of the Northern Colorado I&M Network. Aneth Wight created the report figures and made sure everything worked in a GIS environment.

The staff of Pipe Spring National Monument made us welcome when we arrived to collect the field data and provided access to their files of past vegetation work.

For these and other contributors to the success of the project, we are grateful.

Introduction

Vegetation Classification and Mapping Project, Pipe Spring National Monument

The Pipe Spring National Monument (PISP) Vegetation Mapping Project was organized and coordinated by the Northern Colorado Plateau Network (NCPN) Inventory and Monitoring (I&M) Program during 2007 and 2008, with assistance from several project cooperators. The purpose of this project was to describe and map existing plant associations on 35.4 hectares (87.4 acres) within and immediately surrounding PISP, and to provide this information in written, tabular, digital, and spatial formats useful to NPS resource managers, the NCPN I&M Program, and others. The basic project components consisted of vegetation classification, description, and spatial database development. No accuracy assessment was conducted for this project.

In 2001, the NCPN I&M Program launched a multi-year project to complete vegetation classifications and maps for network park units. Funding was provided by the USGS-NPS Vegetation Mapping Program and the Northern Colorado Plateau Network. The PISP Vegetation Classification and Mapping Project was completed by the NCPN, engineering-environmental Management, Incorporated (e^2M), and NatureServe. Most of the vegetation plot and observation point data collection occurred in 2007; one plot was sampled in 2008. The draft map was created in 2007 and refined in 2008.

Project methods, results, and products are documented in this report. This introductory section describes the NPS I&M Program and the USGS-NPS Vegetation Mapping Program, as well as the PISP project area. Later sections document the methods and results for each of the major steps in the project: scoping, vegetation classification and description, and vegetation mapping.

The USGS-NPS Vegetation Mapping Program

The National Vegetation Mapping Program is a cooperative project between the USGS and the NPS to inventory, classify, describe, and map vegetation in more than 270 national park units within the United States. Consistent vegetation classification, mapping, and accuracy assessment protocols and standards are applied across projects supported by this program. The National Vegetation Mapping Program is administered by the USGS Center for Biological Informatics in cooperation with the NPS I&M Program. Through implementation of the NPS Natural Resource Challenge (NPS 1999), significant funding became available for completing important natural resource baseline inventories in park units, including vegetation classification and mapping. This support provided the NPS with the opportunity to move forward with dozens of new park unit vegetation classification and mapping projects, including PISP. Vegetation classification and mapping products produced by this program are incorporated into the USGS National Biological Information Infrastructure Program, which serves as an information-sharing network (http://biology.usgs.gov/npsveg/).

Northern Colorado Plateau Network Inventory and Monitoring Program

The National Park Service developed an inventory and long-term monitoring program for park natural resources over the last two decades of the twentieth century. This effort was enhanced by

the NPS Natural Resource Challenge (NPS 1999); as a part of this initiative, the NCPN was formed in 2000 to develop an integrated inventory and monitoring program for 16 park units in Utah, Colorado, Arizona, and Wyoming.

A goal of the NPS I&M Program is to complete baseline inventories of biological and geophysical resources for each park unit. These inventories cover 12 basic data sets needed by park staff to guide resource management. Vegetation classification and mapping constitute one of these data sets. Early in the development of its I&M program, the NCPN made completing vegetation maps for each network park unit a priority. In addition to assisting park management, vegetation maps and classification information were seen as contributing significantly to NCPN long-term monitoring efforts. In 2001, the network began implementation of a strategy to complete vegetation mapping in all network park units. The PISP vegetation mapping project is the fifth of the network-coordinated projects to be completed.

Vegetation Mapping Program Standards

The NPS I&M Program established guidance and standards for all vegetation mapping projects in a series of documents:

Protocols

- National Vegetation Classification System (TNC and ESRI 1994a, NatureServe 2003a)
- Field methods and mapping procedures (TNC and ESRI 1994b)
- Statistically rigorous and consistent accuracy assessment procedures (ESRI and TNC 1994)
- Guidelines for using existing vegetation data (TNC 1996)

Standards

- National Vegetation Classification Standard (FGDC 1997)
- Content Standard for Digital Geospatial Metadata (FGDC 1998a)
- Spatial Data Transfer Standard (FGDC 1998b)
- United States National Map Accuracy Standards (USGS 1999)
- Integrated Taxonomic Information System
- Program-defined standards for map attribute accuracy and minimum mapping unit

These documents are available on the USGS-NPS Vegetation Program Web site (http://biology.usgs.gov/npsveg/standards.html).

National Vegetation Classification Standard

The National Vegetation Classification (NVC) is the system used in NCPN vegetation mapping projects (TNC and ESRI 1994a), and is based on the National Vegetation Classification Standard adopted by the Federal Geographic Data Committee (FGDC 1997). The NVC evolved from

work conducted primarily by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network over more than two decades (Grossman et al. 1998). The NVC is based in part on earlier vegetation classification produced by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Use of a standardized classification system helps ensure data compatibility throughout the National Park Service and other agencies. The FGDC Vegetation Subcommittee works to keep this standard current and relevant (http://biology.usgs.gov/fgdc.veg/standards/vegstd.htm).

Classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVC is a hierarchical system that incorporates physiognomic characters and floristic data to define seven levels of terrestrial vegetation classification. The five upper levels (class, subclass, group, subgroup, and formation) are based on physiognomic features. The two lower levels (alliance and association) are distinguished by variability in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). The physiognomic levels of the NVC are based on physical, structural, and environmental characteristics identifiable from satellite imagery, aerial photography, or ground observations (Table 1). Specific criteria defining these physiognomic units are based on ecologic characteristics that vary among major vegetation groups (FGDC 1997).

The alliance and association levels form the base of the NVC and are determined by the most abundant or diagnostic species comprising the strata of a homogenous vegetation community. An association is here defined as a plant community type with a consistent species composition, uniform physiognomy, and similar habitat conditions (Flahault and Schroter 1910). Species composition differentiates associations (TNC and ERSI 1994a). An alliance is "a physiognomically uniform group of plant associations sharing one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation." (Reid and Comer 1998). NatureServe coordinates plant association data for the NCPN vegetation mapping projects. Associations are added to the NVC and older concepts are refined as new data become available.

Table 1. National Vegetation Classification System hierarchy for terrestrial vegetation.

Level	Criteria Delineating Level	Example
Class	Structure (height, cover) of dominant vegetation strata	Woodland
Subclass	Growth form characters including leaf type (evergreen, deciduous) for woody plants and persistence (perennial, annual) for herbaceous species	Evergreen woodland
Group	Leaf morphology (broad leaf, microphyllous, xeromorphic), leaf phenology, and climatic conditions	Temperate or subpolar needle-leaved evergreen woodland
Subgroup	Relative degree of human disturbance	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland

Level	Criteria Delineating Level	Example
Formation	Additional physiognomic characteristics, general environmental conditions, relative landscape position, and hydrologic regimes	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland
Alliance	Dominant or diagnostic species of uppermost or dominant stratum	*Pinus edulis* – (*Juniperus* spp.) Woodland Alliance
Association	Other dominant or diagnostic species from any stratum	*Pinus edulis – Juniperus osteosperma / Amelanchier utahensis* Woodland

Other Standards

In addition to vegetation classification, the FGDC sets standards for map spatial accuracy and for metadata employed in NPS vegetation mapping projects. Standards for map products stipulate map scales of 1:24,000 or finer, and minimum polygon size of 0.5 ha (1.24 acres). Positional accuracy for vegetation maps must meet National Map Accuracy Standards, which specify horizontal errors of less than 10.2 m (33.5 ft.) on the ground for 1:12,000-scale maps.

All digital vegetation products resulting from this project are accompanied by FGDC-compliant metadata. Metadata are “data about the data,” and describe the content, quality, condition, and other characteristics of the spatial dataset. Metadata are critical elements that expedite the interpretation and exchange of information among users.

Project Area Description

Location and Setting

Pipe Spring National Monument is located in Mohave County, Arizona, eight miles south of the Utah state line, in a region known as the "Arizona Strip". The nearest towns are Hurricane, Utah, 72 km (45 miles) to the northwest, Kanab, Utah, 32 km (20 miles) northeast, and Fredonia, Arizona, 24 km (15 miles) east (Figure 1). The Monument is accessible via State Highway 59/389 from either Hurricane or Fredonia. PISP is located entirely within the Kaibab Paiute Reservation boundary (Figure 2). Surrounding Mohave County is sparsely populated, with a density of approximately two people per square kilometer. Approximately 50,000 people per year visit PISP to enjoy the scenery, historic dwellings, and recreation opportunities (NPS 2008).

President Warren G. Harding established Pipe Spring National Monument in 1923 by presidential proclamation. The Monument was created to preserve "Pipe Spring and an early dwelling place, which was used as a place of refuge from hostile Indians by the early settlers". At the time of establishment, it also served as an "oasis in the desert lands … it provides the only water on the road between Hurricane, Utah and the North Rim of the Grand Canyon" (McKoy 2000). The vegetation mapping area includes the 16.2-ha (40-acre) Monument and 19.2 ha (47.4 acres) of the adjoining Kaibab Paiute Reservation.

The primary features of PISP are historic, including three late 19th-century sandstone buildings (the Fort, also called "Winsor Castle", and two smaller cabins), three developed springs, telegraph lines, the quarry trail, and corrals. An irrigated vegetable garden and orchard were not part of the original settlement, but were important in the early history of the Monument. The site was first established as a permanent settlement by the Church of Jesus Christ of Latter Day Saints as a cattle station for gathering animals tithed by Mormon members (Alexander 1988).

Figure 1. Location of PISP in northwestern Arizona.

Topography

The Monument is located on the Arizona Strip, at the southeast corner of Moccasin Mountain where this highland is truncated by the Sevier Fault. To the north is a dissected sandstone plateau; to the west are the Vermilion Cliffs. The landscape to the south is characterized by a plain sloping gently to the north rim of the Grand Canyon.

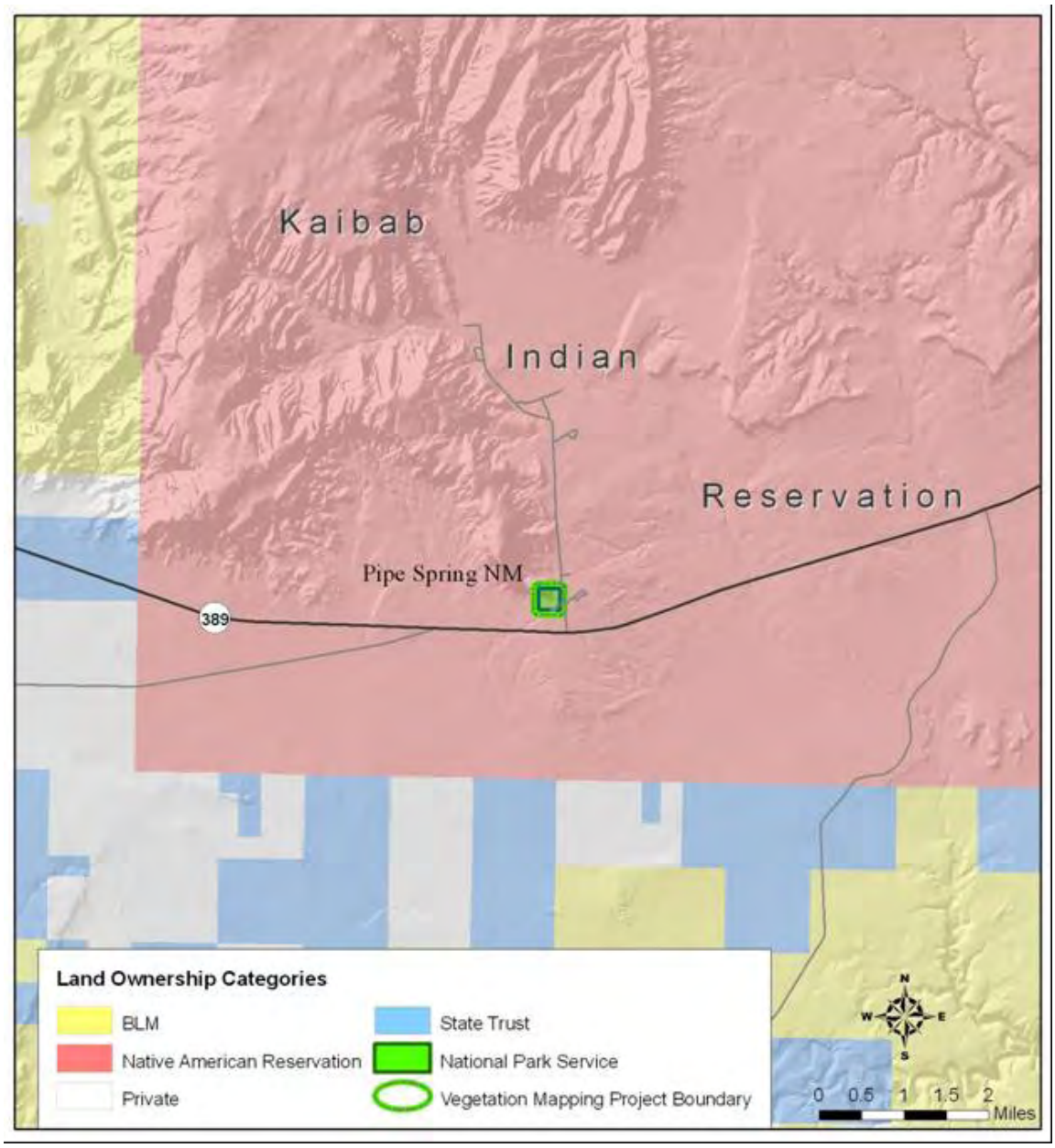

Figure 2. Map of the PISP vegetation mapping project area, showing local land ownership.

PISP occupies the Grand Canyon Section of the Colorado Plateaus Physiographic Province (Fenneman and Johnson 1946). The plain containing the Monument is located on the northern edge of the Uinkaret Plateau, a subplateau of the Colorado Plateau (Billingsley 2004). The Colorado Plateau is a 336,700 km^2 (130,000 mi^2) basin ringed by highlands and subdivided into canyons and plateaus (Figure 3). Most of the Monument is characterized by a level to gently sloping surface; the mesa in the northwestern corner is bounded by a low escarpment. The highest elevation within PISP is 1,570 m (5,150 ft.) in the northwestern corner of the mapping area; the lowest is 1,494 m (4,900 ft.) along the southern boundary.

Figure 3. Location of Pipe Spring National Monument relative to major Colorado Plateau physiographic features. Light gray signifies the extent of the Colorado Plateau. Gray areas represent uplifts and mountains.

Climate

Climate has been monitored at PISP since 1963 (WRCC 2008). Summer high temperatures range from 32 °C to 46 °C (90 °F to 115 °F); in the winter, normal low temperatures range from -18 °C to 4.5°C (0 °F to 40 °F). Precipitation in the region of the Monument is bimodal; one peak occurs in the late winter/spring and results from Pacific storm fronts. A second peak in July/August is

the result of the Arizona Monsoon, characterized by elevated humidity and regular afternoon thunderstorms that can drop more than an inch of rain per hour (Figure 4).

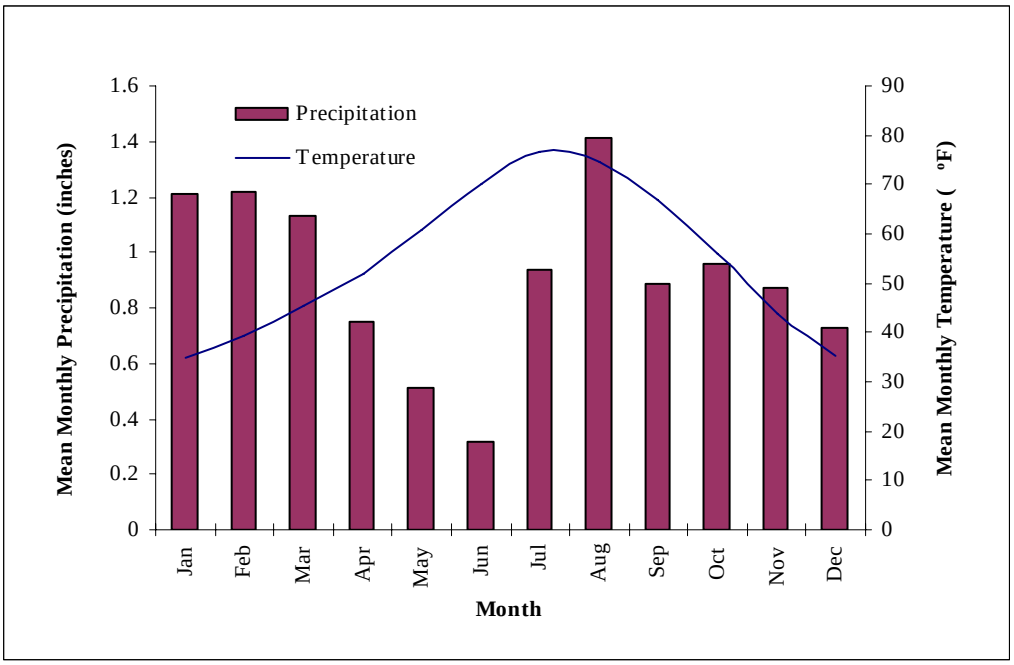

Figure 4. Climate data for PISP (Western Regional Climate Center 2007).

A literature survey by Alexander (1998) reviewed the paleoclimatological findings from packrat midden analysis of sites elsewhere on the Arizona Strip. Paleoecological evidence suggests little change in the general regional vegetation over the past 2500 years, although local shifts among woodland, shrubland, and grassland vegetation are documented. These vegetational shifts correspond largely to shifts in the seasonality and amount of precipitation.

Geology and Vegetation

Pipe Spring National Monument lies within the Grand Canyon Lands Section of the Colorado Plateau Semi-Desert Province (Bailey 2001). PISP is underlain by Mesozoic sedimentary strata that are offset by the Sevier Fault and warped by the Moccasin Monocline (Figure 5). The Jurassic Navajo and Kayenta formations are exposed on the sloping mesa in the northeastern part of the Monument; otherwise, recent alluvial and eolian deposits obscure most of the bedrock geology (Billingsley et al. 2004).

The western segment of the Sevier Fault cuts north to south through the center of the Monument (Billingsley et al. 2004). To the west of the fault, gently folded Mesozoic sediments rise in the Moccasin Monocline northwest to form the Moccasin Mountain highland. The Sevier Fault has probably existed since Precambrian times (> 1 billion years ago). Movements along the fault are associated with major structural events such as the Laramide orogeny (70 million years ago) and extension of the Great Basin beginning 10 million years ago. Most of the visible fault displacement probably occurred during Pliocene and Pleistocene epochs and may continue into

the present (Billingsley and Workman 2000).

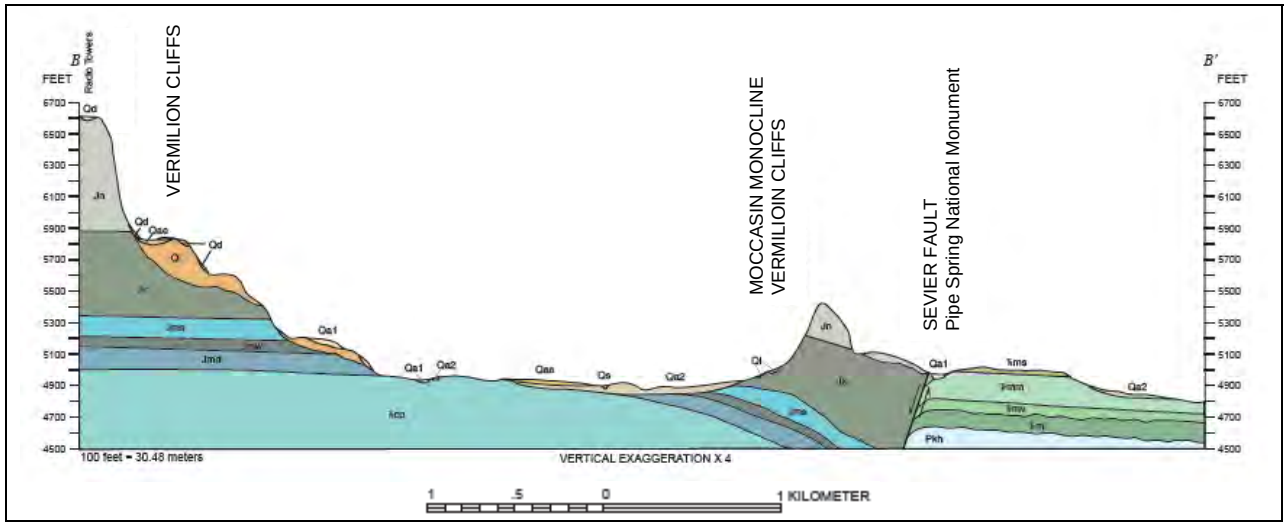

Figure 5. Geologic cross-section of PISP and vicinity oriented roughly west to east. Groundwater flowing down the Moccasin Monocline to the Sevier Fault is the source of the monument's springs (Billingsley et al. 2004).

PISP supports vegetation broadly classified as semi-desert (West 1988) on gentle to moderate topography. The vegetation is closely tied to substrate. An open woodland of two-needle pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) occupies the mesa top (Figure 6), while desert shrublands dominated by fourwing saltbush (*Atriplex canescens;* Figure 7), sand sagebrush (*Artemisia filifolia*; Figure 8) and rabbitbrush (*Chrysothamnus* spp.) occupy the undeveloped flats. Much of the Monument supports introduced plantings of agricultural species or shade trees (Figure 9).

Photo credit: NCPN

Figure 6. Woody vegetation typical of Jurassic Navajo Sandstone exposures.

Photo credit: NCPN

Figure 7. Fourwing saltbush shrublands typical of alkaline soils in and around the Monument.

Photo credit: NCPN

Figure 8. Sand sagebrush shrublands typical of sandy alluvium deposited in the eastern part of the Monument.

Photo credit: NCPN

Figure 9. Semi-natural (L) and cultivated (R) plantings are common throughout the Monument.

Soils

PISP soils are derived from local sandstone and shale and are residual, alluvial, or eolian in origin. In general, shallow residual soils are found on the mesa top, with shallow colluvium on the mesa slopes and deep alluvium or eolian soils at the lowest elevations on the plains. Five soil map units have been described for PISP and environs (Figure 10). All reflect sedimentary rock

origin, 10-14 inches of annual precipitation, and a growing season of 150-180 days. All are well drained to excessively drained. Soil textures range from sandy loam to clay loam. The descriptions that follow are derived from NRCS (2004):

Gypsorthid-Shallow complex, 1-50 percent slopes. This soil map unit covers 2% of the mapping area, in a small unit on the east edge of the environs. This soil unit represents residual and alluvial fan deposits derived primarily from sandstone and shale. Soils are deep and alkaline, slopes are gentle, and sites are not subject to flooding.

Mido fine sand, 1 to 10 percent slopes. This soil map unit covers 4% of the mapping area, in a small unit on the northern edge of the environs. This soil unit represents alluvial and eolian sand deposits on fans and terraces. Soils are deep and moderately alkaline on nearly level slopes. Mido soils differ from Begay fine sandy loam primarily in that they have poor water holding capacity.

Monue fine sandy loam, 1 to 5 percent slopes. This soil map unit covers 52% of the mapping area, in a broad swath extending east to west across the Monument. This soil unit represents alluvial fan deposits derived primarily from sandstone. It is similar in its properties to Begay fine sandy loam but occurs on flatter slopes.

Sheppard fine sand, 1 to 7 percent slopes. This soil map unit covers 18% of the mapping area, in a single unit covering the southern edge of the Monument and the environs. This soil unit represents alluvial and eolian sand deposits on fans and terraces. It is similar to the other soil map units described above except that the soils are least able to hold water of any within the mapping area.

Torriorthents-Rock outcrop complex, 30 to 70 percent slopes. This soil map unit covers 24% of the mapping area, including the mesa and associated colluvium-covered escarpment in the northwestern part of the Monument and environs. As described elsewhere, the density of vegetation is limited by the high cover of rock and bedrock exposure (up to 45% of the surface).

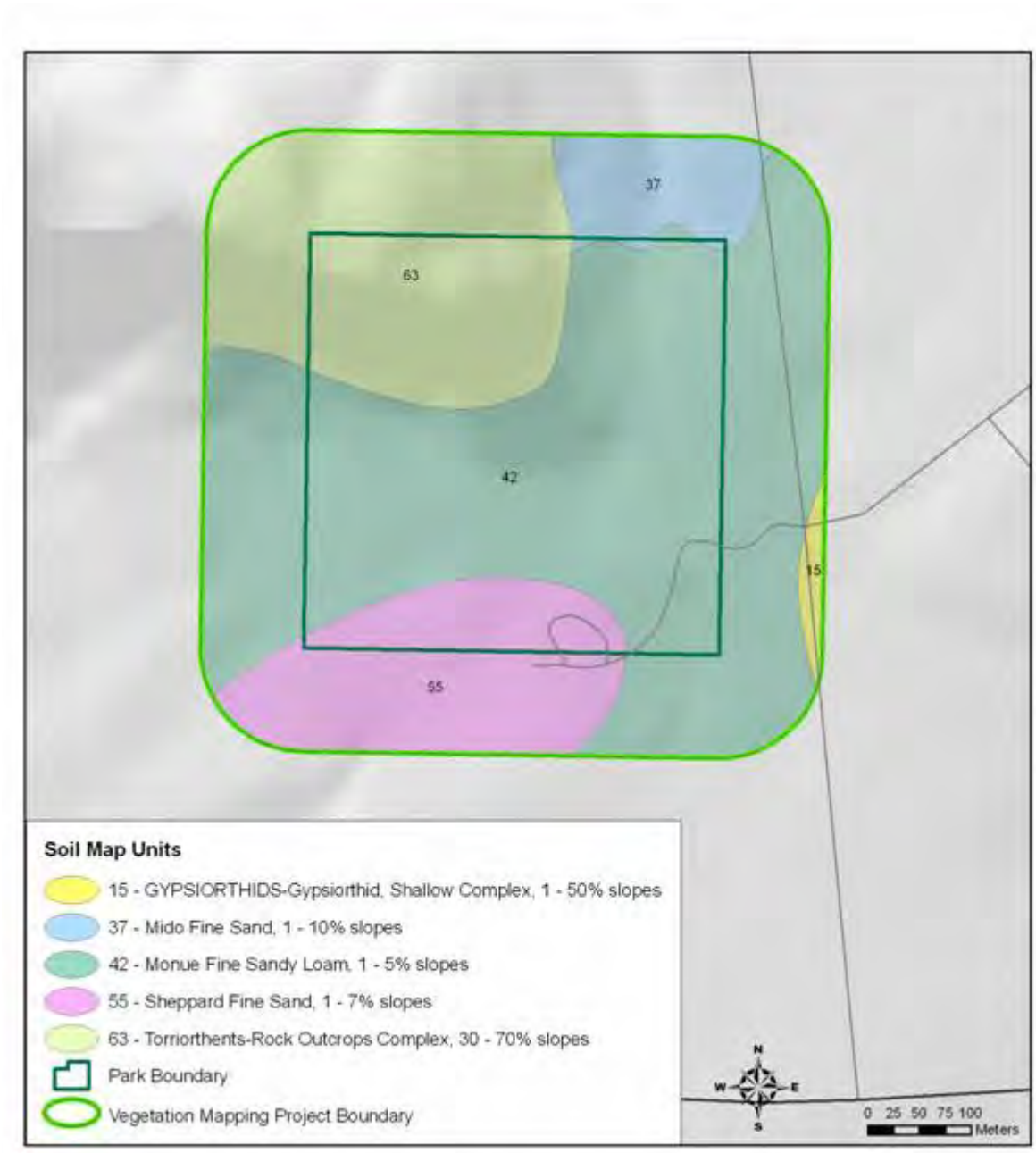

Figure 10. Soil map units within the PISP vegetation mapping project area.

Hydrology and Water Resources

There are three springs within the Monument boundary emerging along the Sevier Fault; all are connected to the Navajo Sandstone aquifer to the north and west, and (Martin 2007). The historical use of these springs by Mormon settlers and ranchers was the primary justification for establishing Pipe Spring National Monument.

Rain and snow falling on the Navajo Sandstone caprock of Moccasin Mountain north and west of the Monument (Figure 11) enters the water table through joints and cracks in the bedrock. Impermeable layers in the upper part of the Kayenta Formation prevent groundwater from penetrating deeper than the base of the Navajo Sandstone. Groundwater flows down the incline of the Moccasin Monocline and emerges at the Sevier Fault because it encounters impermeable Chinle and Moenkopi shales that form the east wall of the fault (Billingsley et al. 2004; Figure 5). A synclinal trough of fractured bedrock paralleling the fault trace also acts to channel groundwater from north to south.

Figure 11. View looking toward Moccasin Mesa as it dips into the Sevier Fault. The location of the Monument is marked by the line of cottonwood trees on the right side of the photograph.

As described in the Geology and Vegetation section, the geologic investigations resulted in a good understanding of the structural geology of the region and its effect on groundwater flow. Monitoring data from wells installed along the fault zone show a clear correlation between groundwater pumping by NPS and the Kaibab Paiute Tribe north of the monument and the decline of flow from springs within the monument. This pumping has lowered the water table and is the primary cause of spring flow decline at Pipe Spring. If groundwater pumping continues, the springs within the monument are very likely to cease flowing.

NPS staff noted a decline in the flow of the springs within the Monument beginning in the 1970s, shortly after new wells supplying both the Monument and the Kaibab Paiute Reservation were installed in the Sevier Fault zone north of the Monument boundary (Figure 12). This decline prompted a series of geologic and hydrologic studies to determine the source of the Monument's groundwater and to identify the cause(s) of the decline. Martin (2007) summarized the hydrologic studies and evaluated the future prospects for spring flow at the Monument. The following paragraph is a brief synopsis of this paper.

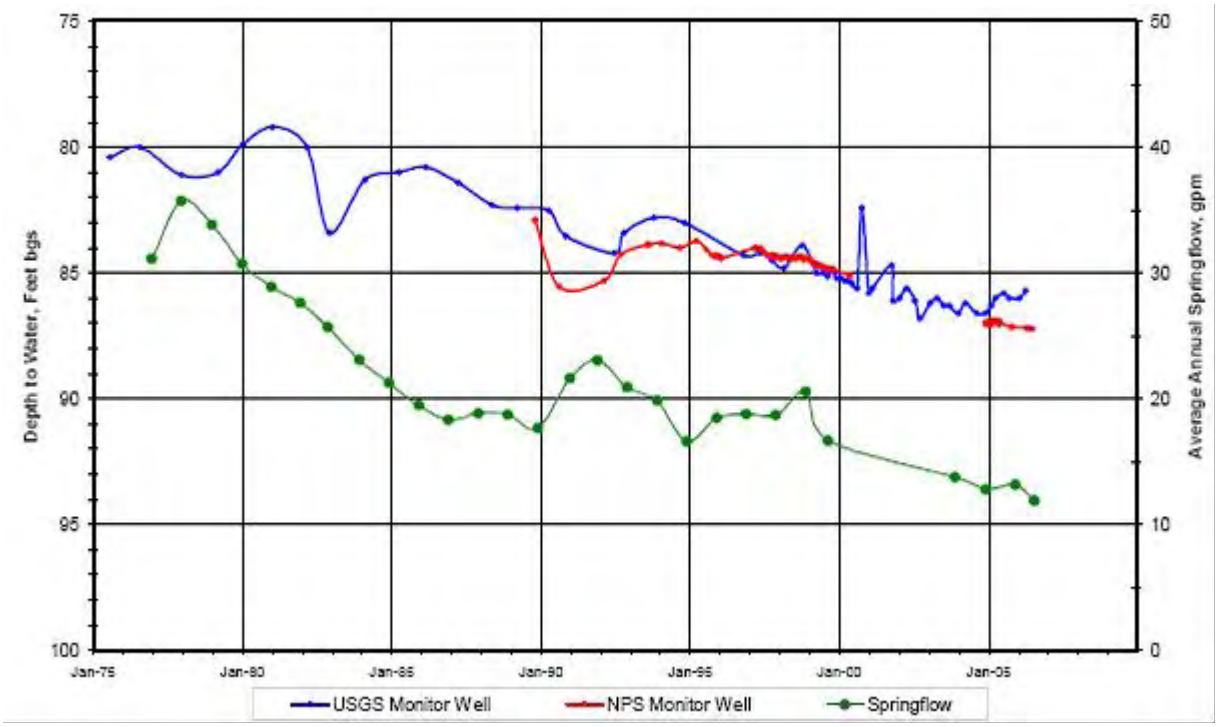

Figure 12. Graph illustrating declines in the groundwater table (as measured in monitoring wells) and spring flows within the Pipe Spring aquifer between 1976 and 2007 (Martin 2007).

Additional hydrologic resources include an intermittent stream course crossing the eastern third of PISP from north to south. This drainage originally carried flows from additional springs emerging along the Sevier Fault, as well as storm runoff. In 1936, after several flood events damaged buildings and vegetation (McKoy 2000), this natural drainage was channeled into a ditch that diverts flows east of the garden and west of the Visitor's Center (Figure 13).

Land Use

The springs emerging within PISP have been used by humans as a water source for thousands of years. Springs emerging along the Sevier Fault are the only perennial surface water for many miles on the semi-arid plateaus north of the Grand Canyon. Permanent settlement and development of the springs by European-Americans began in 1870 with the establishment of a cattle station encompassing the springs. This station was used to receive and tend hundreds of cattle donated to the Church of Jesus Christ of Latter Day Saints by church members living in the area. The springs also provided water for cattle and horses belonging to ranchers throughout the region as they trailed their herds of livestock across the open range. Ranching was the primary use of the area until shortly after Pipe Spring was established as a national monument in 1923 (McKoy 2000).

Figure 13. Diversion ditch draining surface water entering PISP from the north.

At that time, there was probably little surviving native vegetation within the Monument. Most of the pinyon and juniper trees on the mesa west of the Fort had been removed for fuel and timber, and the native grasslands across the plateaus were replaced by packed bare ground or by fourwing saltbush shrublands with very little grass understory (Alexander 1998). The first caretaker of the monument, Leonard Heaton, repaired and maintained the historic structures and turned most of the Monument over to irrigated agriculture. He also planted deciduous trees and shrubs in an attempt to improve the aesthetic appeal of the site and to provide shade for visitors. (McKoy 2000).

Between 1935 and 1939, PISP supported a Civilian Conservation Corps (CCC) camp. The entire southwestern quadrant of the Monument was given over to barracks and administrative buildings that were not removed until 1940 (Figure 14) . Over time, the Monument also contained irrigated pasture, a pond, and a campground; no traces of these developments persist, except that nonnative plant species including Russian-thistle (*Salsola* spp.), puncture vine (*Tribulus*

terrestris), cheatgrass (*Bromus tectorum*), and tumble mustard (*Sisymbrium altissimum*) tend to dominate the areas where they were located (McKoy 2000).

NPS photo

Figure 14. View of the Civilian Conservation Corps buildings that occupied the southwestern part of PISP between 1935 and 1940.

Attempts to restore native vegetation within PISP began after World War II. Soil Conservation Service officials recommended reseeding with galleta grass (*Pleuraphis jamesii*) to control the severe erosion that was occurring throughout the Monument. In 1968 a mix of sand dropseed (*Sporobolus* spp.), Indian rice grass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*) was applied to the most disturbed areas around the visitor center, while pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*) were planted on the mesa. By 1983, these plantings were in poor condition due to use of the restored area by horses and other livestock.

Crops were planted at PISP shortly after its purchase by the federal government and at least some of the Monument has been cultivated ever since. This land use is being evaluated relative to the historical accuracy of supporting cultivated crops on land that was originally a cattle station, not a farm or homestead. Trees, mostly non-native species such as Siberian elm (*Ulmus pumila*) were planted and maintained for visual screening and for shade beginning in the 1920s. Landscape tree planting ceased after 1983, in part because of NPS concern over declining spring flows. Many of the current landscape trees are mature to decadent and will probably die over the next few decades.

A variety of land uses occur within the PISP mapping project area, including roads, historic buildings, NPS housing and maintenance facilities, foot trails, gardens, corrals, and an orchard. Approximately 75.4 acres of the project area (86.7%) currently support native vegetation.

Previous Vegetation Studies

The recorded vascular flora for PISP is relatively diverse for such a small area, consisting of approximately 54 families, 116 genera, and 216 species (Fertig 2008). There have been several formal and informal botanic and vegetation studies involving PISP since 1923 (Fertig and Alexander 2008).

Early NPS staff members Leonard Heaton and J. Whitehead established the original Monument herbarium between 1934 and 1941. They collected specimens of 98 vascular plant species. Mr. Heaton also compiled the first checklist of the Monument's flora in 1935, citing 42 species and estimating that another 100 species remained to be discovered. Many botanists visited PISP between 1945 and the present, adding an average of six new species per decade to the floristic list (Fertig and Alexander 2008).

In 1975, E. Durant McArthur of the USDA Forest Service created a list of plant species occurring adjacent to the nature trail and the Visitor Center. In 1977, Richard King of the USDA-Soil Conservation Service submitted a report to the NPS entitled "The Flora of Pipe Spring National Monument." The report included a list of plant species identified within the Monument boundary, excluding the nonnative trees and shrubs introduced for visual screening, landscaping, or agriculture. Significant botanical inventory began in 1997 when Zion National Park botanists conducted a noxious weed inventory of the Monument. Alexander (1998) confirmed 166 plant taxa for PISP and in 2001 NPS staff and contractors collected 116 vouchers for the PISP herbarium, more than doubling it in size (in terms of collections) and recording 22 new species. A certified list of plants known from the Monument was produced by Fertig (2008).

Alexander (1998) compiled a synopsis of regional vegetation history from historical reference documents and photographs. The major goal of this study was to determine the composition of the presettlement plant communities of PISP. In addition to scientific analyses of packrat middens from nearby areas, Alexander excerpted historical descriptions, journals, and logbooks from the early settlement period, viewed photographs from the late 19th century, and summarized historic NPS documents maintained since 1934.

Project Overview

Partner Roles and Timeline

The goals of this project were to inventory, describe, and map the existing vegetation of Pipe Spring National Monument. The project at PISP is part of a larger effort undertaken by the NCPN to classify and map vegetation in all network parks. As part of the network-wide coordinated effort, the NCPN developed standardized databases, mapping and reporting standards, and naming conventions to ensure that data across parks can be collated or compared.

No formal scoping or preparation was conducted for this vegetation classification and mapping project. PISP staff were contacted in early 2007 and a permit secured to facilitate field work (vegetation sampling and mapping) that was completed in August 2007.

NCPN staff created the draft digital vegetation map and completed the preliminary vegetation classification in October 2007. NatureServe submitted a final vegetation classification in February 2008.

e^2M ecologists prepared local plant association descriptions, while global plant association descriptions were completed by NatureServe ecologists. An illustrated field key to PISP plant associations was developed in 2008.

The NCPN vegetation mapping program manager and GIS technician created the PISP vegetation map from 2007 field data. Map classes were defined for the project on a 1:1 basis, e.g., each map class represents one vegetation type. Polygon attribution follows standards developed by NCPN for all network vegetation mapping projects (Evenden 2004).

A draft map and associated spatial database were completed in 2007. Final revisions were made to the vegetation classification, map, and spatial database during 2008. All geospatial products associated with this project are in the UTM projection, Zone 12, using NAD83.

Table 2 is a timeline for the completion of major project tasks.

Table 2. Project timeline for PISP vegetation mapping project tasks 2007 – 2008.

TASK DESCRIPTION	2007	2008
Planning & Scoping		
Field Data Collection		
Photo Interpretation		
Vegetation Classification		
Local & Global Descriptions		
Spatial Database		

Aerial Photography

Because of budget limitations, the NCPN decided to use existing imagery rather than fly new stereo and orthophotography for the PISP vegetation mapping project. NCPN staff and partners worked with 2006 true-color orthophotographs available through the State of Utah to delineate polygons (Figure 15). The acquired photography had relatively low contrast and 1m resolution (i.e., objects smaller than 1m in diameter, including most shrubs, are usually indistinguishable); however, vegetation boundaries were generally easy to distinguish.

Figure 15. An example of the color orthophotography used as the base image for the PISP Vegetation classification and mapping project. The figure represents the approximate area mapped.

Project Boundary and Map Extent

The orthoimagery was interpreted to an arbitrary project boundary extending 100m (330 ft.) beyond the Monument boundary. The environs surrounding PISP consist exclusively of lands within the Kaibab Paiute Reservation (Figure 2). Only lands within the Monument boundary were sampled for the vegetation classification. The mapping area is 35.4 ha (87.4 acres).

Minimum Mapping Unit

The standard 0.5 ha (1.24 acre) minimum mapping unit (MMU) was discarded in favor of a MMU of 0.1 ha (0.25 acres). Because PISP is so small, using the program standard MMU would have resulted in a loss of detail and reduced the utility of the map. With high-quality, 1:12,000 scale orthoimagery, it is possible to identify distinct features as small as 0.1 ha.

Ecological System Classification

The NCPN elected to use the ecological system classification structure developed by NatureServe (Comer et al. 2003, NatureServe 2003b) as a framework for organizing and presenting plant community data. An ecological system (ES) is defined as a group of plant associations from two or more alliances that tend to co-exist in a given landscape due to similar ecologic processes, substrates, and/or environmental gradients. The ES classification was developed to provide larger scale classification units for application to resource management, mapping, and conservation. Current estimates are that Colorado and Utah contain more than 80 ecological systems (NatureServe Explorer 2008). This approach complements the NVC where the finer-scale association units provide a basis for interpreting larger-scale ES patterns and concepts. A description of each of these units appears in Appendix A.

The ecological system classification addresses natural landscapes. Land-use categories used to organize developed areas are described elsewhere in this report. Seven ecological system units were used for the PISP vegetation mapping project (with their NatureServe identifying codes):

- Colorado Plateau Pinyon-Juniper Woodland (CES304.767)
- Southern Colorado Plateau Sand Shrubland (CES304.793)
- Inter-Mountain Basins Greasewood Flat (CES304.780)
- Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
- Inter-Mountain Basins Semi-Desert Grassland (CES304.787)
- Inter-Mountain Basins Wash (CES304.781)
- Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

Vegetation Classification and Description

Pre-Field Methods

Preliminary Classification List

A preliminary list of vegetation associations and alliances for PISP was compiled prior to vegetation sampling in 2007. Previous vegetation classification work, floristic information for PISP and expert local knowledge were used to refine the list. This list was used to plan field work and assign provisional association names to vegetation plots and observation points.

Field Methods

The primary purpose of classification plot data was to derive quantitative information documenting the composition and structure of PISP vegetation types and their associated environmental conditions. These data became the basis for classifying the vegetation of the Monument. Field methods followed national program standards (e.g., TNC and ESRI 1994a, 1994b) for vegetation classification sampling and mapping. The method we used to sample classification plots (also known as relevé sampling) is widely used by ecologists. The plot dataset was enhanced by collecting observation point data, whose primary purpose was to support aerial photo interpretation. Data gathered by this project can contribute to understanding vegetation relationships across broader landscapes beyond the Monument boundary.

In addition to the basic vegetation data collected at each plot, the NCPN defined additional data fields to meet needs of network managers. Plot forms and individual data field descriptions appear in Appendix B. This section is a summary of the vegetation data collection methods used at PISP.

Field Sampling Approach

The sampling area included the entire Monument and an environs extending 100m beyond the boundary (Figure 2). Given the very small project area and ease of accessibility and landscape viewing, we visited all potential map polygons in the field and collected vegetation plot data, observation point data, and/or field notes on aerial photographs for every polygon. The sampling was completed in August 2007 by the NCPN vegetation mapping program manager. Two vegetation plots and four observation points were sampled and field notes recorded during the 2007 field visit (Figure 16). A third plot was added to the data set in September 2008.

Plot Data Collection

Field crews placed classification plots subjectively within stands in order to represent accurately the association being sampled. Ecotones (areas where two or more plant communities intermix) were avoided. Highly disturbed areas were also avoided unless they covered at least 0.5 hectares. Plots were generally located in stands exceeding the project minimum mapping unit (MMU) of 0.1 hectares. Plot size and shape requirements were consistent with National Vegetation Mapping Program guidelines (TNC and ESRI 1994a). Plot size was determined by the

physiognomy of the community being sampled (Table 3). Plot shape was adjusted as needed to sample smaller stands of vegetation. Plot size and shape were recorded for all PISP plots.

Table 3. Plot sizes used for vegetation classification sampling at PISP.

Vegetation Class	Area (m^2)	Circular Plot Radius (m)	Other Shapes Used (m)
Shrubland, Woodland	400	22.6	40 x 10, 20 x 20
Herbaceous	100	11.3	10 x 10

PISP staff requested that the vegetation plot locations not be permanently marked. Locations were recorded on the orthoimagery field map during field data collection to ensure that the Monument was adequately sampled.

Within each plot and observation point, researchers estimated and recorded an array of vegetation and environmental data using the field forms in Appendix B and data definitions in Appendix C. Three categories of data were collected for vegetation plots (Table 4):

- location and plot identifiers
- environmental description
- vegetation description

Table 4. General plot data categories and specific data components collected at each vegetation classification plot.

Plot Data Category	Data Components
Location and Plot Identifiers	Plot code, park name, site name, state, county, quad name, quad code, GPS unit, GPS file ID, UTM coordinates, UTM zone, GPS error, 3D differential, survey date, surveyor names, directions to plot, plot dimensions, photograph documentation
Environmental Description	Elevation, slope, aspect, topographic position, landform, geology, Cowardin wetland type, hydrologic regime, ground cover, soil texture, soil drainage, evidence of disturbance and animal use
Vegetation Description	Height and cover of all strata, cover by species, physiognomic type, provisional association name, plot representativeness

Location and Plot Identifiers. The bounds of each plot were marked using measuring tapes. The Universal Transverse Mercator (UTM) XY coordinates at the center of each plot were recorded (Zone 12, NAD83) Garmin hand-held GPS receivers. Other data fields documenting the location of each plot are listed in Table 4 and are described in detail in Appendix C.

Environmental Description. The physical characteristics of each plot were documented in both categorical and narrative fields (Table 4; Appendix B, Appendix C). These included topographic site features (elevation, slope, aspect, topography), hydrology, geology, and soils. The ground

surface was divided into categories of rocks, sand, litter, bare soil, biological soil crust, moss, and lichen, and the cover of each category estimated. A narrative field provided for a general description of the plot setting and the influence of physical factors on the vegetation.

Vegetation Description. Every vascular plant species in each plot was assigned to one of 14 physiognomic strata (Appendix B). Within each stratum, the investigator recorded average height and percent canopy cover for all species using the scales in Table 5. Consistent and repeatable cover estimates were obtained by relating the area occupied by an individual species to the area of the entire plot. When it was not possible to identify a species in the field, plant material was collected and pressed for later identification. All plant material collected for identification was destroyed in analysis. Provisional plant association names were assigned to each plot using the preliminary association list and professional judgment.

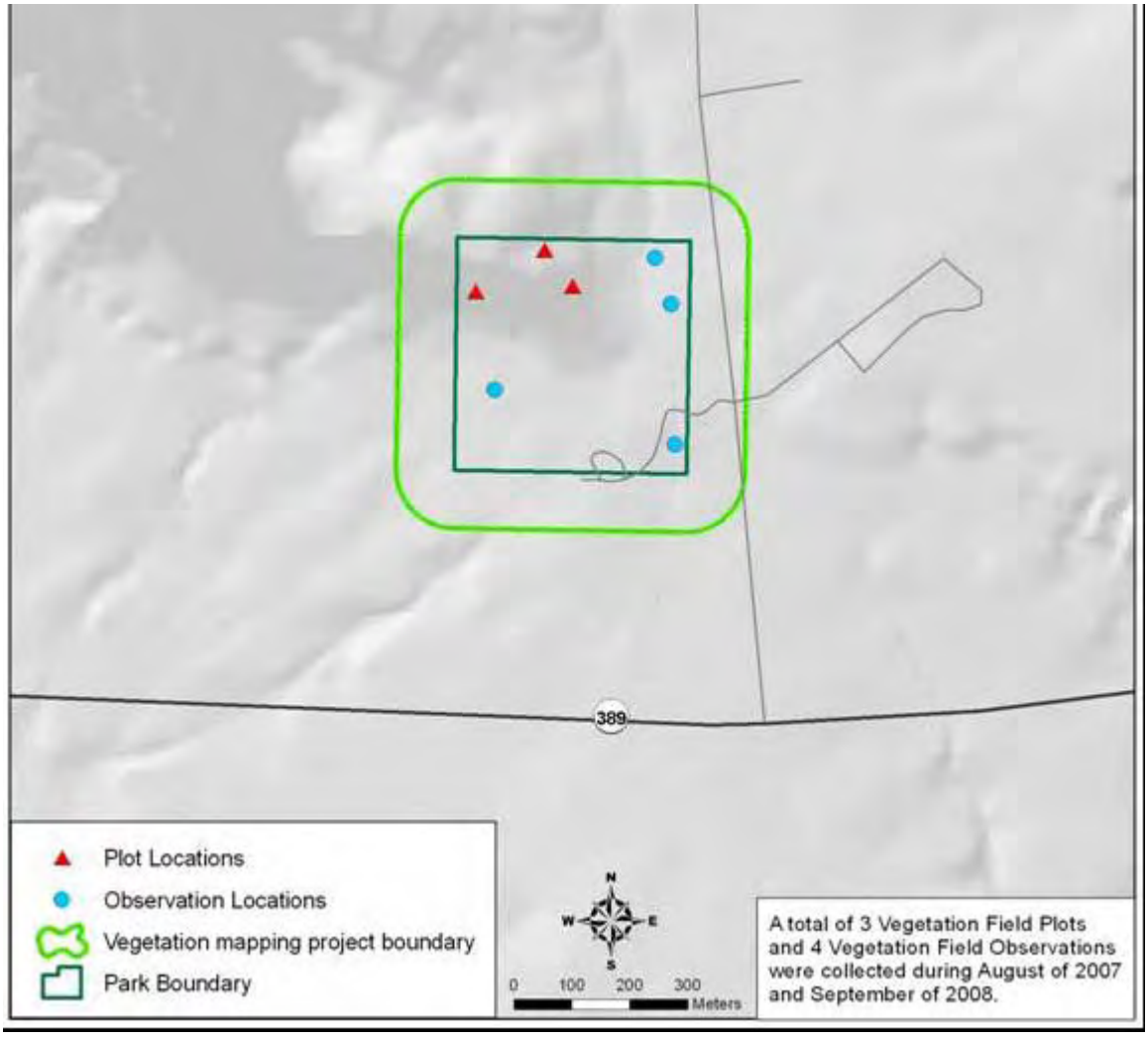

Figure 16. Locations of sample plots (vegetation plots and observation points) in the PISP vegetation mapping project area..

Descriptive Information. Field crews recorded observations as to how well the plot represented

the stand, the relationship of site conditions to vegetative patterns, and site disturbance history. The overall character of the vegetation and features of each plot were documented by two or more 35 mm color slide photographs.

Table 5. Vegetation cover and height classes used in the PISP vegetation mapping project.

Species and Strata Canopy Cover Classes				**Strata Height Classes**			
Code	*Range*	*Code*	*Range*	*Code*	*Range*	*Code*	*Range*
T	0-1%	5	> 45-55%	01	<0.5 m	06	>10-15 m
P	>1-5%	6	>55-65%	02	0.5-1 m	07	>15-20 m
1	>5-15%	7	>65-75%	03	>1-2 m	08	>20-35 m
2	>15-25%	8	>75-85%	04	>2-5 m	09	>35-50 m
3	>25-35%	9	>85-95%	05	>5-10 m	10	> 50 m
4	>35-45%	10	>95%				

Observation Points

In addition to classification plots, the field crew collected vegetation and environmental data at four observation points (Figure 16). Data collected at observation points reflected the vegetation of an undefined area around the point rather than a measured plot, and were less detailed (Appendix B). These data were intended primarily to support modeling and interpretation of the aerial imagery, but were also used to help describe plant associations. Field crews could choose to sample an observation point instead of a full classification plot when:

- they were sampling the environs
- the vegetation was highly disturbed, ecotonal, or otherwise anomalous
- cartographers requested documentation of a specific photo signature or area
- they wished to document special features or vegetation occurring in stands smaller than 0.5 ha (1.24 acres).

Data Processing and Analysis

Plot and observation point data were manually entered into the PISP Vegetation Mapping Project Database. This database is compatible with the data standards of the PLOTS Database System developed for the USGS-NPS Vegetation Classification and Mapping Program by TNC (1997). The PISP database offers NCPN greater flexibility in overall data management than does the NatureServe PLOTS database. The NCPN database was designed to accommodate all project data including plots and observation points. Data standards were established by NCPN for all network vegetation mapping projects, allowing compatibility of data across network park units. Fields associated with the PISP plots database are described in Appendix C.

A thorough quality assessment and quality check (QA/QC) was performed on all field data following entry to the plots database. Individual data records were reviewed with the field data sheets in hand. Additional QA/QC was performed using a set of queries designed to identify inconsistencies across data fields and check for missing data. NCPN technicians standardized the scientific names in the database and noted name changes on the field forms.

The primary authority used for plant names for the PISP vegetation mapping project and all other NCPN I&M projects is *A Utah Flora* (Welsh et al. 2003). It is important to note that NatureServe, a primary project partner, follows Kartesz (1999) as its primary nomenclatural authority. As a result, nomenclature used in the body of this report follows Kartesz, whereas nomenclature in the project database follows Welsh et al. (2003). Differences between the two nomenclatural authorities are reconciled in a crosswalk table (Appendix D).

A GIS data layer (point data) was developed to document classification plot locations. Each 35 mm slide associated with the project was scanned into digital format. The 16 digital images were stored in a photograph database. A unique identifier allows each photograph to be linked with the plots and spatial databases. Slide labels were printed from the database. An additional 49 digital photographs were taken in September 2008 to illustrate the report and appendices.

Classification Data Analysis

Because of the small number of plots and observation points sampled at PISP, we did not conduct a quantitative vegetation classification. Instead, we compared our plot data with information available from NatureServe's Explorer website (www.natureserve.org/explorer), and with plot data from other NCPN vegetation mapping projects. All vegetation plots and observation points classified easily to existing NVC associations. Two additional vegetation types, for which there were no quantitative data, were assigned only to the alliance level of the NVC (Table 6). NatureServe ecologists reviewed our assignments of NVC associations and alliances and concurred with our determinations.

Classification Results

The documented vegetation includes three woodland and six shrubland associations or alliances as well as one herbaceous association. The plot and observation point data recorded in PISP's native vegetation communities classified into six plant associations in five NVC alliances and five ecological systems (Table 6). Two additional alliances (in two additional ecological systems) were described from field notes and refer to communities that were too small or fragmented to sample. Two Utah juniper woodland types, also described from field notes, were assigned to "park special" status, because they describe vegetation not included within the NVC and appear to be unique to the Monument.

Table 6. Plant associations identified within the PISP vegetation mapping project area*.

NVC Association	Common Name	CEGL Code†
UPLAND ASSOCIATIONS		
WOODLANDS		
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)‡		
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	Two-needle Pinyon - Utah Juniper / Sonoran Scrub Oak Woodland	CEGL004007
Juniperus osteosperma / Juncus balticus Woodland [Park Special]	Utah juniper / Baltic Rush Woodland	Park Special
Juniperus osteosperma / Atriplex spp. Woodland [Park Special]	Utah Juniper / Saltbush Species Woodland	Park Special
SHRUBLANDS		
Inter-Mountain Basins Greasewood Flat (CES304.780)		
Sarcobatus vermiculatus Disturbed Shrubland	Black Greasewood Disturbed Shrubland	CEGL001357
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)		
Atriplex canescens - Artemisia tridentata Shrubland	Fourwing Saltbush - Basin Big Sagebrush Shrubland	CEGL001282
Atriplex canescens Shrubland	Fourwing Saltbush Shrubland	CEGL001282
Southern Colorado Plateau Sand Shrubland (CES304.793)		
Artemisia filifolia Colorado Plateau Shrubland	Sand Sagebrush Colorado Plateau Shrubland	CEGL002697
Inter-Mountain Basins Wash (CES304.781)		
Ericameria nauseosa Shrubland Alliance	Rubber Rabbitbrush Shrubland Alliance	A.835
GRASSLANDS		
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)		
Pleuraphis jamesii Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	CEGL001777
RIPARIAN, WETLAND AND MESIC ASSOCIATIONS		
Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)		
Salix (exigua, interior) Temporarily Flooded Shrubland Alliance	(Coyote, Interior) Willow Temporarily Flooded Shrubland Alliance	A.947

* Plant associations determined from the vegetation plot and observation point data. Associations are ordered by physiognomy and grouped by ES. Identification codes are provided for plant associations and ecological systems.

† The CEGL code is assigned by NatureServe to track NVC associations within their databases. Park Specials are not part of the NVC and therefore do not have a CEGL code.

‡ The NatureServe codes following each Ecological System unit name provide a means of tracking the evolution of the concept in NatureServe's Biotics Tracking Database.

Plant Community Descriptions

This section provides a summary of PISP vegetation by physiognomic group. Appendix F provides detailed local and global descriptions of the nine plant associations, alliances, and park special vegetation types occurring within the Monument. Local descriptions are based on plot and observation point data from the Monument. Global descriptions characterize the association across its range, based primarily on published and unpublished literature.

Woodland Associations

Pipe Spring National Monument woodland associations are restricted to the top and slopes of the Moccasin Mesa highland and to the northern part of the Monument where Utah juniper are becoming established in fourwing saltbush shrublands. The woodland associations at PISP include:

- *Juniperus osteosperma / Atriplex* spp. Woodland [Park Special]
- *Juniperus osteosperma / Juncus balticus* Woodland [Park Special]
- *Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland

***Juniperus osteosperma / Atriplex* spp. (Utah Juniper / Saltbush Species) Woodland.** This woodland is in an early stage of development in the northeastern part of the mapping area. Utah juniper trees are becoming established within the existing fourwing saltbush shrubland. The understory is weedy or consists of bare ground, as this is a highly disturbed area.

***Juniperus osteosperma / Juncus balticus* (Utah Juniper / Baltic Rush) Woodland.** This woodland association is restricted to the spring line located along the base of the mesa escarpment north of Winsor Castle. Although the springs are now dry, some mesic species such as Baltic rush (*Juncus balticus*) and wild licorice (*Glycyrrhiza lepidota*) persist under the crowns of large Utah juniper trees. Black poplar saplings were also scattered throughout the stand.

***Pinus edulis – Juniperus osteosperma / Quercus turbinella* (Two-needle Pinyon Pine – Utah Juniper / Sonoran Scrub Oak) Woodland.** This woodland type is restricted to the Navajo Sandstone outcrops in the northwestern part of the monument. An open canopy of two-needle pinyon pine and Utah juniper occurs over a mixed shrub layer dominated by Sonoran scrub oak (*Quercus turbinella*), Utah serviceberry (*Amelanchier utahensis*), Mexican cliffrose (*Purshia stansburiana*), and threeleaf sumac (*Rhus trilobata*). Trees and shrubs root in cracks in the bedrock, while forbs and grasses root in shallow pits where soil has developed. These woodlands are the most diverse community type in the Monument.

Shrubland Associations

As described below, the shrublands at PISP demonstrate sensitivity to soil texture and alkalinity. The shrubland associations at PISP include:

- *Atriplex canescens - Artemisia tridentata* Shrubland
- *Atriplex canescens* Shrubland

- *Artemisia filifolia* Colorado Plateau Shrubland
- *Ericameria nauseosa* Shrubland Alliance
- *Sarcobatus vermiculatus* Disturbed Shrubland

***Artemisia filifolia* (Sand Sagebrush) Colorado Plateau Shrubland.** The sand sagebrush shrubland is rare and has become established in areas where flash flooding along the intermittent drainage and diversion ditch has deposited sandy sediments. Associated shrubs include rubber rabbitbrush (*Ericameria nauseosa*) and fourwing saltbush. The ground layer consists primarily of exotic annual species, including cheatgrass.

***Atriplex canescens - Artemisia tridentata* (Fourwing Saltbush - Big Sagebrush) Shrubland.** This mixed shrubland is rare in the mapping area, occurring only along the northern boundary east of Winsor Castle. Basin big sagebrush may be relict from the now-diverted intermittent wash ecosystem. It is dominant to co-dominant within the sampled stand with fourwing saltbush, rubber rabbitbrush, and sand sagebrush. The understory consists primarily of weedy annual forbs and grasses.

***Atriplex canescens* (Fourwing Saltbush) Shrubland.** Fourwing saltbush shrubland is the dominant shrubland community at PISP, occupying most of the undeveloped flats. In some sites the understory includes significant cover by James' galleta; other areas have an understory consisting of prickly pear cactus (*Opuntia* spp.) and weedy nonnative grasses and forbs. Stands are generally open, with much bare ground between shrub canopies. In the most degraded stands, rubber rabbitbrush and sticky rabbitbrush (*Chrysothamnus viscidiflorus*) may co-dominate the shrub layer.

***Ericameria nauseosa* (Rubber Rabbitbrush) Shrubland Alliance.** A stand of rubber rabbitbrush lines the banks of a ditch that carries overflow from West Cabin Spring. Other species associated with the rabbitbrush include Baltic rush, povertyweed, and field mint.

***Sarcobatus vermiculatus* (Black Greasewood) Disturbed Shrubland.** This community dominates the mesa slope rising above Winsor Castle at PISP. Although this type is normally found on floodplains, here it is supported by seepage from the Sevier Fault zone. Black greasewood (*Sarcobatus vermiculatus*) dominates the relatively closed shrub canopy; fourwing saltbush and snakeweed (*Gutierrezia sarothrae*) are scattered. The understory is sparse, consisting primarily of prickly pear cactus (*Opuntia* spp.).

Herbaceous Associations

Only one stand of naturally occurring native herbaceous vegetation was noted at PISP:

***Pleuraphis jamesii* (James' Galleta) Herbaceous Vegetation.** The James' galleta grassland association is restricted to the south-facing escarpment west of West Cabin. Although the perennial bunchgrasses James' galleta and needlegrass (*Achnatherum* spp.) dominate the stand in terms of cover, scattered shrubs of Bigelow sagebrush (*Artemisia bigelovii*), threeleaf sumac, and green Mormon-tea (*Ephedra viridis*) are visually dominant. James' galleta is only moderately palatable to livestock, helping it to persist following decades of grazing.

Riparian Associations

Pre-settlement vegetation associated with seeps at Pipe Spring probably consisted of stands of coyote willow and scattered Fremont cottonwood (*Populus fremontii*) trees surrounding a swampy area below the spring. Topographic maps and aerial imagery do not reveal a developed channel downslope from the springs, so perennial surface water was probably restricted to the immediate vicinity of the spring. Riparian communities no longer exist within the Monument, but a few relict stands of native wetland vegetation persist:

***Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance.** A dense stand of coyote willow (*Salix exigua*) is clearly visible in a Depression-era photograph of the southwestern corner of the Monument. The water source that supported this stand no longer exists and the water table has dropped so that the stand has broken up into scattered clumps of willow with many dead branches. Openings among the willows support nonnative plant species including horehound (*Marrubium vulgare*), or mesic, disturbance-tolerant forbs such as wild licorice (*Glycyrrhiza lepidota*).

Field Key Preparation

An illustrated dichotomous field key to plant associations of the PISP mapping area was developed for this project (Appendix G). The key is designed to assist users in identifying vegetation associations in the field. The key has two levels; the first level is defined by the physiognomy of the vegetation, i.e., woodland, shrubland, or herbaceous. The second level focuses on the dominant species in each layer. Brief environmental descriptions are included with the floristic descriptions to assist in identifying plant associations. To increase the utility of the key, individual plant associations are cross-referenced to map classes.

The field key was constructed from data collected specifically for this mapping project. Because the key is based on a sample of the vegetation, it may not include all associations occurring within the Monument, nor does it describe the full range of variation of the associations as they appear in the Monument.

Fuels Data Collection

Fuels data were not analyzed as part of this project and data pertinent only to fuels modeling were not collected. The plot photographs and some of the data collected for vegetation classification may be useful for fuels management. Data collected in the vegetation plots at PISP that are potentially useful for fuels modeling include stem diameter at root crown for two-needle pinyon pine and Utah juniper trees. Sampled two-needle pinyon pine – Utah juniper stands were assigned to one of four age-class categories: old-growth, mature, young, or invasive.

Vegetation Mapping

Methods

The process of mapping vegetation and land uses of NCPN park units consists of four steps:

1. Field reconnaissance
2. Map class and attribute development
3. Mapping
4. Spatial database development

Field reconnaissance is intended to familiarize the photo interpreter with the Monument, patterns of vegetation distribution, and environmental factors. During map class and attribute development, the mapping ecologist uses all available information, professional experience, and an inspection of the aerial imagery to develop map classes and appropriate attributes. Mapping is the process during which the photo interpreter uses field data, field notes, and characteristic photo signatures to draw consistent, homogenous polygons on the base photography. During spatial database development, attributes (e.g., vegetation height, land use category) and ancillary datasets (e.g., photos, map class descriptions) are linked to each point or polygon in the spatial layer. Because PISP is a small park, the first three steps were accomplished simultaneously during the plot data collection visit in August 2007.

Field Reconnaissance

Reconnaissance was conducted concurrently with vegetation plot and observation point data collection during August 2007. The primary project ecologist walked the entire park over two days. The reconnaissance focused on comparing site-based vegetation conditions with signatures on a paper plot of the orthoimage of the Monument, understanding environmental drivers influencing vegetation patterns, and identifying what information could be extracted from the project imagery. Field notes were written directly on the orthoimage and were used to guide digitization of the final map.

Map Class and Polygon Attribute Development

The goal of mapping was to identify meaningful units to represent existing vegetation and land uses for the PISP vegetation mapping project area. Map classes specific to this project were developed to characterize vegetation types within the Monument. Standard land-use map classes (Anderson et al. 2002) were used to map developed parts of the Monument such as buildings, corrals, and roads.

Interpretation and attribution of map classes for vegetation addressed all types observed within PISP regardless of size. Most map classes include polygons smaller than the 0.5-hectare program MMU. Because PISP is a small park, it was possible to map the entire Monument in the field to the level of vegetation association.

In order to facilitate use of vegetation maps and mapping data across multiple parks, the NCPN adopted a convention for naming and presenting map classes. For each map class representing an NVC plant association, a translated common name (e.g., Utah Juniper / Baltic Rush Woodland) was used. To facilitate tracking and management of vegetation map class information, a coding system was developed. The original map class coding system used by the photo interpreter consisted of a unique but arbitrary number for each map class. These numeric codes have been retained within the spatial database and map class key (Appendix J). A complementary, five-letter alphacode system for map classes was created for all park vegetation mapping projects. Each alphacode begins with the first letter of the corresponding NVC Class (F = Forest, W = Woodland, S = Shrubland, H = Herbaceous, and N = nonvascular). The subsequent four letters generally abbreviate the map class name. For example, the Utah Juniper / Baltic Rush Woodland map class is represented by the alphacode "W-JUBR". For map classes representing coarser levels of the NVC, geologic exposures, and other non-vegetated features, generic names incorporating vegetation and landscape features were used. Map classes representing developments such as roads or horticultural plantings were given alphacodes with the prefix L = land cover / land use.

Photointerpretation and polygon labeling and attribution procedures were standardized for all park vegetation mapping projects (Evenden 2004). After a map class was assigned to each polygon, the polygon was assigned attributes to characterize vegetation structure (density, pattern, height; Table 7), land use, and disturbance. All map polygons were assigned to a land cover / land use type (Anderson et al. 2002; Appendix H). In addition, all polygons were assigned to higher levels of the NVC hierarchy, with the exception of non-vegetated map classes, which were coded as 'unclassified' or 'unvegetated' in the NVC columns.

Table 7. Physiognomic attributes assigned to map polygons. When appropriate, these attributes were assigned to individual polygons. Otherwise they were assigned to an entire map class.

Category	Attribute	Description
Vegetation Canopy Density (Applied to forest, woodland, and shrub-dominated map classes)	A	Closed Tree Canopy/Continuous (> 60% cover)
	B	Open Tree Canopy/Discontinuous (25- 60% cover)
	C	Dispersed – Sparse Tree Canopy (10-25% cover)
	D	Dense Shrub Canopy (> 40% cover)
	E	Light Shrub Canopy (10 – 40% cover)
Vegetation Pattern (Applied to all vegetation map classes)	1	Clumped/Bunched
	2	Linear
	3	Gradational/Transitional
	4	Regularly Alternating
	5	Homogenous
Vegetation Height (Applied to woody terrestrial vegetation map classes only)	F	Forest and Woodlands > 30 meters tall
	G	Forest and Woodlands 15 – 30 meters
	H	Forest and Woodlands 5 – 15 meters
	I	Forest and Woodlands 1 – 5 meters
	J	Forest and Woodlands < 0.5 meters
	K	Shrublands 1 – 5 meters
	L	Shrublands 0.5 – 1 meters
	M	Shrublands 0 – 0.5 meters

Park Specials

Occurrences of vegetation types that do not fit within the National Vegetation Classification were documented as "park specials" (Table 6). At PISP, the park specials include two unusual Utah juniper woodland types, one with relict wetland species in the understory, the other representing areas where Utah juniper trees are becoming established in existing fourwing saltbush shrublands.

Mapping

The mapping component of the PISP project used a combination of methods to interpret and delineate vegetation polygons. The initial set of polygons was drawn and annotated in the field on a 1:3500-scale print of the base orthoimagery. The lines were transferred to a digital environment in an ArcMap personal geodatabase by means of on-screen digitizing. The Monument and an area of environs surrounding it were interpreted and mapped to the same level of detail.

Spatial Database Development

Each polygon was assigned a map class number, alpha code and name, Anderson land use class, and vegetation density, pattern, and height attributes. In order to improve the utility of the map and related data, the spatial database was moved into a geodatabase format, the general structure of which is illustrated in Figure 17. This format allows text and image information to be incorporated and linked to spatial coordinates. Detailed documentation of the geodatabase is provided in Appendix C.

Map Classes

Twenty-six map classes were developed to describe the PISP vegetation mapping project area (Table 8, Appendix J). Of these, 12 are natural vegetation map classes, eight are planted or cultivated land cover classes, and six are non-vegetated land-use map classes. The 12 natural vegetation map classes represent single NVC plant associations or sub-associations.

Ecological systems (Comer et al. 2003) are used to organize the vegetation map classes. They were developed by NatureServe to complement the finer-scale NVC by creating a mappable classification unit representing groups of biologic communities in similar environments and shaped by similar ecologic processes. Ecological systems typically occur in patches of tens to thousands of hectares and are expected to persist for 50 or more years. The timeframe allows successional dynamics to be integrated into the concept of each ecological system.

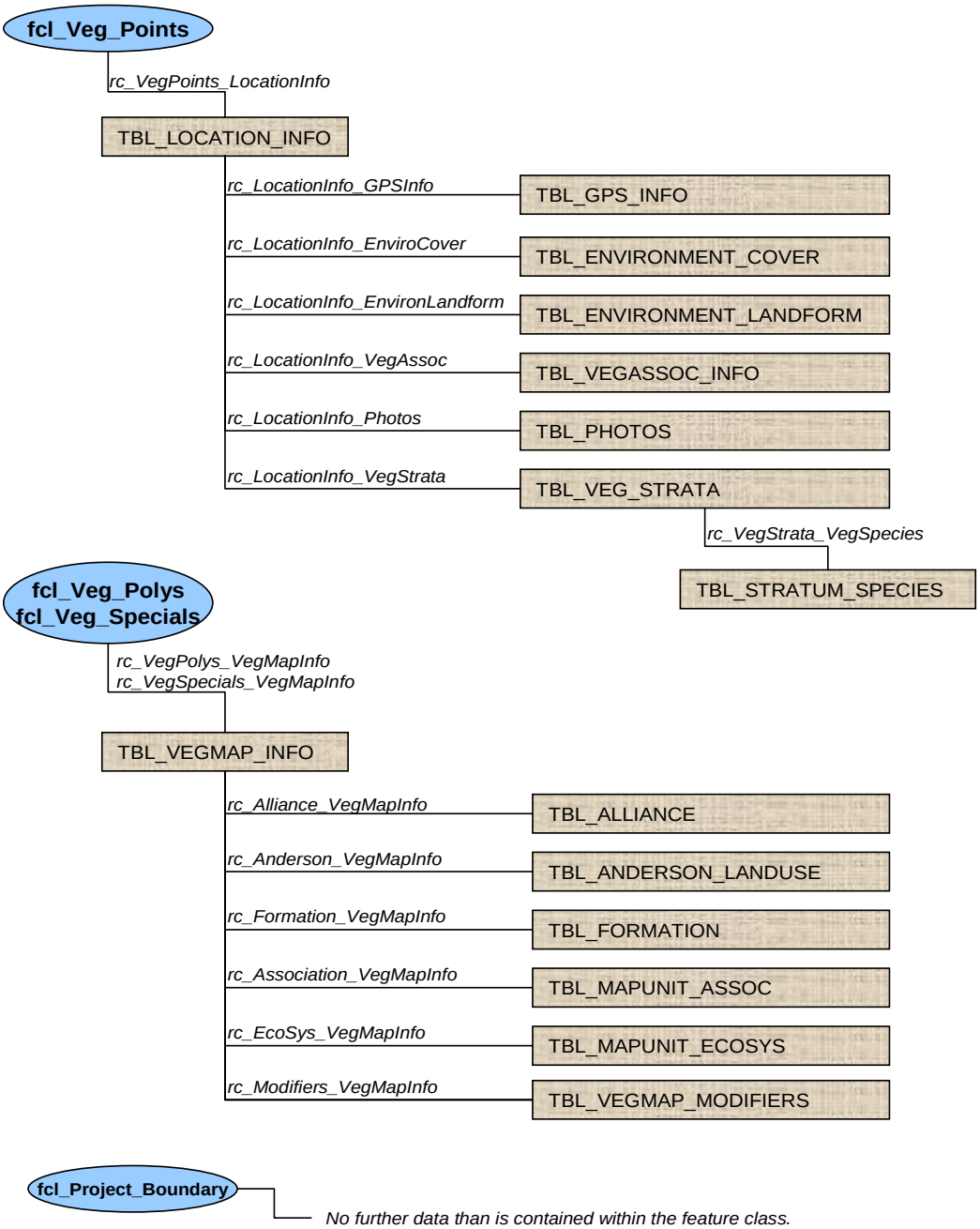

Figure 17. Structure of the PISP geodatabase.

Results

Table 8 shows the relationship of vegetation map classes to ecological systems. Appendix A provides summary descriptions of each ecological system. The Anderson land use and land cover map classes could not be placed within the ecological system classification.

Table 8. Map classes used in the PISP vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. PISP vegetation map classes are arranged using the NatureServe ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Class	Relation
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)				
21	W-PJQT	Pinyon - Juniper / Scrub Oak - Bitterbrush Woodland	*Pinus edulis - Juniperus osteosperma / Quercus turbinella* Woodland	1 : 1
22	W-JUBR	Juniper - Baltic Rush Woodland	*Juniperus osteosperma / Juncus balticus* Woodland [Park Special]	1 : 1
23	W-JUSB	Juniper - Saltbush Woodland	*Juniperus osteosperma / Atriplex* spp. Woodland [Park Special]	1 : 1
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)				
31	S-FWSB	Fourwing Saltbush Shrubland	*Atriplex canescens* Shrubland	many : 1
33	S-FWSS	Fourwing Saltbush – Sand Sagebrush Shrubland	*Artemisia filifolia* Shrubland	many : 1
34	S-ATFW	Basin Big Sagebrush - Fourwing Saltbush Shrubland	*Atriplex canescens - Artemisia tridentata* Shrubland	1 : 1
35	S-FWRR	Fourwing Saltbush - Rabbitbrush Degraded Shrubland	*Atriplex canescens* Shrubland	many : 1
Southern Colorado Plateau Sand Shrubland (CES304.793)				
32	S-SASA	Sand Sagebrush Shrubland	*Artemisia filifolia* Shrubland	many : 1
Inter-Mountain Basins Wash (CES304.781)				
42	S-RURA	Rubber Rabbitbrush Shrubland	*Ericameria nauseosa* Shrubland Alliance	1 : 1
Inter-Mountain Basins Greasewood Flat (CES304.780)				
44	S-BLGR	Black Greasewood Shrubland	*Sarcobatus vermiculatus* Disturbed Shrubland	1 : 1
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)				
51	H-GALL	James Galleta Grassland	*Pleuraphis jamesii* Herbaceous Vegetation	1 : 1
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)				
41	S-WILL	Coyote Willow Shrubland	*Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance	1 : 1
Vegetated Anderson Land Cover Map Classes:				
10	L-COTT	Fremont Cottonwood Woodland	Cottonwoods planted for shade, also to screen the housing area	N/A
11	L-HEAV	Tree-of-Heaven Woodland	Planted primarily to screen modern developments	N/A
12	L-LOCU	Black Locust Woodland	Planted to provide shade near the picnic area and northern corrals	N/A
13	L-SELM	Siberian Elm Woodland	Planted to shade the Fort	N/A
14	L-POPL	White and Black Poplar Woodland	Planted to shade ponds in front of the Fort	N/A
43	L-BERR	Edible Berry Shrubland	*Prunus* spp. and *Ribes* spp. [unclassified]	N/A
260	L-ORCH	Orchard	Irrigated fruit trees	N/A

Table 8. Map classes used in the PISP vegetation map, with map class number, code and name, crosswalk to NVC association, and the relationship of map class to plant associations. PISP vegetation map classes are arranged using the NatureServe ecological systems classification.

Map Class #	Map Class Code	Map Class Name	Associations Assigned to Map Class	Relation
270	L-GARD	Garden	Irrigated vegetable garden	N/A
Non-Vegetated Anderson Land Use Map Classes:				
210	L-CORR	Corrals	Fenced areas containing bare ground or annual or weedy perennial vegetation	N/A
220	L-DIRT	Dirt roads and staging areas	Paved and dirt roads within the Monument, regardless of whether they are open to vehicles; also areas of bare dirt due to heavy foot traffic	N/A
230	L-PARK	Parking Lot	Paved parking area in front of the Visitor Center	N/A
240	L-DUMP	Dumpster	Staging area south of the Visitor Center	N/A
250	L-BUIL	Buildings	NPS buildings and facilities, including those for housing, visitor center, maintenance	N/A
310	L-ROAD	Pipe Spring Road (Paved)	Irrigated fruit trees	N/A

Map Class Descriptions

Appendix J provides detailed descriptions of all map classes used in the final version of the PISP vegetation mapping project. Each map class description includes:

- a summary of the ecological concept of the map class. Reference is made to the abundance and distribution of the map class within the project area
- statistics for polygons of the map class (frequency, area)
- the relevant ecological system, a list of plant associations, and common plant species occurring within the map class
- a qualitative description of the photographic signature along with representative samples from the orthophotography
- ground photographs (if available)

Map Polygons

Seventy-three polygons totaling 35.4 hectares (87.4 acres) were mapped at PISP. Average polygon size is 0.5 ha (1.2 acres). Lands within the Monument totaled 16.2 ha (40 acres) or 46% of the total project area. Thirty-eight polygons (52%) represent natural vegetation map classes covering 86% of the mapping project area. Map classes representing cultivated areas and non-vegetated roads or facilities account for the remaining 35 polygons (48% of polygons, 14% of the mapping area).

The most common vegetation map class is Fourwing Saltbush Shrubland (S-FWSB) with 11 polygons covering 45% of the mapping area. This map class also had the largest average polygon size at 1.4 ha (3.5 acres) per polygon.

A declining coyote willow stand in the southeastern corner of the Monument occupies the site of a spring that has dried up since the 1950s. The once-continuous stand has fragmented into a scattering of willow clumps. Each clump is much smaller than the 0.5 ha MMU. This vegetation type was therefore mapped as a point layer based on GPS data recorded in the field as well as a polygon that encompasses the original extent of the stand.

Figure 18 is an example of a map of the vegetation of PISP created from the GIS spatial database. Because we used a geodatabase to store and organize spatial information, there is far more data in the spatial database than can be conveyed in a two-dimensional map. Maps can be produced with vegetation polygons labeled in many different ways at different levels of resolution. Table 9 provides summary statistics for PISP vegetation map polygons.

Table 9. Summary statistics for polygons of each map class developed for the PISP vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)							
W-PJQT	Pinyon-Juniper / Scrub Oak-Bitterbrush Woodland	1	1	2	1.27	3.20	4.47
W-JUBR	Juniper - Baltic Rush Woodland	1	1	2	0.22	0.20	0.42
W-JUSB	Juniper - Saltbush Woodland	1	4	5	0.18	1.40	1.58
	Subtotal	*3*	*6*	*9*	*1.67*	*4.80*	*6.47*
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)							
S-FWSB	Fourwing Saltbush Shrubland	7	4	11	7.00	8.80	15.80
S-ATFW	Basin Big Sagebrush - Fourwing Saltbush Shrubland	1	0	1	0.30	0	0.30
S-FWRR	Fourwing Saltbush - Rabbitbrush Degraded Shrubland	2	3	5	0.63	3.20	3.83
	Subtotal	*10*	*7*	*17*	*7.93*	*12.0*	*19.93*
Southern Colorado Plateau Sand Shrubland (CES304.793)							
S-FWSS	Fourwing Saltbush – Sand Sagebrush Shrubland	1	0	1	0.19	0	0.19
S-SASA	Sand Sagebrush Shrubland	3	3	6	0.61	0.50	1.11
	Subtotal	*4*	*3*	*7*	*0.80*	*0.50*	*1.30*
Inter-Mountain Basins Greasewood Flat (CES304.780)							
S-BLGR	Black Greasewood Shrubland	1	0	1	0.42	0	0.42
	Subtotal	*1*	*0*	*1*	*0.42*	*0*	*0.42*
Inter-Mountain Basins Wash (CES304.781)							
S-RURA	Rubber Rabbitbrush Shrubland	1	0	1	0.23	0	0.23
	Subtotal	*1*	*0*	*1*	*0.23*	*0*	*0.23*
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)							
H-GALL	James Galleta Grassland	1	1	2	1.01	0.85	1.86
	Subtotal	*1*	*1*	*2*	*1.01*	*0.85*	*1.86*
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)							
S-WILL	Coyote Willow Shrubland	1	0	1	0.20	0	0.20
	Subtotal	*1*	*0*	*1*	*0.20*	*0*	*0.20*

Table 9. Summary statistics for polygons of each map class developed for the PISP vegetation mapping project.

Map Code	Map Class Common Name	Polygons			Area (hectares)		
		Monument	Environs	Total Area*	Monument	Environs	Total Area
VEGETATED LAND COVER MAP CLASSES							
L-COTT	Fremont Cottonwood Woodland	3	0	3	0.68	0	0.68
L-HEAV	Tree-of-Heaven Woodland	2	0	2	0.17	0	0.17
L-LOCU	Black Locust Woodland	2	0	2	0.08	0	0.08
L-SELM	Siberian Elm Woodland	1	0	1	0.11	0	0.11
L-POPL	White and Black Poplar Woodland	1	0	1	0.28	0	0.28
L-BERR	Edible Berry Shrubland	2	0	2	0.14	0	0.14
L-ORCH	Orchard	1	0	1	0.41	0	0.41
L-GARD	Garden	1	0	1	0.15	0	0.15
	Subtotal	*13*	*0*	*13*	*2.02*	*0*	*2.02*
NON-VEGETATED LAND USE MAP CLASSES							
L-CORR	Corrals	3	0	3	0.66	0	0.66
L-ROAD	Pipe Springs Road (paved)	0	1	1	0	0.32	0.32
L-DIRT	Dirt roads and staging areas	5	2	7	1.0	0.12	1.12
L-PARK	Parking lot	0	1	1	0	0.35	0.35
L-DUMP	Dumpster	0	1	1	0	0.04	0.04
L-BUIL	Buildings	8	1	9	0.20	0.21	0.41
	Subtotal	*16*	*6*	*22*	*1.86*	*1.04*	*2.90*
	Total All Map Classes	**50**	**23**	**73**	**16.14**	**19.19**	**35.36**

* Note: Total polygon area may be subject to cumulative rounding error.

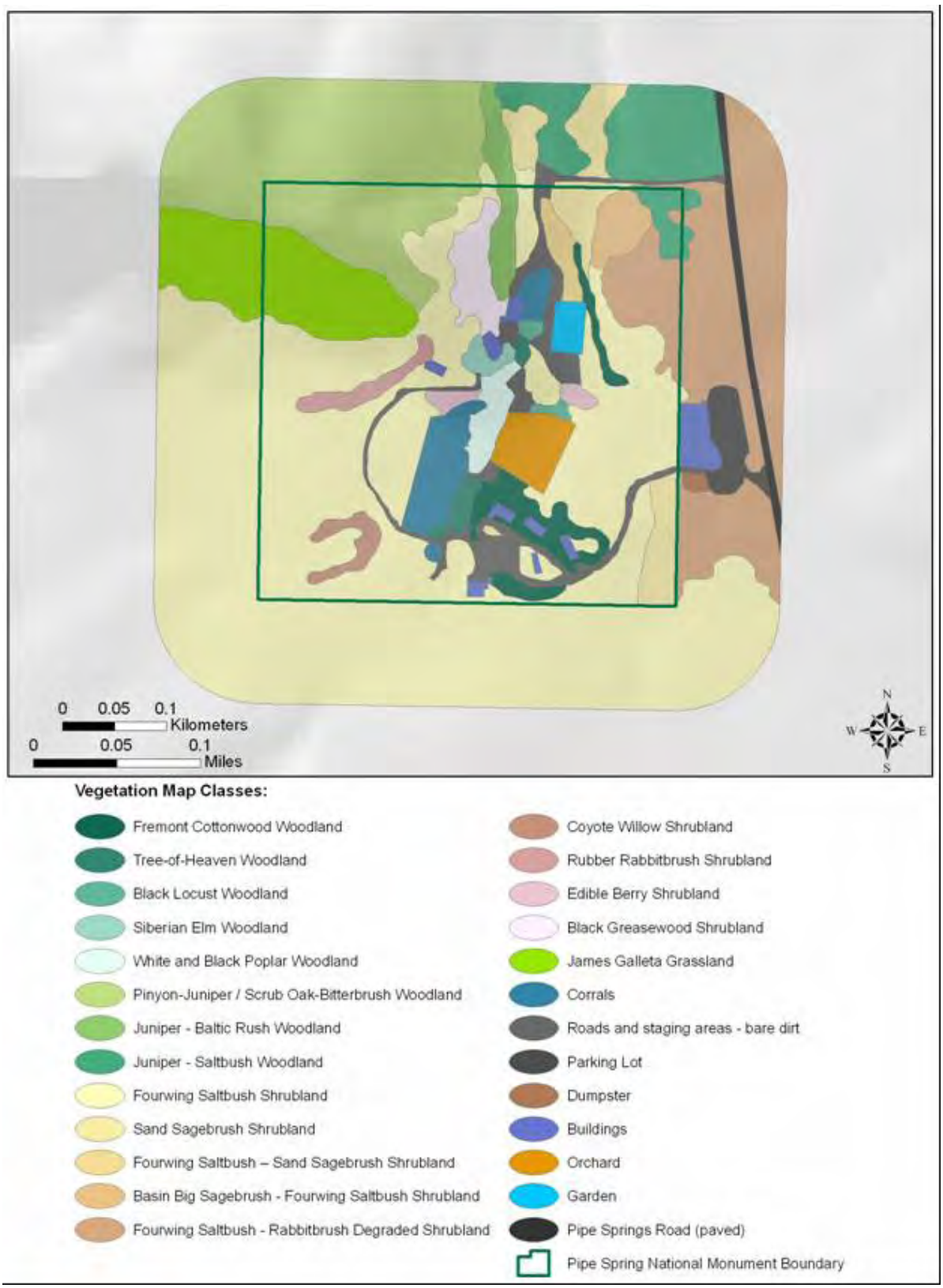

Figure 18. The PISP vegetation map.

Accuracy Assessment

Methods

The PISP vegetation map was not verified by means of the USGS-NPS standard accuracy assessment protocol (ESRI and TNC 1994). The Monument totals only 16.2 ha (40 acres) in size and the terrain is not difficult. Each unit may be visited or viewed in its entirety by a reasonably fit individual in only a few hours. The standard procedure for mapping larger parks is to have four types of field visits spread over the duration of the project: (1) reconnaissance, (2) vegetation plot sampling, (3) map verification, and (4) accuracy assessment. For a park as small and accessible as PISP, following this process would have resulted in a great deal of redundant data and inefficient use of field time.

Because of this potential for redundancy, NCPN ecologists and project partners agreed that it would be more efficient to invest time in the field at the beginning of the project delineating and attributing vegetation polygons in the field as they were observed. The initial map was created in 2007 from detailed field notes recorded on photocopies of the aerial imagery.

The downside of this procedure is that quantification of the degree of confidence users may have in this vegetation map is less rigorous. However, the authors will certify that virtually every acre and management unit was walked, observed, and evaluated, and that (as of September, 2008) this map is accurate.

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Appendix A

Ecological Systems of Pipe Spring National Monument

Introduction

This appendix contains summary descriptions of seven terrestrial and riparian/wetland ecological system (ES) units (NatureServe 2003b, Comer et al. 2003) occurring at Pipe Spring National Monument. Each ecological system represents one or more National Vegetation Classification (NVC) plant associations (Table 6 within the main report). Map classes were also crosswalked to ES units (Table 8 within the main report).

Because the map was created directly from field observations, not every ecological system is represented by a plot or observation point.

The ecological systems classification was developed in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. One purpose of ecological systems is to provide a coarse-scale mapping unit that can be applied across management boundaries.

CES304.767 COLORADO PLATEAU PINYON-JUNIPER WOODLAND
Division 304 (Inter-Mountain Basins); Forest and Woodland

Spatial Scale & Pattern: Matrix
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Montane [Lower Montane]; Lowland [Foothill]; Mesa; Ridge/Summit/Upper Slope; Sedimentary Rock; Temperate [Temperate Xeric]; Aridic; *Pinus edulis, Juniperus osteosperma*
Concept Summary: This ecological system occurs in dry mountains and foothills of the Colorado Plateau region including the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim and east into the northwestern corner of New Mexico. It is typically found at lower elevations ranging from 1,500 m to 2,440 m. These woodlands occur on warm, dry sites on mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of pinyon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. *Pinus edulis* and/or *Juniperus osteosperma* dominate the tree canopy. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, *Juniperus monosperma* and hybrids of *Juniperus* spp may dominate or codominate the tree canopy. *Juniperus scopulorum* may codominate or replace *Juniperus osteosperma* at higher elevations. Understory layers are variable and may be dominated by shrubs, graminoids, or be absent. Associated species include *Arctostaphylos patula, Artemisia tridentata, Cercocarpus intricatus, Cercocarpus montanus, Coleogyne ramosissima, Purshia stansburiana, Purshia tridentata, Quercus gambelii, Bouteloua gracilis, Pleuraphis jamesii*, or *Poa fendleriana*. This system occurs at higher elevations than Great Basin Pinyon-Juniper Woodland (CES304.773) and Colorado Plateau shrubland systems where sympatric.
Range: Occurs on dry mountains and foothills of the Colorado Plateau region from the Western Slope of Colorado to the Wasatch Range, south to the Mogollon Rim. It is typically found at lower elevations ranging from 1,500 m–2,440 m.
Subnations: AZ, CO, NM, UT

CES304.784 INTER-MOUNTAIN BASINS MIXED SALT DESERT SCRUB
Division 304 (Inter-Mountain Basins); Shrubland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Lowland]; Shrubland (Shrub-dominated); Alluvial flat; Alluvial plain; Plain; Alkaline Soil; Saline Substrate Chemistry; Calcareous; Silt Soil Texture; Clay Soil Texture; Xeromorphic Shrub; Dwarf-Shrub; Atriplex spp.
Concept Summary: This extensive ecological system includes open-canopied shrublands of typically saline basins, alluvial slopes and plains across the Intermountain western U.S. This type

also extends in limited distribution into the southern Great Plains. Substrates are often saline and calcareous, medium- to fine-textured, alkaline soils, but include some coarser-textured soils. The vegetation is characterized by a typically open to moderately dense shrubland composed of one or more *Atriplex* species such as *Atriplex confertifolia, Atriplex canescens, Atriplex polycarpa,* or *Atriplex spinifera*. Other shrubs present to codominate may include *Artemisia tridentata ssp. wyomingensis, Chrysothamnus viscidiflorus, Ericameria nauseosa, Ephedra nevadensis, Grayia spinosa, Krascheninnikovia lanata, Lycium* spp., *Picrothamnus desertorum,* or *Tetradymia* spp. *Sarcobatus vermiculatus* is generally absent, but if present does not codominate. The herbaceous layer varies from sparse to moderately dense and is dominated by perennial graminoids such as *Achnatherum hymenoides, Bouteloua gracilis, Elymus lanceolatus ssp. lanceolatus, Pascopyrum smithii, Pleuraphis jamesii, Pleuraphis rigida, Poa secunda,* or *Sporobolus airoides*. Various forbs are also present.
Range: Intermountain western U.S., extending into the southern Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WYAZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CES304.793 SOUTHERN COLORADO PLATEAU SAND SHRUBLAND
Division 304 (Intermountain Basins); Shrubland

Spatial Scale and Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland
Diagnostic Classifiers: Lowland (Lowland, Foothill), Woody Herbaceous, Temperate Xeric, Alkaline Soil, Aridic, Very Short Disturbance Interval, G-Landscape/High Intensity, Mechanical Disturbance, Xeromorphic Shrub, Short (50-100 years) Persistence
Concept Summary: This large-patch ecological system is found on the Colorado Plateau in northeastern Arizona extending into southern and central Utah. It occurs on mesas, basins and plains at low to moderate elevations (1,300-1,800 m). Substrates are stabilized sand sheets or shallow to moderately deep sandy soils. This semi-arid, community is typically dominated by short shrubs (10-30 % cover) with a sparse graminoid layer. Characteristic species include *Ephedra torreyana, Ephedra viridis,* and *Artemisia filifolia*. *Coleogyne ramosissima* is typically not present. *Poliomintha incana, Parryella filifolia, Quercus havardii var. tuckeri,* or *Ericameria nauseosa* may be present to dominant locally. *Ephedra torreyana* and *Ephedra viridis* often assume a distinctive "mot" growth form. Characteristic grasses include *Achnatherum hymenoides, Bouteloua gracilis, Hesperostipa comata,* and *Pleuraphis jamesii*. The general aspect of occurrences is an open low shrubland but may include small blowouts and dunes. Grasses may be locally abundant and form a distinct layer. Disturbance may be important in maintaining the woody component. Eolian processes are evident in the form of pedestalled plants, blowouts or small dunes, but the higher vegetative cover and less prominent geomorphic features distinguish this system from Inter-Mountain Basins Active and Stabilized Dune (CES304.775).
Global Range: This system occurs in sandy plains and mesas on the south-central Colorado Plateau in northeastern Arizona extending into southern and central Utah.
Subnations: AZ, CO?, NM?, UT

CES304.780 INTER-MOUNTAIN BASINS GREASEWOOD FLAT
Division 304 (Inter-Mountain Basins); Mixed Upland and Wetland

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland, Wetland
Diagnostic Classifiers: Lowland; Shrub-dominated; Toeslope / Valley Bottom; Alkaline Soil; Deep Soil; Xeromorphic Shrub
Concept Summary: This ecological system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains and into central Montana. It typically occurs near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites typically have saline soils, a shallow water table and flood intermittently, but remain dry for most growing seasons. The water table remains high enough to maintain vegetation, despite salt accumulations. This system usually occurs as a mosaic of multiple communities, with open to moderately dense shrublands dominated or codominated by *Sarcobatus vermiculatus*. Other shrubs that may be present to codominant in some occurrences include *Atriplex canescens, Atriplex confertifolia, Atriplex gardneri, Artemisia tridentata ssp. wyomingensis, Artemisia tridentata ssp. tridentata, Artemisia cana ssp. cana,* or *Krascheninnikovia lanata*. Occurrences are often surrounded by mixed salt desert scrub or big sagebrush shrublands. The herbaceous layer, if present, is usually dominated by graminoids. There may be inclusions of *Sporobolus airoides, Pascopyrum smithii, Distichlis spicata* (where water remains ponded the longest), *Calamovilfa longifolia, Poa pratensis, Puccinellia nuttalliana,* or *Eleocharis palustris* herbaceous types.
Range: This system occurs throughout much of the western U.S. in Intermountain basins and extends onto the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY

CES304.787 INTER-MOUNTAIN BASINS SEMI-DESERT GRASSLAND
Division 304 (Inter-Mountain Basins); Herbaceous

Spatial Scale & Pattern: Large patch
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.); Upland
Diagnostic Classifiers: Lowland [Foothill, Lowland]; Herbaceous; Temperate [Temperate Xeric]; Alkaline Soil; Aridic; Graminoid
Concept Summary: This widespread ecological system occurs throughout the intermountain western U.S. on dry plains and mesas, at approximately 1,450 m to 2,320 m (4,750–7,610 ft) elevation. These grasslands occur in lowland and upland areas and may occupy swales, playas, mesa tops, plateau parks, alluvial flats, and plains, but sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. When they occur near foothill grasslands, they will be at lower elevations. The dominant perennial bunch grasses and shrubs within this system are all very drought-resistant plants. These

grasslands are typically dominated or codominated by *Achnatherum hymenoides, Aristida* spp., *Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* sp., or *Pleuraphis jamesii* and may include scattered shrubs and dwarf-shrubs of species of *Artemisia, Atriplex, Coleogyne, Ephedra, Gutierrezia,* or *Krascheninnikovia lanata*.
Range: Occurs throughout the Intermountain western U.S. on dry plains and mesas, at approximately 1,450 m to 2,320 m (4,750–7,610 ft) in elevation.
Subnations: AZ, CA, CO, ID, MT?, NM, NV, OR, UT, WA, WY

CES304.781 INTER-MOUNTAIN BASINS WASH
Division 304 (Inter-Mountain Basins); Barren

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Unvegetated (<10% vasc.); Upland; Wetland
Diagnostic Classifiers: Lowland; Shrub-dominated; Wash; Toeslope / Valley Bottom; Riverine / Alluvial; Alkaline Soil; Xeromorphic Shrub; *Sarcobatus vermiculatus*
Concept Summary: This barren and sparsely vegetated (generally <10% plant cover) ecological system is restricted to intermittently flooded streambeds and banks that are often lined with shrubs such as *Sarcobatus vermiculatus, Ericameria nauseosa, Fallugia paradoxa, Artemisia tridentata ssp. tridentata,* and/or *Artemisia cana ssp. cana* (in more northern and mesic stands) that form relatively dense stringers in open dry uplands. Shrubs form a continuous or intermittent linear canopy in and along drainages but do not extend out into flats. Typically it includes patches of saltgrass meadow where water remains for the longest periods. In parts of Wyoming, stringers or patches of *Artemisia tridentata ssp. tridentata* are large and distinct enough from surrounding upland vegetation due to the influence of the wash that they can be classified separately. However, small intermittent washes may also be included with adjacent uplands if vegetation is not different enough floristically or structurally from uplands (e.g., just a little denser canopy). Soils are generally less alkaline than those found in the playa system.
Range: This system occurs throughout the Intermountain western U.S. extending east into the western Great Plains.
Subnations: AZ, CA, CO, ID, MT, NV, OR, UT, WA, WY

CES306.821 ROCKY MOUNTAIN LOWER MONTANE–RIPARIAN WOODLAND AND SHRUBLAND
Division 306 (Rocky Mountain); Woody Wetland

Spatial Scale & Pattern: Linear
Required Classifiers: Natural/Semi-natural; Vegetated (>10% vasc.)
Diagnostic Classifiers: Montane [Lower Montane]; Riverine / Alluvial; Mineral: W/ A-Horizon <10 cm; Unconsolidated; Short (<5 yrs) Flooding Interval; Short (50–100 yrs) Persistence
Concept Summary: This system is found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 m to 2,800 m. This system often

occurs as a mosaic of multiple communities that are tree-dominated with a diverse shrub component. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. Occurrences are found within the flood zone of rivers, on islands, sand or cobble bars, and immediate stream banks. They can form large, wide occurrences on mid-channel islands in larger rivers or narrow bands on small, rocky canyon tributaries and well-drained benches. It is also typically found in backwater channels and other perennially wet but less scoured sites, such as floodplains swales and irrigation ditches. Dominant trees may include *Acer negundo, Populus angustifolia, Populus balsamifera, Populus deltoides, Populus fremontii, Pseudotsuga menziesii, Picea pungens, Salix amygdaloides*, or *Juniperus scopulorum*. Dominant shrubs include *Acer glabrum, Alnus incana, Betula occidentalis, Cornus sericea, Crataegus rivularis, Forestiera pubescens, Prunus virginiana, Rhus trilobata, Salix monticola, Salix drummondiana, Salix exigua, Salix irrorata, Salix lucida, Shepherdia argentea*, or *Symphoricarpos* spp. *Elaeagnus angustifolia* and *Tamarix* spp. are common in some stands. Generally, the upland vegetation surrounding this riparian system is different and ranges from grasslands to forests.

Range: Found throughout the Rocky Mountain and Colorado Plateau regions within a broad elevation range from approximately 900 m to 2,800 m. It is also found in the island mountain ranges of central and eastern Montana.

Subnations: AZ, CO, ID, MT, NM, NV, OR, SD, UT, WY

Appendix B

Plot and Observation Point Instructions and Data Forms

Introduction

This appendix contains the forms and instruction manuals used in collecting field data for the NCPN Vegetation Mapping Project. Two types of data were collected: vegetation plot and observation point. Vegetation plots were used primarily in developing the NVC classification for the Monument. They were also used by photo interpreters to help recognize aerial photo signatures. Observation points were used primarily for assisting with photo interpretation, and secondarily for supporting NVC association descriptions and documenting non-standard vegetation types. No accuracy assessment data were collected in this park.

Appendix B.1. Plot and Observation Point Field Sampling Manual

Pipe Spring National Monument
A Basic Guide for Field Work Modified for the 2007 Field Season

This document is intended to give you general instructions and guidelines for conducting your field work at Pipe Spring National Monument. Detailed, field-by-field coding conventions for the primary form you'll be completing in the field (the Plot Survey form) are provided in the 'cheat sheet' at the back of this guide. You will also be taking Observation Points on a form reduced from and similar to the Plot Survey form.

OVERVIEW
The data that you collect this year will be used to create a relatively fine-scale delineation of vegetation pattern in this Northern Colorado Plateau Network (NCPN) park and its environs. The range of habitats and the corresponding diversity of vegetation types, found in this park are complex. The understanding of finer-scale, ecologically distinct vegetation types that you will help create may be used by the park to plan appropriate management activities, monitor the results of these activities, track long-term changes in vegetation, direct searches for rare species, model fire behavior, and portray the wealth of natural diversity on park lands to the public.

Plot location will be guided by aerial photographs, staff advice, and topographic maps, with the goal of adequately sampling the vegetation. A classification based on this sampling will result in interpretation of aerial photos to produce a vegetation map. A combination of manual and electronic digitizing approaches will be used for Pipe Spring National Monument to delineate polygons and label the vegetation types. The vegetation "types" the photo interpreters will choose to name their polygons are included within the U.S. National Vegetation Classification System (Grossman et al. 1998).

The field crew will evaluate the field data, assign a preliminary vegetation type based on a list of potential vegetation types developed from the existing literature, and update the tally of vegetation types by number of plots still needed. The goal is to use your time as efficiently as possible: we are trying our best to avoid oversampling of some types and undersampling of others. Deciding where to sample to capture the full range of diversity throughout the monument is an iterative process.

GETTING THERE
You will have a copy of the 1:6,000-scale orthophotography to guide you. You will navigate towards each selected photo-signature using your Monument road and trail map, USGS 7.5 mm. topographic map, the photo, and/or GPS.

Before you leave…check that you have all the materials needed to complete your field work (Please see the checklist and 'considerations for mission planning" at the end of this document to help you).

Every single morning…check your GPS receiver to make sure it is set to NAD 83.

Along the way...look around. The goal of this field work is to sample all the different vegetation types that occur in Pipe Spring National Monument. If, on the way to one vegetation type, you see an assemblage of plants that seems unique, please sample if time allows.

ONCE THERE

Establishing a Plot

1) Figure out where to place your plot. This is a subjective process. You'll want to place your plots in areas that seem to be both relatively **homogenous** and **representative** of the vegetation of the signature as a whole. Avoid areas where the vegetation appears to be transitioning from one type to another (ecotones) and areas with anomalous or heterogeneous structure or species composition. Look at *all* the vegetation strata to determine if the area is structurally and floristically uniform and generally try to place your plots at least 30 m from what you see as the 'boundary' between this vegetation type and any neighboring, distinctly different types. During the training period this step will be emphasized and discussed in detail. However, the rule-of-thumb is to conduct a reconnaissance of the plot area if time and topography allows.

Note: In cases where a signature is very heterogeneous, more than one plot or a plot and observation points may be needed. Again, look around, use that human perception.

2) Using your GPS (Global Positioning System) receiver, record the UTM (Universal Transverse Mercator) coordinates in the center of the plot under the Field UTM X and Field UTM Y on the field form. Also mark and label the location of the plot on a USGS 7.5 min. topographic map and/or on an aerial photo. If you cannot obtain a GPS reading, estimate UTMs from the USGS topographic map and note on the form that you had to resort to this method. Plots may be circular, rectangular or square. Note shape and dimensions on the field form. If the plot is rectangular or square, record the azimuth of the long side (any side if square) to help relocate the plot. It may make more sense to establish rectangular plots in linear vegetation types (e.g. riparian or ridgeline types). Standard plot sizes should be as follows:

If you're in a ...	**You should usually make your plot…**	**Giving you a plot area of…**
Forest (trees have overlapping crowns usually forming 60-100% cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Woodland (open stands of trees with crowns usually not touching. Canopy tree cover is 10-60% OR exceeds shrub, dwarf-shrub, herb, & nonvascular cover).	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Shrubland (shrubs greater than 0.5 m tall are dominant, usually forming more than 10% cover OR exceeding tree, dwarf shrub, herb, & nonvascular cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Dwarf-shrubland (shrubs less than 0.5 m tall are dominant, usually forming more than 10% cover OR exceeding tree, shrub, herb, & nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Herbaceous (herbs dominant, usually forming more than 10 percent cover OR exceeding tree, shrub, dwarf-shrub, & nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Nonvascular (lichen or moss cover dominant, usually more than 10% cover).	2.82 m radius OR 5 m x 5 m	25 m^2 25 m^2

Note: You can deviate from the standard plot *shapes* where that makes sense, but the total plot *area* encompassed by the boundaries should be as listed above for each major class of vegetation. For example, forested riparian vegetation may be sampled in a more linear 10 x 40 m (400 m^2) plot; herbaceous riparian or ridgeline vegetation in a 2 x 50 m (100m^2) plot. You may also increase the size of the plot to the next

standard size if necessary to sample the heterogeneity of the vegetation. Forests, woodlands and shrublands can be increased to 1000 m^2. Please make a note on plot form.

3) Once the plot is established, it is generally a good time to fill out the **Identifiers/Locators** part of your Plot Survey Form (see the cheat sheet) and take the plot photos.

Taking photographs
Two color photos will be taken of each plot using slide film. The purpose is to obtain a good representation of the vegetation of the plot, not individual species. A piece of paper (or a chalk board or dry erase board) should be placed in the plot, with the plot number recorded on it, so that the photo includes the plot number. Preprinted plot numbers could be printed or copied onto colored paper (white has such strong contrast as to be unreadable in the photo) and attached to the back of a clipboard. This saves having to write plot numbers in the field. Take the photograph looking across the contour if the slope is steep. Record roll #, frame # and azimuth on plot form.

Data Collection
Environmental Description
See the coding instructions at the end of this document for guidance on the specific fields.

Vegetation Description
For guidance on the specific fields on the second page of the form, see the coding instructions.

As you begin to collect the species, DBH (diameter at breast height – 4.5'), and cover information, keep these rules in mind they will speed your data collection considerably:

1) Except in very diverse plots, don't spend more than **20 minutes** looking for new species to record. Remember that these plot data are to be used to classify the overall vegetation of the Monument, not to make a complete species list for it. If you had to spend much more than 20 minutes *to find* a species, it probably isn't going to be important in characterizing the vegetation type. For diverse plots with over 25 taxa you may take up to 30 minutes on the listing process.

2) If you can't identify a plant to species, record it on your form as "unknown species 1,' "unknown species 2,' "*Carex* unknown sp. I", etc. Record associated cover class and other data for the unknown as you would for any other species. Then do one of two things:

If you need the species identified right away because it appears to be dominant or diagnostic (you're seeing it all over the place or you're seeing much more in this particular vegetation type than in others), take a sample of the species with as much of the plant as possible, especially intact sexual parts (flowers and fruits), if present. Place the sample in a baggie, and label the baggie (or specimen) with the plot code and the name you gave it on the data form.

If you don't need the plant keyed right away, press it. Mark the pressed specimen with the plot code and the name you gave it on the data form.

Store specimens in a cool, dry place. Bagged specimens will keep fresh longer in the refrigerator or ice chest until pressed or identified. You can key some of these out yourself if you want to, but don't let plant keying get in the way of your primary responsibility: field data *collection.* No one expects you to identify every plant but you should make an effort to learn at least the common species that keep recurring in plots. A quick prioritization of what to key and what to press may be made based on the recurrence of the species in samples and on the cover-class estimate of the species in a particular plot. If the species has a

high cover value (>1%) it is more of a priority to identify. Field crews should mark the specimen tag with its cover class estimate as well as its unique identifying number for the vegetation sample.

Observation Point Form

When you have sampled one particular vegetation type thoroughly, but want to further define its distribution or when you encounter small but unique vegetation patches that are below the minimum mapping unit in size (<1.5 ha), record the site on an Observation Point form. This is an abbreviated Plot Survey form and usually takes about 15 minutes to fill in the data. The major difference is that an Observation Point is unbounded and includes an area roughly equal to that of the minimum mapping unit (20 m radius around the observer) or it encompasses the entirety of a small but unique vegetation patch. The data fields are the same as those on the Plot Survey form, so use the above instructions. Minor differences in the Observation Point form from the Plot Survey form include the elimination of some data fields, more general cover classes for ground cover estimates, and only the dominant or diagnostic species are recorded. In addition, only one photo is taken to record the Observation Point plant community.

Accuracy Assessment Point Form

You will navigate to pre-selected coordinates within polygons, scout out the polygon briefly to get a feel for what it is like, and record some general data to characterize it on an Accuracy Assessment Point form. This is also an abbreviated version of the Plot Survey form, much like the Observation Point form, and the same cheat sheet can be used to help with filling it out. A sample completed Accuracy Assessment Point form is provided at the end of this document.

We hope your field season on the northern Colorado Plateau enjoyable and rewarding. Good luck!

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INSTRUCTIONS FOR FILLING OUT PLOT AND OBSERVATION POINT SURVEY FORMS

PLOT DESCRIPTION

Plot Code
Code indicating the specific plot within the vegetation polygon. For the 2007 field season, the codes will be in the following format "PARK ACRONYM.XXX" (i.e., Pipe Spring National Monument = "PISP.XXX"). Begin with PISP.00l and go from there. If another team is working, decide which plot numbers each team will use to identify the data they gather. For example, if a second team is working at Pipe Spring National Monument and approximately 100 plots have already been collected, they may number their plots PISP.125 through PISP.150.

Provisional Community Name
Using the provisional classification of the parks with which you've been provided, assign the name of the vegetation type that most closely resembles this type. Enter the finest level of the classification possible. In fact, *none* of the names may be a good fit; you may have found a new type. If that is the case, create a provisional name with the dominant and diagnostic species. The 'provisional community name' that is assigned will be used to update the tally of types x number of plots needed.

State UT

Park Name PISP

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 or park map.

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

Quad Code
Code of quadrangle map.

Field UTM X
Use GPS, but if you can't obtain a GPS reading, estimate coordinates from a topographic map and note on the form that this method was used.

Field UTM Y
Use GPS, but if you can't obtain a GPS reading, estimate coordinates from a topographic map and note on the form that this method was used.

GPS Error
Note the error in the GPS reading off the unit.

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

Surveyors
Names of surveyors, with principal surveyor (usually the Lead Ecologist) listed first.

Directions to Plot

Precise directions to the site using a landmark (e.g., a named point on the topographic map, a major highway, using park naming conventions for roads) readily locatable on a 7.5 minute topographic or park map as the starting point. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances as closely as possible to the 0.1 mile and use compass directions. Give additional directions to the plot within the site. Do not take more than a couple of minutes to fill this out.

Plot Length and Plot Width
Enter diameter for circular plots and 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	11.3 m radius or 20 m x 20 m	400 m^2
Woodland	11.3 m radius or 20 m x 20 m	400 m^2
Shrubland	11.3 m radius or 20 m x 20 m	400 m^2
Dwarf-shrubland	5.65 m radius or 10 m x 10m	100 m^2
Herbaceous	5.65 m radius or 10 m x 10 m	100 m^2
Nonvascular	2.82 m radius or 5 m x 5 m	25 m^2

Plot Photos/ Roll Number/Frame Numbers
Indicate (Y or N) if photos of the plot were taken at the time of sampling, and their roll and frame numbers. Also record azimuth of the photo if not taken in the standard direction.

Plot Permanent (if/when applicable)
Check off that the plot has been permanently marked.

Plot Representativeness
Does this plot represent the full variability of the photo signature? If not, were additional plots taken? Note additional species not seen in the plot in the space provided below. 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.

ENVIRONMENTAL DESCRIPTION
Elevation
Elevation of the plot. Specify whether in feet or meters. We have determined that the reading you obtain from a topographic map, provided you are certain where you are, is more accurate than the average reading from the GPS unit. Thus, please attempt to estimate your elevation with the topographic map.

Slope
Measure the slope in degrees using a clinometer.

Aspect
Measure the slope aspect using a compass (be sure to correct for the magnetic declination). Note: all compasses should be pre-set to an average declination for the park and thus, readings from the compasses carried by the field crews may be directly noted.

Topographic Position
Topographic position of the plot. 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.

HIGH SLOPE (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.

HIGH LEVEL (mesa). Level top of a plateau.

MIDSLOPE (transportational midslope, middle slope). Intermediate slope position.

BACKSLOPE (dipslope). Midslopes that are steep, linear, and may include cliff segments.

STEP IN SLOPE (ledge, terracette). Level shelf interrupting a steep slope, rock wall, or cliff face.

LOWSLOPE (lower slope, foot slope, colluvial footslope). Gently inclined surface at the base of a slope. Surface profile is usually concave and transitions between midslope 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.

LOW LEVEL (terrace). Valley floor or shoreline representing the former position of an alluvial plain, lake, or shore.

CHANNEL WALL (bank). Sloping side of a channel.

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

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

Landform
Enter the landform that describes the site where the plot was taken. Note on the code sheet the landform choices are listed at different scales. Thus, one can select more than one for plot if appropriate (e.g., mountain could be macro and ridge could be meso scale). Please be consistent so we can analyze by landform. Appendix A provides definitions for these landforms and more.

arroyo	lowland
alluvial fan	mid slope
alluvial flat	mountain
alluvial terrace	lake
bajada	mud flat
bank	piedmont
basin	plain
bench	plateau
butte	ravine
channel	ridge
cinder cone	rim
cliff	rock fall avalanche

colluvial slope	saddle
debris slide	seep
depression	shoreline
drainage	slide
drainage channel (undifferentiated)	slope
dune (undifferentiated)	slough
escarpment	soil creep slope
flood plain	stream terrace (undifferentiated)
foothills	streambed
gap	swale
gorge	talus
hills	toe slope
hogback	valley floor
interfluve	wash

Surficial Geology
Note the geologic substrate influencing the plant community (bedrock or surficial materials). Accurately recording the geology at the plot is especially important if the plot is on an inclusion in the type on the geology map. The list below provides types from the PISP geology map.

Pipe National Monument Geology Map Units:

- Quaternary Alluvium
- Eolian Sand
- Navajo Sandstone
- Kayenta Formation

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

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

SEMIPERMANENTLY FLOODED - Surface water persists throughout growing season 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 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 flood-plain 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.

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

UNKNOWN - The water regime of the area is unclear. The unit is described as a non-tidal wetland.

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.

Unvegetated Surface
Estimate the approximate percentage of the *total* surface area covered by each category. Only include categories with over 5 percent cover.

Soil Texture
Using the key below, assess average soil texture (Brewer and McCann 1982)

Al	Soil does not remain in a ball when squeezed	sand
A2	Soil remains in a ball when squeezed	B
Bl	Squeeze the ball between your thumb and forefinger, attempting to make a ribbon that you push up over your finger.	
	Soil makes no ribbon	loamy sand
B2	Soil makes a ribbon; may be very short	C
C1	Ribbon extends less than 1 inch before breaking	D
C2	Ribbon extends 1 inch or more before breaking	E
D1	Add excess water to small amount of soil	
	Soil feels at least slightly gritty	loam or sandy loam
D2	Soil feels smooth	silt loam
E1	Soil makes a ribbon that breaks when 1 2 inches long;	
	Cracks if bent into a ring	F
E2	Soil makes a ribbon 2+ inches long; does not crack when bent into a ring	G
Fl	Add excess water to small amount of soil;	
	Soil feels at least slightly gritty	sandy clay loam or clay loam
F2	Soil feels smooth	silty clay loam or silt
G1	Add excess water to a small amount of soil;	
	Soil feels at least slightly gritty	sandy clay or clay
G2	Soil feels smooth….	silty clay

Soil Drainage
The soil drainage classes are defined in terms of (l) 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. We recognize 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 be used as criteria of moisture status. We also know that soil profile morphology, such as mottling, normally but not always reflects soil moisture status; however, 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.

RAPIDLY DRAINED - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water addition. Soils are free from any evidence of gleying throughout the profile. Rapidly drained soils are commonly coarse textured or soils on steep slopes.

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. Soils are usually free from mottling in the upper 3 feet, but may be mottled below this depth. B horizons, if present, are reddish, brownish, or yellowish.

MODERATELY WELL DRAINED - The soil moisture in excess of field capacity remains for a small but significant period of the year. Soils are commonly mottled (chroma <2) in the lower B and C horizons or below a depth of 2 feet. The Ae horizon, if present, may be faintly mottled in fine-textured soils and in medium-textured soils that have a slowly permeable layer below the solum. In grassland soils the B and C horizons may be only faintly mottled and the A horizon may be relatively thick and dark.

SOMEWHAT POORLY DRAINED - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year. Soils are commonly mottled in the B and C horizons; the Ac horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

POORLY DRA1NED - The soil moisture in excess of field capacity remains in all horizons for a large part of the year. The soils are usually very strongly gleyed. Except in high-chroma parent materials the B, if present and upper C horizons usually have matrix colors of low chroma. Faint mottling may occur throughout.

VERY POORLY DRAINED - Free water remains at or within 12 inches of the surface most of the year. The soils are usually very strongly gleyed. Subsurface horizons usually are of low chroma and yellowish to bluish hues. Mottling may be present but at the depth in the profile. Very poorly drained soils usually have a mucky or peaty surface horizon.

VEGETATION DESCRIPTION

Leaf Phenology
Select the value that 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 admixed.

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

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

Leaf Type
Select one value that 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).

MICROPHYLLOUS - Woody cover primarily microphyllous.

GRAMINOID - Herbaceous vegetation composed of more than 50 percent graminoid 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.

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, respectively.

Shrubland: Shrubs generally greater than 0.5 m tall with individuals or clumps overlapping to not touching (generally forming more than 10% cover, trees generally less than 10% cover). Shrub cover may be less than 10% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, respectively. Vegetation dominated by woody vines is generally treated in this class.

Dwarf-shrubland: Low-growing shrubs usually under 0.5 m tall. Individuals or clumps overlapping to not touching (generally forming more than 10% cover, trees and tall shrubs generally less than 10% cover). Dwarf-shrub cover may be less than 10% where it exceeds tree, shrub, herb, and nonvascular cover, respectively

Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 10% cover; trees, shrubs, and dwarf-shrubs generally with less than 10% cover). Herb cover may be less than 10% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, respectively.

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, respectively.

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 10% and greater than 0%).

Strata/Lifeform, Height, Cover, 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 *5* m in height or greater at maturity and under optimal growing conditions. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions.

Herbaceous layers are: Ht = total, H1 = Graminoids (grass, sedge, rush), H2 = Forbs (Dicot herbaceous), H3 = Ferns and Fern allies, and H4 = tree seedlings. List the dominant species in each stratum. If a species present is known to be diagnostic of a particular vegetation type, list these as well, marking them with an asterisk.

Cover Scale for Strata		**Height Scale for Strata**	
T	<1%	01	<0.5 m
P	1-5%	02	0.5-1 m
1	5-15%	03	l-2 m
2	15-25%	04	2-5 m
3	25-35%	05	5-10 m
4	35-45%	06	l0-l5 m
5	45-55%	07	15-20 m
6	55-65%	08	20-35 m
7	65-75%	09	35-50 m
8	75-85%	10	>50 m
9	85-95%		
10	95+		

Animal Use Evidence
Comment on any evidence of use of the plot/polygon by non-domestic animals (i.e., tracks, scat, gopher 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.

Other Comments
Any other comments.

Species/DBH/Percent Cover Table
Starting with the uppermost stratum, list all the species present and cover class (using the 12 point scale) and percent cover of each species in that particular stratum. Indicate strata in the left-hand columns. If in

the tree layer (single-stemmed woody plants, generally *5* m in height or greater at maturity), note in the "T" column if Tl (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If in the shrub layer, note in the "5', column if S1 (tall shrub,> 2m), S2 (short shrub, <2m), or S3 (dwarf-shrub <0.5m). If in the ground layer, note in the "G" column if H1 (herbaceous - graminoid), H2 (herbaceous - forb), H3 (herbaceous - fern), H4 (tree seedlings) N (nonvascular other than ferns), V (vine/liana), or F (epiphyte).

*For plots with trees, estimate cover of seedlings, saplings, mature (all others), and total cover for each tree species. Use a separate line for each and assign the most appropriate strata class (by height). Seedlings are generally less than 1.5 m, but that may vary by species.

Also record the DBH (in cm) of all trees above *5* cm diameter. Separate the measurements with a comma. For plots with very high tree density DBH measurements will be done in a subplot. If the number of trees with a DBH greater than *5* cm is more than about 25, divide the plot into quarters and measure the DBH of trees in the southeast quadrant, or the quadrant nearest southeast. CLEARLY NOTE on the form that this is what you've done.

PIPE SPRING NATIONAL MONUMENT – CHEAT SHEET

LANDFORMS

alluvial fan
alluvial flat
alluvial plain
remnant
alluvial terrace
alluvium
artificial levee
backslope
bajada
ballena
basin
basin floor
bench
blowout
bluff
borrow pit
bottomland
braided stream
break
butte
canyon
channel
cliff
closed depression
colluvium
crest
cuesta
deflation basin
depression
desert pavement
dip
ditch
divide
drainageway
draw
dune
eolian deposit
eolian sands
ephemeral stream
escarpment
finger ridge
flat
flood plain
foothills
gorge
gravel pit
gulch
gully
hill
hillslope
interdune
interfluve
intermittent stream
knob
knoll
ledge
levee
mesa
natural levee
overflow channel
pediment
plain
plateau
playa
pool
quarry
ravine
ridge
rise
rim
rockfall
saddle
sand ramp
sand sheet
scarp
shoulder
slope
slope alluvium
slope wash
stream terrace
summit
swale
talus slope
tank
terrace
toeslope
valley
valley floor
valley side
wash

TOPOGRAPHIC POSITION

SEE THE ATTACHED DIAGRAM

VEGETATIVE STRATA

T1 = emergent tree
T2 = tree canopy
T3 = tree sub-canopy
S1 = tall shrub > 2m
S2 = short shrub < 2m
S3 = dwarf shrub < 0.5m
H = herbaceous
H4 = Tree seedlings
N = nonvascular other than ferns

PHYSIOGNOMIC CLASS

Forest: Crowns touching

Woodland: Trees>10%, crowns not touching

Shrubland: Shrubs> grass, forbs or trees

Dwarf Shrubland: Shrubland <0.5 m tall

Shrub Herbaceous: Shrubs = Forbs/grasses

Herbaceous: Grass/forbs > trees or shrubs

Wooded Herbaceous: Trees= grass/forbs

Sparsely Vegetated: Total veg<5-7%

ASPECT

Flat
Azimuth (deg.)
Variable

GPS SETTINGS

NAD1983
WAAS on

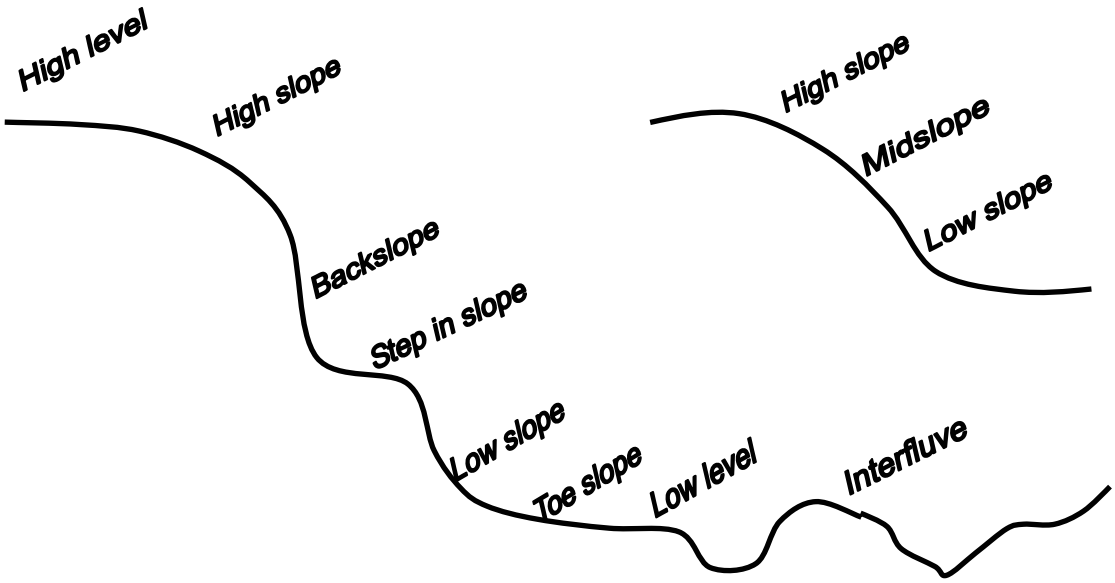
SURFICIAL GEOLOGY

Obscured by soil
Quaternary Alluvium
Eolian Sands
Navajo Sandstone
Kayenta Formation

DISTURBANCE

Water gullies
Mass wasting
Mountain pine beetle damage
Flash flooding
Grazing evidence
Development, historic structures
Agriculture
ORV use or Recreation
Wildlife concentration
Fire
Drought

TOPOGRAPHIC POSITION - CHEAT SHEET



CONSIDERATIONS FOR PLANNING

Planning for the day:

1. Safety and sustenance: Plenty of food, water, first-aid kit, raingear, sunscreen.
2. Field communications:
   a. Develop a plan with other team(s) for radio check-in time.
   b. Do you have a radio and are batteries charged? If you have a walkie-talkie, do you have extra batteries for it? Does park staff know the area in which you will be working?
3. Make sure you have the right maps and photos.
4. Check your GPS (Datum set to NAD83? WAAS on? Needs new batteries?).
5. Plan the day's mission before departing using a) USGS quads, b) aerial photos, c) BLM maps.
6. Considerations for mission planning:
   a. Plan travel based on topography, best access routes, density and complexity of vegetation
   b. Communicate with the other team member(s) to make sure you aren't duplicating effort.

Planning for the Week (do this on the first day of the trip)

1. Do you have all appropriate maps, photos?
2. Develop a reasonable estimate of the number of points for each team broken up by day and based on an estimate of individual team's travel logistics for the week.
3. Develop plan of attack for the week to capture all AA points in the work area.
4. Balance points two and three above with the expected work schedule of the teams and ensure adequate time-off and reduce over-time concerns.
5. Do you have all necessary information and backups for the week's planning? E.g., blank field forms, film, plenty of batteries.

Wrap-up (Do this on the last day of the trip, after you have returned to base)

1. Clean, recharge and repair equipment.
2. Hold brief meeting to discuss data collection issues, things that came up during the work week, and plan for next work hitch.
3. Edit field forms and file them systematically. File observation points separately.
4. Re-file the aerial photos and maps.
5. Send exposed rolls of film to be developed.
6. Key unknown plants.
7. Enter edited data into database.

Communicate among teams / Topics for wrap-up meetings.

1. What were your questions about the polygons visited during the week?
2. Do you have any questions about the forms or fields?
3. What was accomplished, what was not accomplished?
4. Pass on developments and questions after every trip. Don't let them build up. For example, should we sample the new types we saw? Were there problems with interpreting the aerial photos, or are there personnel issues, problems in consistency in interpreting the forms, or with park-related logistics?

Materials Checklist

- Monument research permit
- Topo maps
- Monument and BLM maps for general navigation
- DOQQ photos of AA point locations
- Geology map
- Compass with adjustable declination
- Clinometer
- GPS receiver
- Extra AA batteries for walkie-talkie
- Radio or walkie-talkie and/or cell phone
- 35 mm camera & slide film (allow at least 2 exposures per point)
- Baggies for temporary storage of unknown plants, and masking tape for labeling
- Plant press & paper
- Plant Keys / Flora(s)
- Pencils / sharpies
- Forms: plot and observation point
- Clipboard/forms holder
- Pens, pencils, pencil lead, slate board, chalk, and chalkboard eraser or supply of clean rags
- Key to the plant associations of the park
- All ancillary information (cheat sheet, species list, floras, sampling priority list for zone, main sampling protocol).
- First aid kit, personal gear (food, water, rain gear, etc.)

APPENDIX A: Landform Glossary (fromhttp://soils.usda.gov/technical/handbook/contents/part629glossary1.html)

alluvial fan - A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes, shaped like an open fan or a segment of a cone, deposited by a stream (best expressed in semiarid regions) at the place where it issues from a narrow mountain or upland valley; or where a tributary stream is near or at its junction with the main stream. It is steepest near its apex which points upstream and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

alluvial flat (a) (colloquial: western US) A nearly level, graded, alluvial surface in bolsons and semi-bolsons which commonly does not manifest traceable channels, terraces or floodplain levels. (b) (**not preferred**) A general term for a small flood plain bordering a river, on which alluvium is deposited during floods.

alluvial terrace - (not preferred) refer to stream terrace.

alluvium - Unconsolidated, clastic material subaerially deposited by running water, including gravel, sand, silt, clay, and various mixtures of these.

arroyo - (colloquial: southwest A.) The channel of a flat-floored, ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material; sometimes called a wash. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed. Where arroyos intersect zones of ground-water discharge, they are more properly classed as intermittent stream channels.

backslope - The hillslope profile position that forms the steepest and generally linear, middle portion of the slope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below. They may or may not include cliff segments (i.e. free faces). Backslopes are commonly erosional forms produced by mass movement, colluvial action, and running water.

basin - (a) Drainage basin; (b) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated. (c) (colloquial: western US) A general term for the nearly level to gently sloping, bottom surface of an intermontane basin (bolson). Landforms include playas, broad alluvial flats containing ephemeral drainageways, and relict alluvial and lacustrine surfaces that rarely, if ever, are subject to flooding. Where through-drainage systems are well developed, flood plains are dominant and lake plains are absent or of limited extent. Basin floors grade mountainward to distal parts of piedmont slopes.

bench - (not preferred) refer to structural bench.

bluff - (a) A high bank or bold headland, with a broad, precipitous, sometimes rounded cliff face overlooking a plain or body of water, especially on the outside of a stream meander; ex. a river bluff. (b) (not preferred) use cliff. Any cliff with a steep, broad face.

borrow pit - An excavated area from which earthy material has been removed typically for construction purposes offsite; also called barrow pit.

bottomland - (not recommended) use flood plain. An obsolete, informal term loosely applied to a flood plain.

break - An abrupt change or inflection in a slope or profile, or a marked variation of topography, or a tract of land distinct from adjacent land, or an irregular or rough piece of ground.

breaks - (colloquial: western US) A landscape or large tract of steep, rough or broken land dissected by ravines and gullies and marks a sudden change in topography as from an elevated plain to lower hilly terrain, or a line of irregular cliffs at the edge of a mesa or a river (e.g., the Missouri River breaks).

butte - An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments, commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

channel - (a) The hollow bed where a natural body of surface water flows or may flow. The deepest or central part of the bed of a stream, containing the main current and occupied more or less continuously by water. (b) (colloquial: western US.) The bed of a single or braided watercourse that commonly is barren of vegetation and is formed of modern alluvium. Channels may be enclosed by banks or splayed across and slightly mounded above a fan surface and include bars and mounds of cobbles and stones. (c) Small, trough-like, arcuate or sinuous channels separated by

small bars or ridges, caused by fluvial processes; common to flood plains and young alluvial terraces; a constituent part of *bar and channel* topography.

colluvium - Unconsolidated, unsorted material being transported or deposited on sideslopes and/or at the base of slopes by mass movement (e.g. direct gravitational action) and by local, unconcentrated runoff.

deflation basin - A topographic basin excavated and maintained by wind erosion which removes unconsolidated material and commonly leaves a rim of resistant material surrounding the depression. Unlike a blowout, a deflation basin does not include adjacent deposits derived from the basin.

depression - Any relatively sunken part of the Earth's surface; especially a low-lying area surrounded by higher ground. A closed depression has no natural outlet for surface drainage (e.g. a sinkhole). An open depression has a natural outlet for surface drainage.

desert pavement - A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments, mantling a desert surface. It is formed where wind action and sheetwash have removed all smaller particles or where coarse fragments have migrated to the surface. It usually protects the underlying, finer-grained material from further deflation. The coarse fragments commonly are cemented by mineral matter.

ditch - An open and usually unpaved (unlined), channel or trench excavated to convey water for drainage (removal) or irrigation (addition) to or from a landscape; smaller than a canal; some ditches are modified natural waterways.

drainageway - (a) A general term for a course or channel along which water moves in draining an area. (b) a term restricted to relatively small, roughly linear or arcuate depressions that move concentrated water at some time, and either lack a defined channel (e.g. head slope, swale) or have a small, defined channel (e.g. low order streams).

draw - A small, natural watercourse cut in unconsolidated materials, generally more open with a broader floor and more gently sloping sides than an arroyo, ravine or gulch, and whose present stream channel may appear inadequate to have cut the drainageway that it occupies.

eolian deposit - Sand, silt or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess. Conventionally, primary volcanic deposits (e.g. tephra) are handled separately.

ephemeral stream - Generally a small stream, or upper reach of a stream, that flows only in direct response to precipitation. It receives no protracted water supply from melting snow or other sources and its channel is above the water table at all times.

eroded fan remnant - All, or a portion of an alluvial fan that is much more extensively eroded and dissected than a fan remnant; sometimes called an *erosional fan remnant*. It consists primarily of a) eroded and highly dissected sides (*eroded fan-remnant sideslopes*) dominated by hillslope positions (shoulder, backslope, etc.), and b) to a lesser extent an intact, relatively planar, relict alluvial fan “summit” area best described as a tread.

escarpment - A continuous, steep slope or cliff produced by erosion or faulting and that topographically interrupts or breaks the general continuity of more gently sloping land surfaces . The term is most commonly applied to cliffs produced by differential erosion. Synonym = scarp.

flat - (a) (adjective) Said of an area characterized by a continuous surface or stretch of land that is smooth, even, or horizontal, or nearly so, and that lacks any significant curvature, slope, elevations, or depressions. (b) (noun) An informal, generic term for a level or nearly level surface or small area of land marked by little or no local relief.

flood plain - The nearly level plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is usually a constructional landform built of sediment deposited during overflow and lateral migration of the streams.

gulch - (colloquial: western US.; not preferred - refer to ravine) A small stream channel, narrow and steep-sided in cross section, and larger than a gully, cut in unconsolidated materials. General synonym - ravine.

gully - A small channel with steep sides caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water usually during and immediately following heavy rains or ice / snow melt. A gully generally is an obstacle to wheeled vehicles and too deep (e.g., > 0.5 m) to be obliterated by ordinary tillage; (a rill is of lesser depth and can be smoothed over by ordinary tillage).

hill - A generic term for an elevated area of the land surface, rising at least 30 m (100 ft.) to as much as 300 meters

(approx. 1000 ft.) above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. A hill can be further specified based on the magnitude of local relief: *low hill* (30 - 90 m) or *high hill* (90 - 300 m). Informal distinctions between a hill and a mountain are often dependent on local convention.

hillslope - A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of the hill.

intermittent stream - A stream, or reach of a stream, that does not flow year-round (commonly dry for 3 or more months out of 12) and whose channel is generally below the local water table; it flows only when it receives a) base flow (i.e. solely during wet periods), or b) ground-water discharge or protracted contributions from melting snow or other erratic surface and shallow subsurface sources.

landslide - A general, encompassing term for most types of mass movement landforms and processes involving the

mesa - A broad, nearly flat-topped, and usually isolated landmass bounded by steep slopes or precipitous cliff and capped by layers of resistant, nearly horizontal, rocky summit width greater than the height of bounding escarpments. (Colloquial: western US; not preferred) Also used to designate broad structural benches and alluvial terraces that occupy intermediate levels in stepped sequences of platforms bordering canyons and valleys.

overflow channel - A watercourse that is generally dry but conducts flood waters that have overflowed the banks of a river, commonly from large storms or annual meltwater.

plain - A general term referring to any flat, lowland area, large or small, at a low elevation. Specifically, any extensive region of comparatively smooth and level gently undulating land. A plain has few or no prominent hills or valleys but sometimes has considerable slope, and usually occurs at low elevation relative to surrounding areas. Where dissected, remnants of a plain can form the local uplands. A plain may be forested or bare of trees and may be formed by deposition or erosion.

plateau - A comparatively flat area of great extent and elevation; specifically an extensive land region considerably elevated (more than 100 meters) above adjacent lower-lying terrain, and is commonly limited on at least one side by an abrupt descent, has a flat or nearly level surface. A large part of a plateau surface is near summit level.

pool - A small, natural body of standing water, usually fresh; e.g. a stagnant body of water in a marsh, or a transient puddle in a depression following a rain.

ravine - A small stream channel; narrow, steep-sided, commonly V-shaped in cross section and larger than a gully, cut in unconsolidated materials. General synonym (not preferred) - gulch.

rim - The border, margin, edge, or face of a landform, such as the curved brim surrounding the top part of a crater or caldera; specifically the rimrock of a plateau or canyon.

rockfall - The process, associated sediments (rockfall deposit) or resultant landform characterized by a very rapid type of *fall* dominated by downslope movement of detached rock bodies which fall freely through the air or by leaps and bounds (lacks an underlying slip face); also spelled rock fall.

saddle - A low point on a ridge or interfluve, generally a divide (pass, col) between the heads of streams flowing in opposite directions.

sand sheet - (a) A sand-covered plain which may originate by deflation of sand dunes, and who's lower limit of erosion is governed by the ground-water level. Also spelled *sandplain*. (b) (not preferred - refer to *sandy* outwash plain) A small outwash plain composed chiefly of sand deposited by meltwater streams flowing from a glacier.

scarp - An escarpment, cliff, or steep slope of some extent along the margin of a plateau, mesa, terrace, or structural bench. A scarp may be of any height.

shoulder - The hillslope profile position that forms the convex, erosional surface near the top of a hillslope. If present, it comprises the transition zone from summit to backslope.

slope - (also called slope gradient or gradient) The inclination of the land surface from the horizontal. Percent slope is the vertical distance divided by the horizontal distance, then multiplied by 100.

slope alluvium - Sediment gradually transported down mountain or hill slopes primarily by non-channel alluvial processes (i.e., slope wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long

slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of coarse fragments and may be separated by stone lines. Sorting of pebbles or cobbles and burnished peds distinguish these materials from unsorted colluvial deposits.

slope wash - A collective term for non-fluvial, incipient alluvial *processes* (e.g. overland flow, minor rills) that detach, transport, and deposit sediments down hill and mountain slopes. Related sediments (*slope alluvium*) exhibit nominal sorting or rounding of particles, peds, etc., and lateral sorting downslope on long slopes; stratification is crude and intermittent and readily destroyed by pedoturbation and frost action. Also called *slope wash processes*.

stream terrace - One or a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream, and representing the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition (i.e., currently very rarely or never floods; inactive cut and fill and/or scour and fill processes). Erosional surfaces cut into bedrock and thinly mantled with stream deposits (alluvium) are called “strath terraces.” Remnants of constructional valley floors thickly mantled with alluvium are called alluvial terraces.

swale - (a) A shallow, open depression in unconsolidated materials which lacks a defined channel but can funnel overland or subsurface flow into a drainageway. Soils in swales tend to be more moist and thicker (cummulic) compared to surrounding soils. (b) A small, shallow, typically closed depression in an undulating ground moraine formed by uneven glacial deposition. (c) (not preferred; refer to interdune) A long, narrow, generally shallow, trough-like depression between two beach ridges, and aligned roughly parallel to the coastline.

talus - Rock fragments of any size or shape (usually coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of loose broken rock formed chiefly by falling, rolling, or sliding.

tank - (colloquial: southwestern US) A natural depression or cavity in impervious rocks in which water collects and remains for the greater part of the year.

terrace - A step-like surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, or lake or sea shore. The term is usually applied to both the relatively flat summit surface (tread), cut or built by stream or wave action, and the steeper slope (scarp, riser), descending to a lower base level. Practically, terraces

toeslope - The hillslope position that forms the gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear, and are constructional surfaces forming the lower part of a hill-slope continuum that grades to valley or closed-depression floors.

valley - An elongate, relatively large, externally drained depression of the Earth's surface that is primarily developed by stream erosion or glacial activity.

valley floor - A general term for the nearly level to gently sloping, lowest surface of a valley. Landforms include axial stream channels, the flood plain, flood-plain steps, and, in some areas, low terrace surfaces.

valley side - The sloping to very steep surfaces between the valley floor and summits of adjacent uplands. Well-defined, steep valley sides have been termed valley walls (not recommended). Note: Scale, relief, and perspective may require use of closely related terms such as hill slope or mountain slope.

wash (dry wash) - (colloquial: western US.) The broad, flat- floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in alluvium. Note: When channels reach intersect zones of ground-water discharge they are more properly classed as “intermittent stream” channels. Synonym - arroyo.

Appendix B.2. Example of a Vegetation Plot Data Form

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM
IDENTIFIERS/LOCATORS

Plot Code (Please Circle One): GOSP PISP TICA .002

Provisional Community Name Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland

State UT Park Name (Circle One) Golden Spike, Pipe Spring, Timpanogos Park Site Name Mesa top

Quad Name _____ Quad Code _____ Aerial Photo # _____

GPS file name PS 0002 Field UTM X 344862 m E Field UTM Y 4081252 m N
DATUM NAD83 UTM Zone: 12S Error +/- 5.7 m 3D Differential? Y / (N)
Comments/GPS device used: Garmin GPS 12

Survey Date 8/3/2007 Surveyors J. Coles

Directions to Plot Walk west along north boundary fence until you've climbed about 75 m up the escarpment. Plot center is just downslope of the interpretive trail and 15 m S of the boundary fence. Plot is more or less parallel to the north boundary fence.

Plot Permanent: NO

Plot length(m) 40m Azimuth 90° Plot Photos (y/n) Y Roll # JJC1 Frame # 27,28,29

Plot width(m) 10m Diameter if circle ____ Digital camera frame # _____

Photo Comments: One frame is without a signboard

Cryptogamic Soils Photos (y/n) __ Roll # _____ Frame # _____

Digital camera frame # _____

Plot representativeness (discuss plot placement and explain non-representativeness)

a. Representativeness of association compared with occurrences outside park (if known):

b. Representativeness of plot in stand: Dominant shrubs vary among QUTU, AMUT, SYRO, and PUST, but QUTU is the most consistent, although not always dominant

ENVIRONMENTAL DESCRIPTION

Elevation: 1534 ft / (m) (circle one) Slope: 15 deg. Aspect: 52 deg.

Topographic Position (see cheat sheet) Midslope

Landform (see cheat sheet) Mesa, Cuesta

Surficial Geology (see cheat sheet/map) Navajo Sandstone

Cowardin System		Hydrology		
X Upland	___ Palustrine	___ Permanently Flooded	___ Unknown	___ Temporarily Flooded
___ Riverine	___ Lacustrine	___ Semipermanently Flooded	___ Seasonally Flooded / ___ Saturated	___ Intermittently Flooded

Environmental Comments (factors controlling community/plant distribution, seral stage, fire history etc): Ground surface very rocky. Most trees are young, invasive. Plot is just upslope of the spring line marked by a row of young junipers. Many young PUST present.

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*

18 Bare soil	25 Large rocks (>10 cm)
10 Bedrock	T Lichen
2 Sand (0.1-2 mm) dune /alluvium	T Wood (>1 cm)
5 Moss	20 Small rocks (0.2-10 cm)
/ Other (describe):	/ Water
20 Litter / duff	T Cryptogam

Soil Texture (see cheat sheet):
___ sand X loamy sand ___ sandy loam ___ loam
___ silt loam ___ silt ___ clay loam ___ silty clay
___ sandy clay ___ clay ___ peat ___ muck

Soil Drainage:
X 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	Height Scale for Strata	Cover Scale for Strata
Trees and Shrubs X Evergreen __ Cold-deciduous __ Mixed evergreen-cold-deciduous Herbs __ Annual __ Perennial	__ Broad-leaved X Needle-leaved __ Microphyllous __ Graminoid __ Forb __ Pteridophyte __ Non-vascular __ Mixed (describe)	__ Forest X Woodland __ Shrubland __ Dwarf Shrubland __ Shrub Herbaceous __ Herbaceous __ Nonvascular __ Sparsely Vegetated	01 <0.5 m 02 0.5-1m 03 1-2 m 04 2-5 m 05 5-10 m 06 10-15 m 07 15-20 m 08 20-35 m 09 35 – 50 m 10 >50 m	T 0-1% P >1-5% 1 >5-15% 1b = 10-15% 2 >15-25% 3 >25-35% 4 >35-45% 5 >45-55% 6 >55-65% 7 >65-75% 8 >75-85% 9 >85-95% 10 > 95%

	Height Class	Cover Class	Dominant Species (mark Diagnostic species with *)
T1 Emergent			
T2 Canopy	04	1b	Pinus edulis, *Juniperus osteosperma
T3 Sub-canopy			
S1 Tall shrub			
S2 Short Shrub	02	1b	Quercus turbinella, Amelanchier utahensis, Purshia stansburiana
S3 Dwarf-shrub	01	T	Gutierrezia sarothrae, *Sclerocactus whipplei
Ht Herbaceous			
H1 Graminoids	01	T	Stipa comata
H2 Forbs	01	T	Penstemon sp.
H3 Ferns			
H4 Tree seedlings	01	T	Pinus edulis, Juniperus osteosperma
N Non-vascular			
V Vine/liana			
E Epiphyte			

Animal Use Evidence (including scat, browse, burrows, bedding sites, etc)
Porcupine poop

Natural and Anthropogenic Disturbance Comments (see cheat sheet for examples; describe intensity and effect on the vegetation, also whether disturbance is current, chronic, episodic or historic) Scattered stumps in plot. Trail crosses W end of plot. Ancient burned stumps at ground level.

Other Comments/Continuation from previous sections. **Describe surrounding communities and how they relate to the plot.**
This type extends N into the reservation. It stops abruptly at the spring line (Atriplex canescens below). This type covers much of the top of the mesa wherever Navajo Sandstone is exposed.

Plot Code (Please Circle One): GOSP-PISP-TICA . 002

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, and total cover indicating stratum. **List species outside the plot at the end of the table and designate with a 0 in Cover Class column.**

Stratum	Species Name	% Cover Class	Stratum	Species Name	% Cover Class	Stratum	Species Name	% Cover Class	TOTALS
T2	Pinus edulis	7							
	Juniperus osteosperma	6				H1	Hilaria jamesii	T	
			S2	Quercus turbinella	4		Aristida purpurea	T	T1 =
				Purshia stansburiana	2		Stipa comata	T	T2 = 16
				Amelanchier utahensis	3				T3 =
				Shepherdia rotundifolia	T				S1 =
				Rhus trilobata	1				S2 = 16
				Chrysothamnus nauseosus	1				S3 = P
				Ephedra viridis	T	H2	Penstemon sp. (shrubby, glaucous)	T	H1 = T
									H2 = T
H4	Pinus edulis	T							H3 =
	Juniperus osteosperma	T							H4 =
			S3	Yucca kanabensis	T	N	Moss	5	N = P
				Sclerocactus whipp.	T				V =
				Opuntia phaeacantha	1				E =
				Opuntia "no spines"	T				
				Gutierrezia sarothrae	T				

Cover Class Scale:	Strata:
T = >0-1%	T1 = Emergent
P = >1-5%	T2 = Canopy
1 = >5-15%	T3 = Subcanopy
2 = >15-25%	S1 = Tall Shrub
3 = >25-35%	S2 = Short Shrub
4 = >35-45%	S3 = Dwarf Shrub
5 = >45-55%	H1 = Graminoid
6 = >55-65%	H2 = Forb
7 = >65-75%	H3 = Fern
8 = >75-85%	H4 = Tree seedling
9 = >85-95%	N = Nonvascular
10 = >95%	V = Vine/liana
	E = Epiphyte

Tree DBH and Fuels Form Units in (Metric) / English (circle one) Subplot? (Y) / N (circle one) Plot Code (Please Circle One) GOSP PISP TICA . 002

Record the diameter at root crown (DRC) of all stems of all woodland trees more than 4.5 feet tall, or diameter at breast height (DBH) of all forest trees greater than 5 cm in diameter.
Record duff, depth and other tree crown characteristics only in Douglas-fir and ponderosa pine plots.
Tree structure stage (PIPO, DF only): D=Dominant (emergent), C=Codominant (canopy), I=Intermediate (subcan), S=Suppressed (sap/seedl)

Fuels Photo Guides

Series	Photo #
Ponderosa/Douglas-fir	
Pinyon-Juniper	
Sagebrush	

P-J age class

___ Not P-J
___ Old-growth
___ Mature
_X_ Young
___ Invasive

PIPO/DF Litter & Duff Loading

Location	Litter Depth	Duff Depth
Origin		
10m N		
10m E		
10 m S		
10m W		

Canopy and Fuel Loading Characteristics - Record woodland data in open columns, forest data in shaded columns.

(cm) DRC	Species	(cm) Crown Width	(m) Crown Height	DRC	Species	Crown Width	Crown Height	DBH	Species	Tree Height	Crown Ratio	Crown Base Height	Tree Structure Stage
26.2	JUOS	1.5	2										
8.6	PIED	1.5	1.5										
8.2	PIED	1	2										
20.2	JUOS	3	2.5										
30.5	JUOS	4	3										
18.6	PIED	3.5	2										
9.1	PIED	1.5	1.5										
9.6	PIED	1.5	1.5										
24.8	JUOS	3	2										
28.4	JUOS	1	2.5										
10.0	PIED	1	1.5										
10.1	PIED	1	1.5										
34.8	JUOS	4m	2										
36.1	PIED	4.5	4										

Appendix B.3. Example of an Observation Point Data Form

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

IDENTIFIERS/LOCATORS

Plot Code (Please Circle One): GOSP (PISP) TICA 9002

Provisional Community Name: Atriplex canescens Shrubland

State: UT Park Name (Pleae Circle One): Golden Spike, (Pipe Spring) Timpanogos Park Site Name: Visitor Center

Quad Name: Quad Code:

GPS File Name: PS 9002 Field UTM X: 345081 mE Field UTM Y: 4081159 mN +/- 4.5 m

Please do not complete the following information when in the field:

Corrected UTM X: mE Corrected UTM Y: mN Zone: 12S

Observers: J. Coles Date: 8/2/2007 Photos: JJC1 #16

ENVIRONMENTAL DESCRIPTION

Elevation: 1510 m Slope: 2 deg. Aspect: 300 deg.

Topographic Position: Low level

Landform: Valley floor Geology: Sandy alluvium

Cowardin Wetland Classification System

- X Upland
- ___ Estuarine
- ___ Riverine
- ___ Palustrine
- ___ Lacustrine

Hydrologic Regime - Non Tidal

- ___ Permanently Flooded
- ___ Semi-permanently Flooded
- ___ Seasonally/Temporarily Flooded
- ___ Saturated
- ___ Seasonally Flooded/Saturated
- ___ Intermittently Flooded

Environmental Comments: Highly disturbed; much bare ground + evidence of sheetwash. Plot has a few invading juniper. The Shepherdia is an oddball refugee from the mesa. Relict scraps of dark cyanobacteria + moss under shrub canopies. Some areas are pure ATRCAN, but most are mixed with rabbitbrush.

Unvegetated Surface (*please use cover scale below*)

- / Bedrock
- / Rocks >10 cm
- / Rocks 0.2-10 cm
- 01 Sand
- / Other (describe)___
- 04 Bare Soil
- 02 Litter/Duff
- 01 Wood

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic Class	Cover Scale for Strata and Unvegetated Surface
Trees and Shrubs ___ Evergreen ___ Cold-deciduous ___ Drought-deciduous X Mixed evergreen/ cold-deciduous Herbs ___ Annual ___ Perennial	X Broad-leaved ___ Needle-leaved ___ Microphyllous ___ Graminoid ___ Forb ___ Pteridophyte ___ Mixed (describe)	___ Forest ___ Woodland X Shrubland ___ Dwarf shrubland ___ Shrub Herbaceous ___ Herbaceous ___ Nonvascular ___ Sparsely vegetated	01 = 0 - 10% 02 = 10 - 25% 03 = 25 - 60% 04 = 60 - 100%

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM

Stratum	Height	Cover Class	Dominant species (mark diagnostic spp with a *)	% cover
T1: Emergent				
T2: Canopy	04	01	Juniperus osteosperma	2
T3: Sub-canopy				
S1: Tall shrub	03	01	Shepherdia rotundifolia	1
S2: Short shrub	02	02	Opuntia erinacea	T
			Atriplex canescens	3
			Chrysothamnus viscidiflorus	5
			Gutierrezia sarothrae	2
			Artemisia filifolia	2
			Chrysothamnus nauseosus	1
			Yucca kanabensis	T
H: Herbaceous	01	01	*	
			Aristida purpurea	T
			Stipa comata	T
			Hilaria jamesii	T
			Castilleja chromosa	T
N: Non-vascular	01	01	moss	T
			dark cyanobacteria	T
V: Vine/liana				
E: Epiphyte				

Height Scale for strata:		Cover scale for strata and Unvegetated Surface:
01 = <0.5 m	06 = 10-15m	
02 = 0.5-1m	07 = 15-20m	01 = 0 - 10%
03 = 1-2m	08 = 20-35m	02 = 10 - 25%
04 = 2-5m	09 = 35-50m	03 = 25 - 60%
05 = 5-10m	10 = >50m	04 = 60 - 100%

Appendix C

C.1. Plots Database Documentation

Background

This database, designed for data resulting from fieldwork related to vegetation mapping projects, was developed by the Northern Colorado Plateau Network (NCPN). The Plots Database System, developed by The Nature Conservancy, was the starting point for this database. From this starting point, NCPN normalized the data structure, added fields and lookup tables, and developed an extensive user interface. Similar versions of this database, subsequently referred to as the PISP VegMapDB, have been used for all vegetation mapping projects conducted by NCPN. PISP VegMapDB contains plot and observation point data collected during project field work.

Two database files are required to use PISP VegMapDB:

- *PISP_Plots.mdb*. This "frontend" file contains all queries, forms, reports, associated modules and Visual Basic code.
- *PISP_Plots_be.mdb*. This "backend" file contains the database tables.

The frontend/backend file structure allows multiple users to enter data in a network environment, and allows for easy backup and transfer of the data tables. Users typically launch the frontend file, and a utility will prompt them to establish a link to the backend file. The contents of the backend file, however, can be used independently of the frontend.

Entity Relationship Diagram

The primary tables and relationships from the backend file (PISP_Plots_be.mdb) are illustrated below. The database follows the design structure of the National Park Service Natural Resource Database Template, which is based on a location record, one or more related event records, and observation data elements linked to each event.

Data Dictionary

The database consists of two types of tables: plot data and lookup tables (which provide a standardized list of values to be used for certain data fields). Tables appear in alphabetical order within each of these two categories.

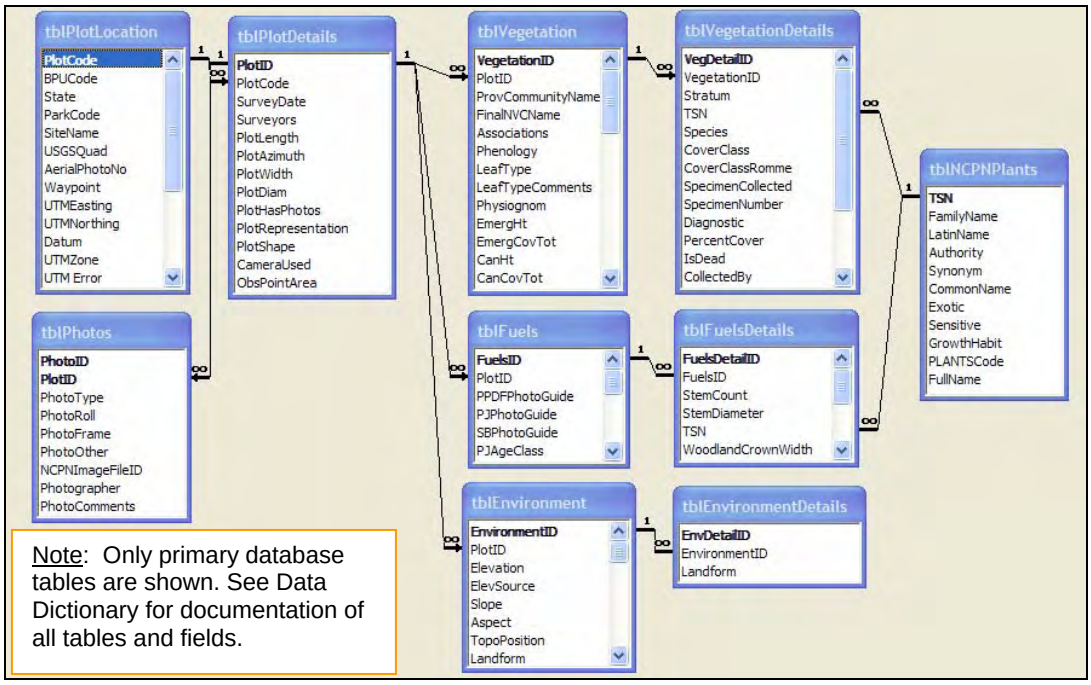


Figure 1. Entity Relationship Diagram for PISP VegMapDB

Plot-related tables

Table Name: tblDataMgmtLog
Description: Table containing a log of data set manipulations or database object alterations.

Field Name	Field Description	Field Type	Field Width
ActionDate	The date on which the data set was massaged or manipulated.	dbDate	8
ActionMonth	If ActionDate known to month only, use this field and the ActionYear field.	dbText	50
ActionYear	If ActionDate known to year only, use this field.	dbText	50
Action	What was done with the data set. How was it altered, massaged, manipulated, etc. Include changes to data and changes to database objects or structures.	dbMemo	0
Who	The name of the person who performed the action with the data set.	dbText	50

Table Name: tblEnvironment
Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvironmentID	Unique record identifier	dbLong	4
PlotID	Foreign key; links record to tblPlotDetails	dbLong	4
Elevation	Elevation of plot in meters as estimated from either map or GPS unit	dbLong	4
ElevSource	How elevation was derived in the field (GPS or Quad Map)	dbText	50
Slope	Slope of plot measured in degrees	dbLong	4

Field Name	Field Description	Field Type	Field Width
Aspect	Aspect of plot	dbText	50
TopoPosition	Topographic position of plot; value selected from tlkpTopography	dbText	50
Landform	Landform on which plot is located; value selected from tlkpLandform	dbText	50
Geology	Geologic substrate influencing the plant community; value selected from tlkpGeology	dbText	75
CowardinSystem	If the plot is in a wetland system, select term that best describes its hydrology; value selected from tlkpCowardin	dbText	12
Hydrology	Select value that best describes hydrology of plot from tlkpHydrology	dbText	50
EnvironmentalComments	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbMemo	0
BareSoil	Estimate to the nearest percentage of bare soil ground cover	dbText	3
Bedrock	Estimate to the nearest percentage of bedrock ground cover	dbText	3
Sand	Estimate to the nearest percentage of sand (particle size 0.1-2mm) ground cover	dbText	3
Moss	Estimate to the nearest percentage of moss ground cover	dbText	3
Other	Estimate to the nearest percentage of other type of ground cover	dbText	3
Litter	Estimate to the nearest percentage of litter ground cover	dbText	3
Rocks	Estimate to the nearest percentage of rocks >10cm wide ground cover	dbText	3
Lichen	Estimate to the nearest percentage of lichen ground cover	dbText	3
Wood	Estimate to the nearest percentage of wood >1cm ground cover	dbText	3
Gravel	Estimate to the nearest percentage of rocks <10cm wide ground cover	dbText	3
Water	Estimate to the nearest percentage of water ground cover	dbText	3
Cryptogam	Estimate to the nearest percentage of cryptogram ground cover	dbText	3
SoilTexture	Assessment of average soil texture from sample taken a few inches below the surface; values selected from tlkpSoilTexture	dbText	50
SoilDrainage	Soil drainage class based on actual moisture content and extent period; values selected from tlkpSoilDrainage	dbText	30
AnimalUseComments	Comments on evidence of use by non-domestic animals in plot area	dbMemo	0
DisturbanceComments	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbMemo	0
OtherComments	Other general comments	dbMemo	0

Field Name	Field Description	Field Type	Field Width
LandscapeComments	Description of landscape context of plot, including any important landscape features influencing the community	dbMemo	0
SoilTaxonDesc	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
LiveVegLitter	Estimate to the nearest percentage of live veg litter ground cover	dbText	3
LiveVegWood	Estimate to the nearest percentage of live veg wood ground cover	dbText	3
LiveBasalArea	n/a for PISP	dbText	4
LichenRocks	Estimate to the nearest percentage of lichen covering rocks	dbText	3
LichenGround	Estimate to the nearest percentage of lichen ground cover (on the soil, associated with cryptogams)	dbText	3
MossPct	Estimate to the nearest percentage of moss ground cover	dbText	3
DarkCyanobacteria	Estimate to the nearest percentage of dark cyanobacteria ground cover	dbText	3
TotalPct	Calculated total percent of ground cover.	dbInteger	2

Table Name: tblEnvironmentDetails
Description: Table containing values on environmental features and conditions of plot or observation point

Field Name	Field Description	Field Type	Field Width
EnvDetailID	Unique record identifier	dbLong	4
EnvironmentID	Foreign key; links to tblEnvironment	dbLong	4
Landform	Landform value corresponding to plot location; values chosen from tlkpLandform	dbText	50

Table Name: tblFuels
Description: Table containing details on fuels characteristics of plot.

Field Name	Field Description	Field Type	Field Width
FuelsID	Unique record ID	dbLong	4
PlotID	Foreign key; links to tblPlotDetails	dbLong	4
PPDFPhotoGuide	n/a for PISP plots	dbText	3
PJPhotoGuide	n/a for PISP plots	dbText	3
SBPhotoGuide	n/a for PISP plots	dbText	3
PJAgeClass	If plot contains pinyon and/or juniper, enter value that best describes the age class of the stand; values stored in tlkpPJAge	dbText	15
LitterOrigin	n/a for PISP plots	dbText	3
LitterNorth	n/a for PISP plots	dbText	3
LitterEast	n/a for PISP plots	dbText	3
LitterSouth	n/a for PISP plots	dbText	3
LitterWest	n/a for PISP plots	dbText	3
DuffOrigin	n/a for PISP plots	dbText	3
DuffNorth	n/a for PISP plots	dbText	3

Field Name	Field Description	Field Type	Field Width
DuffEast	n/a for PISP plots	dbText	3
DuffSouth	n/a for PISP plots	dbText	3
DuffWest	n/a for PISP plots	dbText	3
IsSubplot	Indicate if measurements are for subplot (if plot has >25 trees, one quadrant (subplot) of plot can be measured for fuels	dbBoolean	1

Table Name: tblFuelsDetails
Description: Details on stems, height, crown width, and other attributes of trees within plot.

Field Name	Field Description	Field Type	Field Width
FuelsDetailID	Unique identifier for record	dbLong	4
FuelsID	Foreign key, links to tblFuels	dbLong	4
StemCount	Number of stems measured. Value will be 1 if forest species; >=1 if woodland species.	dbInteger	2
StemDiameter	Diameter in cm of stem(s). If stem count =1 for a forest species, diameter represents dbh. If stem count is >1 for a woodland species, diameter represents the average diameter of all stems measured at crown base.	dbDouble	8
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
WoodlandCrownWidth	n/a for PISP plot	dbDouble	8
WoodlandCrownHeight	n/a for PISP plot	dbDouble	8
ForestCrownBaseHeight	n/a for PISP plot	dbDouble	8
ForestCrownHeight	n/a for PISP plot	dbDouble	8
CrownRatio	n/a for PISP plot	dbText	12
StructureStage	n/a for PISP plot	dbText	12
Comments	n/a for PISP plot	dbText	255

Table Name: tblGeneralPhotos
Description: Information pertaining to photos not associated with plots.

Field Name	Field Description	Field Type	Field Width
GenPhotoID	Unique record identifier	dbLong	4
GenPhotoDate	Date photo taken	dbText	50
GenPhotographer	Name of photographer	dbText	75
GenPhotoParkCode	Park Code	dbText	4
GenPhotoDesc	General description of photo contents	dbText	250
GenPhotoAssocName	Association name	dbText	50
GenPhotoUTME	UTME of photo	dbLong	4
GenPhotoUTMN	UTMN of photo	dbLong	4
GenUTMZone	UTMZone of photo UTM coordinates	dbLong	4
GenPhotoRoll10	Roll number of photo	dbText	50
GenPhotoFrame	Frame number of photo	dbText	10
GenPhotoDigFile	Digital file name of photo	dbText	50
ImageFileID	New image file name as indicated in NCPN Photo Database	dbText	50
GenPhotoComments	General comments	dbText	250

Table Name: tblGeneralSpecimens

Description: Table used to enter data on specimens collected outside of plots or observation points but within the park

Field Name	Field Description	Field Type	Field Width
GenSpecimenID	Unique record ID	dbLong	4
GenSpecFamily	Family name of species collected	dbText	50
GenSpecLatinName	Latin name of species collected	dbText	120
GenSpecCollector	Name of person collecting specimen	dbText	50
GenSpecCollectNum	Reference of specimen assigned by collector	dbText	50
GenSpecAccNumber	NPS Accession Number of specimen	dbText	15
GenSpecCatNumber	NPS Catalog Number of specimen	dbText	15
GenSpecDate	Date collection made	dbDate	8
GenSpecUTMN	Northing of collection location	dbLong	4
GenSpecUTME	Easting of collection location	dbLong	4
GenSpecCounty	County of collection location	dbText	50
GenSpecElev	Elevation (ft) of collection location	dbLong	4
GenSpecLocality	Description of locality where specimen was collected	dbText	250
GenSpecHabitat	Description of habitat where specimen was collected	dbText	250
GenSpecAssocSpec	Associated species where specimen was collected	dbText	250
GenSpecComments	Comments associated with specimen collected	dbText	250

Table Name: tblPhotos
Description: Details on individual photos taken of plot or observation point.

Field Name	Field Description	Field Type	Field Width
PhotoID	Unique record identifier	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
PhotoType	Type of photo being referenced	dbText	16
PhotoRoll	Reference number for film roll of photo	dbText	12
PhotoFrame	Frame number of photo within roll	dbText	50
PhotoOther	Other unique identifier or reference number for digital photo or name of movie file	dbText	25
NCPNImageFileID	NCPN PhotoDatabase digital image file name	dbText	50
Photographer	Name of photographer	dbText	50
PhotoComments	Brief description of photo	dbText	255

Table Name: tblPlotDetails
Description: Information on a plot that is specific to a visit

Field Name	Field Description	Field Type	Field Width
PlotID	Unique identifier for record	dbLong	4
PlotCode	Foreign key, links to tblPlotLocation	dbText	10
SurveyDate	Date plot was visited and data collected	dbDate	8
Surveyors	Names of persons collecting data at plot (last names)	dbText	75
PlotLength	Length of plot, in meters	dbText	5
PlotAzimuth	Azimuth of plot; synonymous with aspect. One or the other, or both, can be used	dbText	5
PlotWidth	Width of plot, in meters	dbText	5
PlotDiam	Diameter of plot, in meters, if plot is circular	dbText	5
PlotHasPhotos	Yes if photos are taken of plot	dbBoolean	1
PlotRepresentation	Description or discussion of representativeness of plot in stand, and in comparison to associations outside the park (if known)	dbMemo	0

Field Name	Field Description	Field Type	Field Width
PlotShape	Shape of plot	dbText	15
CameraUsed	Make and model of camera used to photograph plot	dbText	50
ObsPointArea	Estimated size of observation point	dbText	50

Table Name: tblPlotLocation
Description: Basic and unchanging information on plot or observation point location

Field Name	Field Description	Field Type	Field Width
PlotCode	Identifier assigned to plot by survey crew	dbText	10
BPUCode	Biophysical unit code where plot is located. Numbers before the slash refer to the BPU number, while numbers after the slash are unique identifiers for the plot. N/a means the plot was not in a BPU.	dbText	25
State	State where plot is located	dbText	2
ParkCode	Park unit where plot is located	dbText	4
SiteName	Short, descriptive name of site where plot is located	dbText	100
USGSQuad	USGS quadrangle (1:24K) where plot is located	dbText	50
AerialPhotoNo	Aerial photo number corresponding to plot location	dbText	10
Waypoint	Garmin plot code	dbText	7
UTMEasting	UTM easting of plot	dbText	50
UTMNorthing	UTM northing of plot	dbText	7
Datum	Datum of UTM coordinates	dbText	10
UTMZone	UTM zone of coordinates	dbText	4
UTM Error	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
PDOP	Satellite Precision Dilution of Position (based on reading from Trimble GPS unit)	dbText	50
DiffCorrected	Indicate if coordinates have been differentially corrected	dbText	3
DirectionsToPlot	Precise directions to plot	dbMemo	0
County	County where plot is located	dbText	50
GPSUnit	Manufacturer and model of GPS unit (e.g., Trimble GeoExplorer 3)	dbText	25
GPSComments	Any brief comments on GPS data collection at plot	dbText	255
InPark	Select Yes if plot is within park boundaries	dbBoolean	1
IsObservationPt	Yes if observation point	dbBoolean	1

Table Name: tblVegetation
Description: Overall vegetation characteristics of a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegetationID	Unique record ID	dbLong	4
PlotID	Foreign key, links to tblPlotDetails	dbLong	4
ProvCommunityName	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training 04/04	dbText	120
FinalNVCName	Final name assigned to association by NatureServe	dbText	100
Associations	Association corresponding to provisional community name	dbText	100
Phenology	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	35
LeafType	Leaf form of the dominant stratum	dbText	20

Field Name	Field Description	Field Type	Field Width
LeafTypeComments	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
Physiognom	Physiognomic class of plot (from tllkPhysiogClass)	dbText	20
EmergHt	Height class of emergent stratum (classes are in tlkpHeightClass)	dbText	2
EmergCovTot	Cover class of emergent stratum (classes are in tlkpCover)	dbText	4
CanHt	Height class of canopy stratum	dbText	2
CanCovTot	Cover class of canopy stratum	dbText	50
SubHt	Height class of subcanopy stratum	dbText	2
SubCovTot	Cover class of subcanopy stratum	dbText	4
TallShHt	Height class of tall shrub stratum	dbText	2
TallShCovTot	Cover class of tall shrub stratum	dbText	4
ShrubHt	Height class of short shrub stratum	dbText	2
ShrubCovTot	Cover class of short shrub stratum	dbText	4
DwarfHt	Height class of dwarf shrub stratum	dbText	2
DwarfCovTot	Cover class of dwarf shrub stratum	dbText	4
HerbHt	Height class of herbaceous stratum (all H layers)	dbText	2
HerbCovTot	Cover class of herbaceous stratum (all H layers)	dbText	4
GramHt	Height class of graminoid stratum	dbText	2
GramCovTot	Cover class of graminoid stratum	dbText	4
ForbHt	Height class of forb stratum	dbText	2
ForbCovTot	Cover class of forb stratum	dbText	4
FernHt	Height class of fern and fern ally stratum	dbText	2
FernCovTot	Cover class of fern and fern ally stratum	dbText	4
SeedlHt	Height class of seedling stratum	dbText	2
SeedlCovTot	Cover class of seedling stratum	dbText	4
NonvasHt	Height class of nonvascular stratum	dbText	2
NonvasCovTot	Cover class of nonvascular stratum	dbText	4
VineHt	Height class of vine stratum	dbText	2
VineTotCov	Cover class of vine stratum	dbText	4
EpiHt	Height class of epiphyte stratum	dbText	2
EpiTotCov	Cover class of epiphyte stratum	dbText	4
OutsidePlotHt	Height class of species occurring outside plot	dbText	50
OutsidePlotTotCov	Cover class of species occurring outside plot	dbText	50
Alliance	Alliance name	dbText	100

Table Name: tblVegetationDetails
Description: Species and strata-specific data related to a plot or observation point

Field Name	Field Description	Field Type	Field Width
VegDetailID	Unique record ID	dbLong	4
VegetationID	Foreign key, links to tblVegetation	dbLong	4
Stratum	Strata class from tlkpStrata	dbText	2
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
Species	Latin names of species, from tblNCPNPlants	dbText	100
CoverClass	Cover class to describe species and strata (from tlkpCover)	dbText	4
CoverClassRomme	n/a for PISP	dbText	50
SpecimenCollected	Check yes if a specimen of the species was collected	dbBoolean	1

Field Name	Field Description	Field Type	Field Width
SpecimenNumber	Enter the collector's reference number for the specimen collected	dbText	50
Diagnostic	Check yes if the species is known to be diagnostic of the vegetation type	dbBoolean	1
PercentCover	Percent (0-100) cover of each species	dbLong	4
IsDead	Check yes if the species being documented was dead	dbBoolean	1
CollectedBy	Name of person making collection	dbText	50
NPSAccessionNumber	Accession number of specimen	dbText	50
NPSCatalogNumber	Unique reference number for individual specimen assigned by park curator	dbText	50
SpecimenLocality	Brief description of where collection was made	dbText	250
SpecimenHabitat	Description of habitat where collection was made	dbText	250
SpecimenAssocSpecies	Description of associated species where collection was made	dbText	250

Lookup tables

Table Name: tblNCPNPlants
Description: Master look-up table for plant species names and taxonomic information. Derived from ITIS (USDA - Integrated Taxonomic Information System).

Field Name	Field Description	Field Type	Field Width
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
FamilyName	Family name of taxon	dbText	255
LatinName	Latin name of taxon	dbText	255
Authority	Authority of Latin name	dbText	255
Synonym	Accepted synonyms of taxon	dbText	255
CommonName	Locally accepted common name for taxon	dbText	255
Exotic	Check yes if species is exotic	dbBoolean	1
Sensitive	check yes if species is threatened, endangered, or sensitive	dbBoolean	1
GrowthHabit	Select GrowthHabit for species -- habit can vary based on region; edit as needed to reflect habit in park	dbText	255
PLANTSCode	Code for taxonomic unit assigned by USDA PLANTS	dbText	255
FullName	Temporary field; concatenation of Latin name and authority	dbText	255

Table Name: tlkpAlliances
Description: Look-up of provisional community names.

Field Name	Field Description	Field Type	Field Width
Alliance	Alliance name from NatureServe classification	dbText	100

Table Name: tlkpAssociations
Description: Look-up of association names.

Field Name	Field Description	Field Type	Field Width
Associations	Association names from NatureServe classification	dbText	100

Table Name: tlkpCamera
Description: Look-up of Camera make/models used for plot photos.

Field Name	Field Description	Field Type	Field Width
CameraType	Model and make of camera used for photographs of plot	dbText	50
CameraComments	Additional comments on camera, including default focal length	dbText	50

Table Name: tlkpCover
Description: Look-up of cover classes assigned to species and strata in VegetationDetails.

Field Name	Field Description	Field Type	Field Width
CoverClass	Cover class code: T, P, 1, 1a, 1b, 2, 3, ... 10	dbText	50
CoverClassDef	Cover class definition: T >0-1% P >1-5% 1a >5-10% 1b >10-15% 2 >15-25% 3 >25-35% 4>35-45% 5 >45-55% 6>55-65% 7>65-75% 8>75-85% 9>85-95% 10>95%	dbText	50

Table Name: tlkpCowardin
Description: Look-up table of Cowardin system categories for Environment descriptions.

Field Name	Field Description	Field Type	Field Width
CowardinSystem	Cowardin system descriptors for environmental description of plot.	dbText	50

Table Name: tlkpElevSource
Description: Lookup table of options for source of elevation data.

Field Name	Field Description	Field Type	Field Width
ElevSource	Source of elevation data entered on field forms	dbText	50

Table Name: tlkpGeology
Description: Look-up of geology types to describe substrate of plot.

Field Name	Field Description	Field Type	Field Width
Geology	Geology types used to describe substrate of plot or observation point	dbText	75

Table Name: tlkpHeightClass
Description: Look-up of height classes assigned to strata in VegetationDetails.

Field Name	Field Description	Field Type	Field Width
HeightClass	Height class code: 01, 02, ... 10	dbText	2
HeightClassDef	Height class definition: 01<.5m 02=.5-1m 03=1-2m 04=2-5m 05=5-10m 06=10-15m 07=15-20m 08=20-35m 09=35-50m 10=>50m	dbText	50

Table Name: tlkpHydrology
Description: Look-up of hydrology types from Cowardin et al. 1979.

Field Name	Field Description	Field Type	Field Width
Hydrology	Hydrology descriptors for plots that are in a wetland or upland with intermittent flooding (dry wash)	dbText	50

Table Name: tlkpLandform
Description: Look-up of landforms in Veg Mapping Manual (from http://soils.usda.gov/technical/handbook/contents/part629glossary1.html).

Field Name	Field Description	Field Type	Field Width
Landform	Landforms from appendix 1 of field manual	dbText	50

Table Name: tlkpLeafPhen
Description: Look-up of phenology types to describe dominant stratum (from VegMapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
Phenology	Leaf phenology descriptors to describe dominant stratum	dbText	40

Table Name: tlkpLeafType
Description: Look-up of leaf form of dominant stratum (from VegMapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
LeafType	Leaf form description of the dominant stratum	dbText	35

Table Name: tlkpParks
Description: Look-up table of parks in the Northern Colorado Plateau Network.

Field Name	Field Description	Field Type	Field Width
ParkCode	Four-letter abbreviation for park code	dbText	4
ParkName	Full name of park where data were collected	dbText	50

Table Name: tlkpPhotoComments
Description: Lookup table of photo comments.

Field Name	Field Description	Field Type	Field Width
PhotoComments	Photograph comments	dbText	50

Table Name: tlkpPhotographer
Description: Lookup table of photographer names.

Field Name	Field Description	Field Type	Field Width
Photographer	Photographer name	dbText	50

Table Name: tlkpPhotoTypes
Description: Look-up of types of photos taken during data collection.

Field Name	Field Description	Field Type	Field Width
PhotoType	Type of photo taken, associated with plot	dbText	50

Table Name: tlkpPhysiogClass
Description: Look-up of physiognomic types to describe each plot or observation point.

Field Name	Field Description	Field Type	Field Width
Physiognom	Physiognomic class used to describe plot	dbText	50

Table Name: tlkpPJAge
Description: Look-up of Pinyon-Juniper age classes.

Field Name	Field Description	Field Type	Field Width
PJAgeClass	Pinyon-Juniper age class, if plot contains either of these two species	dbText	15

Table Name: tlkpPlotShapes
Description: Look-up of shapes of plots.

Field Name	Field Description	Field Type	Field Width
PlotShape	shapes of plots	dbText	15

Table Name: tlkpSoilDrainage
Description: Look-up of soil drainage classes to describe plot or observation point.

Field Name	Field Description	Field Type	Field Width
SoilDrainage	Soil drainage classes used to describe soil where plot is located	dbText	30

Table Name: tlkpSoilTexture
Description: Look-up of soil textures based on Bowker 2003 field key for CANY, ARCH, and NABR.

Field Name	Field Description	Field Type	Field Width
SoilTexture	Look-up of soil textures based on Bowker 2003 field key for CANY, ARCH, and NABR	dbText	15

Table Name: tlkpStates
Description: Look-up of all states in the USA.

Field Name	Field Description	Field Type	Field Width
StateCode	Two-letter abbreviation for each state	dbText	2
StateName	Full name of each state in the USA	dbText	50

Table Name: tlkpStrata
Description: Look-up of strata classes in VegetationDetails (from VegMapping Manual 04/04).

Field Name	Field Description	Field Type	Field Width
Stratum	T1=Emergent T2=Canopy T3=Subcanopy S1=Tall Shrub S2=Short Shrub S3=Dwarf Shrub H1=Graminoid H2=Forb H3=Fern H4=Tree Seedl N=Nonvasc V=Vine E=Epiphyte	dbText	3

Table Name: tlkpStructureStages
Description: Look-up of standard fuel model classes for forest and woodland trees.

Field Name	Field Description	Field Type	Field Width
StructureStage	Standard fuel model classes for forest and woodland trees indicating their position in the canopy	dbText	12

Table Name: tlkpSurveyors
Description: Look-up of data collection teams for 2007 PISP field season.

Field Name	Field Description	Field Type	Field Width
SurveyorName	Last names of crew members on 2007 PISP data collection team	dbText	75

Table Name: tlkpTopography
Description: Look-up of topographic positions to describe where plot or observation point is located on its related landform.

Field Name	Field Description	Field Type	Field Width
TopoPosition	Topographic positions used to describe where plot or observation point is located on its related landform	dbText	50

Table Name: tlkpUSGS_Quad
Description: Look-up of all 7.5 minute USGS quads for PISP.

Field Name	Field Description	Field Type	Field Width
USGSQuad	Names of all 7.5 minute USGS quads for PISP	dbText	50
USGSQuadCode	n/a for PISP	dbText	7

Table Name: tlkpUTMZone
Description: Look-up for UTM zones of PISP.

Field Name	Field Description	Field Type	Field Width
UTMZone	UTM zone where PISP plots were collected	dbText	5

C.2. Geodatabase Documentation

Background

The geodatabase was designed to consolidate all spatial and non-spatial (i.e., tabular) data from the PISP vegetation mapping project. In the geodatabase, feature classes were created for the spatial datasets, including plots, observation points, and polygons. These feature classes were then linked to the tables in the Plots database via relationship classes.

Entity Relationship Diagram

The primary tables and relationships for the geodatabase are illustrated below.

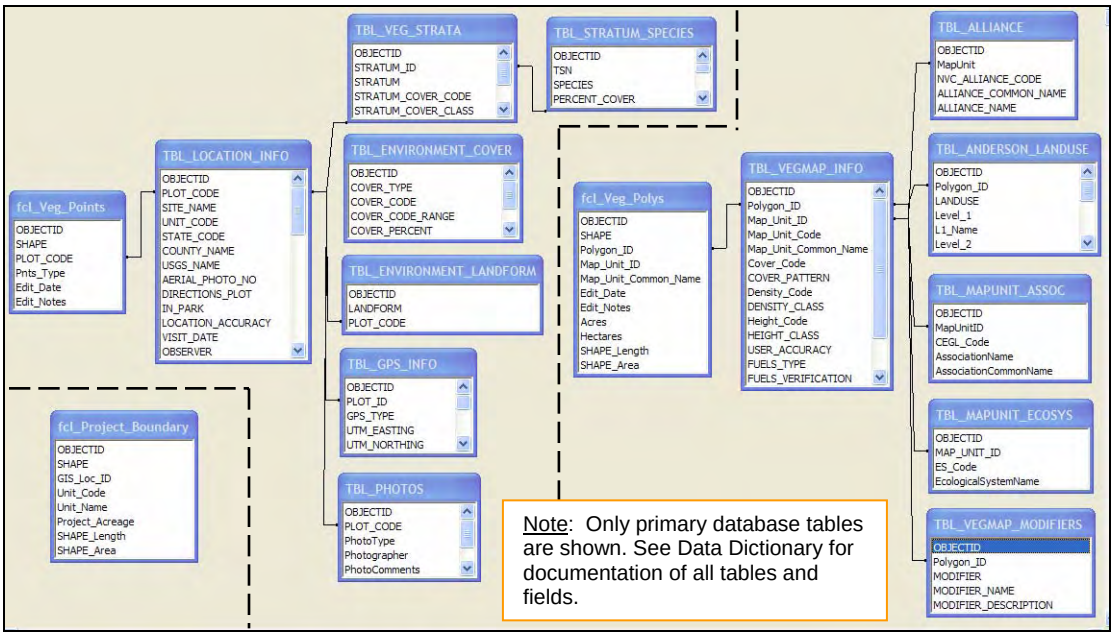


Figure 2. Entity Relationship Diagram for PISP Geodatabase

Data Dictionary

The geodatabase consists of two types of tables: spatial (i.e., feature classes), and non-spatial tables. Tables appear in alphabetical order within these two categories.

Spatial tables

Table Name: fcl_Project_Boundary
Description: The feature class of the boundary of the vegetation mapping project area.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
GIS_Loc_ID	unique ID	dbText	128
Unit_Code	Four-letter park code (PISP)	dbText	10
Unit_Name	Full name of national park (Pipe Spring National Monument)	dbText	255
Project_Acreage	Acreage of project area	dbLong	4

Field Name	Field Description	Field Type	Field Width
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8

Table Name: fcl_Veg_Points
Description: The feature class containing all point data associated with the vegetation project (Plots, Observations).

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
PLOT_CODE	Unique Plot code, used for relating tables and feature class (TBL_LOCATION_INFO)	dbText	20
Pnts_Type	Type of point (plot, observation)	dbLong	4
Edit_Date	Date of any edits to the point or data	dbText	10
Edit_Notes	Notes regarding any edits.	dbText	255

Table Name: fcl_Veg_Polys
Description: The feature class displaying the vegetation mapping units for the park.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
SHAPE	ESRI generated	dbLongBinary	0
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	128
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Edit_Date	Date of any edits to the polygon or its attributes	dbDate	8
Edit_Notes	Notes regarding any edits to the polygon or its attributes	dbText	250
Acres	Acres per polygon, generated using ArcMap	dbDouble	8
Hectares	Hectares per polygon, generated using ArcMap	dbDouble	8
SHAPE_Length	ESRI generated	dbDouble	8
SHAPE_Area	ESRI generated	dbDouble	8

Non-spatial tables

Table Name: TBL_ALLIANCE
Description: Contains the alliances for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnit	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	12
NVC_ALLIANCE_CODE	The NVC alliance code	dbText	20
ALLIANCE_COMMON_NAME	NVC alliance common name	dbText	250
ALLIANCE_NAME	NVC alliance latin name	dbText	250

Table Name: TBL_ANDERSON_LANDUSE

Description: Contains the Anderson Landuse classes for the vegetation polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
LANDUSE	The Anderson landuse classes of the polygon (version 1.5, January 2002)	dbDouble	8
Level_1	Anderson landuse code for level one	dbText	255
L1_Name	Anderson landuse name for level one	dbText	255
Level_2	Anderson landuse code for level two	dbText	50
L2_Name	Anderson landuse name for level two	dbText	255
Level_3	Anderson landuse code for level three	dbText	255
L3_Name	Anderson landuse name for level three	dbText	255
Level_4	Anderson landuse code for level four	dbText	255
L4_Name	Anderson landuse name for level four	dbText	255
Level_5	Anderson landuse code for level five	dbText	255
L5_Name	Anderson landuse name for level five	dbText	255
Level_6	Anderson landuse code for level six	dbText	255
L6_Name	Anderson landuse name for level six	dbText	255

Table Name: TBL_ENVIRONMENT_COVER
Description: Contains ground cover data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
COVER_TYPE	Ground cover type	dbText	30
COVER_CODE	Cover code from field sheet (obs points only)	dbText	5
COVER_CODE_RANGE	Percent cover range for observations data	dbText	25
COVER_PERCENT	Estimate to the nearest percentage of ground cover type (plots only)	dbDouble	8
COVER_PERCENT_DESC	Description of cover, if "other"	dbText	255
PLOT_CODE	Unique Plot code, used for relating tables	dbText	20

Table Name: TBL_ENVIRONMENT_LANDFORM
Description: Contains landform data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
LANDFORM	Landform on which plot is located, any landform could be entered by crew.	dbText	100
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20

Table Name: TBL_FORMATION
Description: Contains NVC formation level data for the vegetation polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAP_UNIT_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Formation_Code	NVC formation level code	dbText	30

Field Name	Field Description	Field Type	Field Width
Formation_Name	NVC formation level name	dbText	255

Table Name: TBL_GPS_INFO
Description: Contains information about the GPS unit and accuracies of data collected for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_ID	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	20
GPS_TYPE	Manufacturer and model of GPS unit (e.g., Garmin Etrex)	dbText	30
UTM_EASTING	UTM easting of plot	dbDouble	8
UTM_NORTHING	UTM northing of plot	dbDouble	8
UTM_ZONE	UTM zone of coordinates	dbText	3
DATUM	Datum of UTM coordinates (NAD83)	dbText	10
GPS_ERROR	Error, in meters, of location data (based on reading from Garmin GPS unit)	dbText	5
DIFF_CORRECTED	Indicates if coordinates have been differentially corrected (from Garmin screen)	dbText	3
GPS_COMMENTS	Any brief comments on GPS data collection at plot.	dbText	255
GPS_QUALITY	Indicates the quality of the GPS unit used (recreational, mapping grade)	dbText	35
PDOP	Positional Dilution Of Precision reading (from Garmin screen)	dbText	30
ERROR_RANGE	General error range, in meters, of the type of GPS unit used.	dbText	20

Table Name: TBL_LOCATION_INFO
Description: Contains data about the location of the point and general observations about the area for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables and feature class (fcl_Veg_Points)	dbText	20
SITE_NAME	General Site name given by field crew	dbText	255
UNIT_CODE	4 letter park code (PISP)	dbText	10
STATE_CODE	State (Arizona)	dbText	2
COUNTY_NAME	County where plot is located (San Juan County)	dbText	100
USGS_NAME	USGS 1:24k Topo Name	dbText	100
AERIAL_PHOTO_NO	9X9 photo name on which the point most directly falls	dbText	30
DIRECTIONS_PLOT	Directions to the location of the plot	dbText	255
IN_PARK	Indicates if the point was inside or outside the park boundary	dbBoolean	1
LOCATION_ACCURACY	Indicates general range of locational error of the point coordinates.	dbText	45
VISIT_DATE	Date the location was visited	dbText	10
OBSERVER	The names of the field crew member(s)	dbText	50

Field Name	Field Description	Field Type	Field Width
	observing the site.		
PLOT_WIDTH	The width of the point	dbText	3
PLOT_LENGTH	The length of the point	dbText	3
PLOT_DIAMETER	The diameter of the point	dbText	5
PLOT_AZIMUTH	The azimuth of the point	dbText	5
PLOT_SHAPE	The shape of the area observed as a point	dbText	20
REPRESENTATIVENESS	The representativeness of the vegetation	dbText	255
ASPECT	Aspect of plot	dbText	50
ELEVATION	Elevation of plot in meters, created from 10 meter DEMs	dbDouble	8
SLOPE	Slope of plot measured in degrees	dbText	15
TOPO_POSITION	Topographic position of plot	dbText	50
SOIL_TEXTURE	Assessment of average soil texture from sample taken a few inches below the surface	dbText	50
COWARDIN_SYSTEM	If the plot is in a wetland system, select term that best describes its hydrology (Upland, Palustrine, Riverine, Lacustrine)	dbText	50
HYDROLOGY	Describes hydrology of plot	dbText	50
GEOLOGY	Geologic substrate influencing the plant community	dbText	50
SOIL_DRAINAGE	Soil drainage class based on actual moisture content and extent period	dbText	30
ENV_COMMENTS	Comments on environmental setting and its effect on the vegetation; also comments on any disturbance or reproduction factors	dbText	255
ANIMAL_USE_COMMENTS	Comments on evidence of use by non-domestic animals in plot area	dbText	255
DISTURBANCE_COMMENTS	Comments on evidence of natural or anthropogenic disturbance in plot area, severity and effects on vegetation	dbText	255
LANDSCAPE_COMMENTS	Description of landscape context of plot, including any important landscape features influencing the community	dbText	255
OTHER_COMMENTS	Other general comments	dbText	255
SOIL_TAXON_DESC	Field used for either identifying soils keyed, or to describe if large rocks or outcrops are present on the surface	dbText	255
ALLIANCE	Alliance corresponding to provisional community name	dbText	100
PROVISIONAL_COMM_NAME	Community name (provisional) assigned by field crews by following naming protocols as described in field manual and training (2004).	dbText	200
PHENOLOGY	Leaf phenology of the dominant stratum. Field is blank for non-vascular plots	dbText	200
LEAF_TYPE	Leaf form of the dominant stratum.	dbText	100
LEAF_TYPE_COMMENTS	If Leaf Type is "mixed," this field describes the multiple leaf types found in the dominant stratum.	dbText	255
PHYSIOGNOMIC_NAME	Physiognomic class of plot	dbText	100
PLANT_SPECIES_COMMENTS	Comments about the plant species observed.	dbText	200

Table Name: TBL_MAPUNIT_ASSOC
Description: Contains association data for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MapUnitID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	20
CEGL_Code	NVC association code	dbText	18
AssociationName	The NVC Association name	dbText	250
AssociationCommonName	The NVC Association Common name	dbText	250

Table Name: TBL_MAPUNIT_ECOSYS
Description: Contains ecological system data for the vegetation polygons by map unit ID.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
MAP_UNIT_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
ES_Code	Ecological System code	dbText	30
EcologicalSystemName	Ecological system name (mid-scale classification, larger than associations or alliances, smaller than ecoregions).	dbText	255

Table Name: TBL_PHOTOS
Description: Details on individual photos taken of a point.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
PLOT_CODE	Unique Plot code, used for relating tables (TBL_LOCATION_INFO)	dbText	50
PhotoType	Type of photo being referenced.	dbText	16
Photographer	Name of photographer.	dbText	50
PhotoComments	Brief description of photo.	dbText	255
IMAGE_ID	NCPN Photo Database (unique) file name.	dbText	50
PHOTO_PATH	Path to photos	dbText	200

Table Name: TBL_STRATUM_SPECIES
Description: Contains species level data by stratum.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
TSN	Taxonomic Serial Number - unique taxon identifier assigned by ITIS	dbDouble	8
SPECIES	Latin names of species	dbText	255
PERCENT_COVER	Percent cover by species (Applicable to AA data only; not applicable to PISP)	dbText	4
COVER_CODE	Cover class code to describe species and strata	dbText	5
COVER_CLASS	Cover class to describe species and strata	dbText	50
DIAGNOSTIC	Check yes if the species is known to be diagnostic of the vegetation type.	dbInteger	2
SPECIMEN_COLLECTED	"yes" if a specimen of the species was collected.	dbInteger	2
SPECIMEN_NO	The collector's reference number for the specimen collected.	dbText	10

Field Name	Field Description	Field Type	Field Width
DEAD	Percent cover of dead species seen at plot. Not completed of every species, but always done if diagnostic species.	dbInteger	2
STRATUM_ID	Unique ID, relates to TBL_VEG_STRATA	dbLong	4

Table Name: TBL_VEG_STRATA
Description: Contains stratum data for the veg points feature class.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
STRATUM_ID	Links to strata	dbLong	4
STRATUM	Stratum name/type ("Herbaceous" is a summed class, no species directly related)	dbText	20
STRATUM_COVER_CODE	stratum cover code	dbText	5
STRATUM_COVER_CLASS	stratum percentage cover class	dbText	50
STRATUM_HEIGHT_CODE	stratum height code	dbText	5
STRATUM_HEIGHT_CLASS	stratum height class in meters	dbText	50
PLOT_CODE	Unique Plot code, used for relating tables (TBL_STRATUM_SPECIES)	dbText	12

Table Name: TBL_VEGMAP_INFO
Description: Contains map unit level data for each vegetation map unit polygon.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables and feature classes (fcl_Veg_polys)	dbText	30
Map_Unit_ID	The map unit identifier, used by the mappers (aka: grid_code or map class code)	dbText	10
Map_Unit_Code	NCPN code (X-XXXX)	dbText	10
Map_Unit_Common_Name	The name of the map unit (or map class)	dbText	250
Cover_Code	Cover pattern value class code	dbText	1
COVER_PATTERN	Characterizes the pattern of vegetation on the landscape (Clumped/Bunched, Linear, Gadational/Transitional, Regularly alternating, Homogenous (default)) per polygon.	dbText	100
Density_Code	Density value code	dbText	1
DENSITY_CLASS	Density of Forest/Woodland vegetation, and density for shrub communities per polygon	dbText	100
Height_Code	Height class value code	dbText	1
HEIGHT_CLASS	Vegetation height classes assigned to each polygon of forest/woodland and/or shrubland types	dbText	100
USER_ACCURACY	User accuracy of the map unit determined during AA meetings (Not applicable to PISP)	dbText	3
FUELS_TYPE	Fuels vegetation types	dbText	50
FUELS_VERIFICATION	Fuels verification	dbText	255
VEGMAP_COMMENTS	Any comments about the particular polygon or map class.	dbText	255
MAP_UNIT_PDF	File name of pdf describing map unit (class)	dbText	50
MAP_UNIT_PDF_PATH	Hard-coded link to Map Unit description PDF document -	dbText	250

Field Name	Field Description	Field Type	Field Width
	path name (e.g. C:/PISP/Vegetation/MapClassDescriptions/MU4.pdf)		

Table Name: TBL_VEGMAP_MODIFIERS
Description: Contains modifiers for the vegetation map unit polygons.

Field Name	Field Description	Field Type	Field Width
OBJECTID	ESRI generated autonumber	dbLong	4
Polygon_ID	Unique polygon code, used for relating tables (TBL_VEGMAP_INFO)	dbText	20
MODIFIER	Modifier code (one lower case letter)	dbText	12
MODIFIER_NAME	Name/type of modifier	dbText	50
MODIFIER_DESCRIPTION	Description of modifier	dbText	255

Appendix D

Plant Species List and Crosswalk

Thirty-one vascular plant species representing 16 families were noted during plot and observation point collection at Pipe Spring National Monument (PISP). Because the data collection occurred in August when many plants were dormant, the list is depauperate compared with the true diversity of plant species within the Monument.

The Northern Colorado Plateau Network uses three taxonomic authorities for vascular plants: Welsh et al. 2003 as the nomenclatural authority for Utah parks, Weber and Wittmann (2001) for Colorado parks, and Dorn and Lichvar (1984) for the single park in Wyoming; the PISP vegetation mapping project database reflects scientific names as assigned by Welsh. These names are crosswalked to Kartesz (1999), which is the nomenclatural authority used by NatureServe for the National Vegetation Classification. Scientific and common names used by NatureServe are presented in this crosswalk; these names are used throughout the PISP vegetation mapping report and in the individual association descriptions in Appendix F. The taxonomic serial number (TSN) assigned by the Integrated Taxonomic Information System (ITIS) is provided for each species.

Family	Scientific Name (Welsh et al. 2003)	Scientific Name (Kartesz 1999)	Common Name (NatureServe)	TSN
Agavaceae	Yucca kanabensis McKelvey	Yucca angustissima var. kanabensis	Kanab yucca	523600
Anacardiaceae	Rhus aromatica var. trilobata (Nutt.) Gray ex. S. Wats.	Rhus trilobata	threeleaf sumac	539586
Asteraceae	Artemisia bigelovii Gray	Artemisia bigelovii	Bigelow sagebrush	35452
	Artemisia campestris L.	Artemisia campestris	common sagewort	183748
	Artemisia filifolia Torr.	Artemisia filifolia	sand sagebrush	35463
	Artemisia tridentata ssp. tridentata Nutt.	Artemisia tridentata ssp. tridentata	Basin big sagebrush	35499
	Chrysothamnus nauseosus (Pallas ex Pursh) Britt.	Ericameria nauseosa	rubber rabbitbrush	37055
	Chrysothamnus viscidiflorus (Hook.) Nutt.	Chrysothamnus viscidiflorus	green rabbitbrush	37090
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	Gutierrezia sarothrae	broom snakeweed	37483
	Iva axillaris Pursh	Iva axillaries	poverty weed	36033
Cactaceae	Opuntia erinacea Engelm. & Bigelow ex Engelm.	Opuntia erinacea	Mohave pricklypear cactus	19705
	Opuntia erinacea var. utahensis (Engelm.) L. Benson	Opuntia erinacea var. utahensis	Utah pricklypear cactus	195276
	Opuntia phaeacantha Engelm.	Opuntia phaeacantha	brownspine pricklypear	19724
	Sclerocactus whipplei (Engelm. & Bigelow) Britt. & Rose	Sclerocactus whipplei	Whipple's fishhook cactus	19765
Chenopodiaceae	Atriplex canescens (Pursh) Nutt.	Atriplex canescens	fourwing saltbush	20518
	Sarcobatus vermiculatus (Hook.) Torr.	Sarcobatus vermiculatus	black greasewood	20707
Cupressaceae	Juniperus osteosperma (Torr.) Little	Juniperus osteosperma	Utah juniper	194859
Elaeagnaceae	Shepherdia rotundifolia Parry	Shepherdia rotundifolia	roundleaf buffaloberry	27780
Ephedraceae	Ephedra viridis Coville	Ephedra viridis	green Mormon-tea	502319
Fagaceae	Quercus turbinella Greene	Quercus turbinella	Sonoran scrub oak	19440
Juncaceae	Juncus balticus Willd.	Juncus arcticus ssp. littoralis	Arctic rush	39223
Lamiaceae	Mentha arvensis L.	Mentha arvensis	field mint	565302
Pinaceae	Pinus edulis Engelm.	Pinus edulis	two-needle pinyon	183336
Poaceae	Aristida purpurea Nutt.	Aristida purpurea	purple threeawn	41429
	Bromus tectorum L.	Bromus tectorum	cheatgrass	40524
	Hilaria jamesii (Torr.) Benth.	Pleuraphis jamesii	James' galleta	41768
	Stipa comata Trin. & Rupr.	Hesperostipa comata	needle-and-thread grass	42172
	Stipa speciosa Trin. & Rupr.	Achnatherum speciosum	desert needlegrass	42194
Polygonaceae	Eriogonum corymbosum Benth.	Eriogonum corymbosum	crispleaf buckwheat	21103
	Eriogonum inflatum Torr. & Frém.	Eriogonum inflatum	desert trumpet	21163
Rosaceae	Amelanchier utahensis Koehne	Amelanchier utahensis	Utah serviceberry	25121
	Purshia mexicana (D. Don) Henrickson	Purshia stansburiana	Stansbury cliffrose	195899
Salicaceae	Salix exigua Nutt	Salix exigua	coyote willow	22529
Scrophulariaceae	Castilleja chromosa A. Nels.	Castilleja chromosa	Indian paintbrush	33102

Appendix E

Field Plot Crosswalk to NVC Associations

Plots and observation points from PISP are assigned to National Vegetation Classification associations based on their composition and structure as they were recorded in the field. Element codes are used by NatureServe and state Natural Heritage Programs to track nomenclature and status of rare plants, rare animals, and communities ("elements"). Nomenclature used by the NVC follows Kartesz (1999).

Plant Association Scientific Name	Element Code	No. of Samples	Supporting Plots and Observation Points
Artemisia filifolia Colorado Plateau Shrubland	CEGL002697	1	PISP.9003
Atriplex canescens - Artemisia tridentata Shrubland	CEGL001282	1	PISP.9001
Atriplex canescens Shrubland	CEGL001281	2	PISP.9002, PISP.9004
Ericameria nauseosa Shrubland Alliance	A.835	0	Field observations only
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland	CEGL004007	1	PISP.0002
Pleuraphis jamesii Herbaceous Vegetation	CEGL001777	1	PISP.0001
Salix (exigua, interior) Temporarily Flooded Shrubland Alliance	A.947	0	Field observations only
Sarcobatus vermiculatus Disturbed Shrubland	CEGL001357	1	PISP.0003

Appendix F

Plant Association Descriptions for Pipe Spring National Monument

The Pipe Spring National Monument (PISP) vegetation mapping project sampled six National Vegetation Classification (NVC) plant associations. Detailed vegetation descriptions are essential for recognizing floristic vegetation types (association and alliance levels of the NVC) in the field. Local and global descriptions "*provide specific information on the geographical distribution, level of acceptable physiognomic and compositional variation, and the key ecological process and environmental / abiotic factors that are associated with a type*" (Grossman et al. 1998). The two levels of vegetation descriptions are valuable for comparing each association as it appears in the park with the global range of variation for that association.

The following report was prepared by NatureServe to provide local and global descriptions for each plant association sampled at PISP. These descriptions reflect NatureServe's accumulated data and analysis. Global descriptions of NVC associations are available on NatureServe's Explorer Web site (http://www.natureserve.org/explorer); local descriptions are not.

In this appendix, NVC plant associations are arranged by physiognomic class (i.e., Woodland, Shrubland, Herbaceous). Within each physiognomic class, associations are sorted by alliance (e.g., *Atriplex canescens* Shrubland Alliance).

Four vegetation types documented only from field notes are not included in this report:

- *Juniperus osteosperma / Juncus balticus* Woodland [Park Special]
- *Juniperus osteosperma / Atriplex* spp. Woodland [Park Special]
- *Ericameria nauseosa* Shrubland Alliance
- *Salix (exigua, interior)* Temporarily Flooded Shrubland Alliance

The characteristics of these communities are documented elsewhere in the report and appendices.

TABLE OF CONTENTS

Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland
Two-needle Pinyon - Utah Juniper / Turbinella Live Oak Woodland

CODE	CEGL004007
PHYSIOGNOMIC CLASS	Woodland (II)
PHYSIOGNOMIC SUBCLASS	Evergreen woodland (II.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar needle-leaved evergreen woodland (II.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.)
FORMATION	Rounded-crowned temperate or subpolar needle-leaved evergreen woodland (II.A.4.N.a.)
ALLIANCE	PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE (A.516) Two-needle Pinyon - (Juniper species) Woodland Alliance

ECOLOGICAL SYSTEM(S): Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in northern Arizona in the southern Colorado Plateau. It occurs on canyon slopes, rims and mesa tops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands. The vegetation is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have tree cover between 5-10% cover. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha* var. *polyacantha*, and *Opuntia whipplei*. Herbaceous cover is variable, ranging from sparse to moderately dense, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Exotic annual grass *Bromus tectorum* is present in some stands.

DISTRIBUTION

Pipe Spring National Monument

This association is restricted to the top of the sandstone mesa in the northwestern corner of the Monument, where it is the only association present.

Globally

This woodland is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona.

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

This woodland stand occupies the dipping top of a mesa (15-degree slope). The sampled stand is at 1536 m (5036 feet) elevation. Rocks, bedrock, and litter cover most of the ground surface. The soil is a thin, rapidly drained loamy sand derived from Navajo Sandstone.

Globally

This woodland association is known from Canyon de Chelly and Pipe Springs national monuments in the southern Colorado Plateau of northern Arizona. It occurs on canyon slopes,

rims, and mesa tops from 1536 to 2104 m (5040-6900 feet) elevation. Stands occur on gentle to steep slopes (2-35%) on warmer southern and western aspects. The substrates are generally shallow, rocky sandy loam to silt loam soils. The surface typically has moderate to high cover of boulders or rock outcrops. Cover by lichens is moderate to high in some stands.

VEGETATION DESCRIPTION

Pipe Spring National Monument

The density of woody plants in this stand is controlled by the availability of cracks in the bedrock substrate; herbaceous species tend to be clumped in areas where soil has managed to collect. The canopy contains approximately equal cover by *Pinus edulis* and *Juniperus osteosperma* trees. The shrub layer has equal or slightly greater cover and consists primarily of *Quercus turbinella, Amelanchier utahensis,* and *Purshia stansburiana*. Seedling *Pinus edulis* and *Juniperus osteosperma* trees are present. Additional shrubs contribute low cover and include *Ephedra viridis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia erinacea, Rhus trilobata* var. *trilobata, Shepherdia rotundifolia, Sclerocactus whipplei,* and *Yucca angustissima* var. *kanabensis*. The herbaceous layer is patchy and sparse but relatively diverse. Common herbaceous species include *Aristida purpurea, Hesperostipa comata, Pleuraphis jamesii,* and *Penstemon* sp. Mosses provide up to 5% cover.

Globally

This woodland is characterized by an open to moderately dense tree canopy (10-50% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. Very open stands may have tree cover between 5 and 10%. *Quercus turbinella* dominates or codominates the open to moderately dense shrub layer. Other shrubs may be present, including *Amelanchier utahensis, Artemisia bigelovii, Chrysothamnus greenei, Ephedra viridis, Fendlera rupicola, Opuntia phaeacantha, Opuntia polyacantha* var. *polyacantha, Opuntia whipplei,* and *Purshia stansburiana*. Additional shrubs contribute low cover and include *Ericameria nauseosa, Gutierrezia sarothrae, Opuntia erinacea, Rhus trilobata* var. *trilobata, Shepherdia rotundifolia, Sclerocactus whipplei,* and *Yucca angustissima* var. *kanabensis*. Herbaceous cover is variable, ranging from sparse to moderate, but is often dominated the perennial graminoid *Bouteloua gracilis* with scattered perennial forbs. Other common species include grasses *Achnatherum hymenoides, Aristida purpurea, Bouteloua barbata, Bouteloua curtipendula, Hesperostipa comata, Pleuraphis jamesii, Poa fendleriana,* and forbs such as *Brickellia microphylla* var. *scabra, Gutierrezia microcephala, Heterotheca villosa, Lesquerella fendleri,* and *Stephanomeria minor* var. *minor*. Exotic annual grass *Bromus tectorum* is present in some stands.

MOST ABUNDANT SPECIES

Pipe Spring National Monument

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

Globally

Data are not available.

OTHER NOTEWORTHY SPECIES

Pipe Spring National Monument
Data are not available.

Globally
Bromus tectorum

CONSERVATION STATUS RANK
Global Rank & Reasons: GNR (19-Jul-2006).

CLASSIFICATION COMMENTS
Pipe Spring National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE:

ELEMENT SOURCES
Pipe Spring National Monument Inventory Notes: The dominant shrubs vary among shrub live oak, Utah serviceberry, and Mexican cliffrose, but shrub live oak is the most consistent throughout the site. The surface is very rocky and most trees are young.
Pipe Spring National Monument Field Data: This description was based on 2007 field data (1 plot: PISP.0002).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. G. Kittel

REFERENCES: Western Ecology Working Group n.d.

Artemisia filifolia Colorado Plateau Shrubland
Sand Sagebrush Colorado Plateau Shrubland

CODE	CEGL002697
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Microphyllous evergreen shrubland (III.A.4.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural microphyllous evergreen shrubland (III.A.4.N.)
FORMATION	Lowland microphyllous evergreen shrubland (III.A.4.N.a.)
ALLIANCE	ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE (A.816) Sand Sagebrush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Southern Colorado Plateau Sand Shrubland (CES304.793)
Colorado Plateau Blackbrush-Mormon-tea Shrubland (CES304.763)
Inter-Mountain Basins Active and Stabilized Dune (CES304.775)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally

This sand sagebrush shrubland association is widespread in the Colorado Plateau of Utah, Arizona and probably New Mexico. It occurs on sandy, often somewhat disturbed sites on valley floors, stream terraces, stabilized dunes and sand sheets, benches, floodplains and alluvial fans. Most sites are level to gently sloping, with a few on moderate slopes (up to 21%), and may be oriented to any aspect, although there is a slight tendency toward warmer southerly aspects. Elevations range from 1122 to 1769 m (3680-5803 feet). Sand or bare soil covers most of the unvegetated ground surface, although biological soil crusts may have up to 40% cover. Soils are sandy and derived from local sandstones, alluvium, or eolian deposits. Total vegetation cover ranges broadly, from sparsely vegetated disturbed sites with less than 5% total cover to stable, well-developed communities with more than 50% cover. Regardless of cover, the vegetation is characterized by an open shrub canopy dominated by *Artemisia filifolia* that is usually mixed with other shrubs, especially *Atriplex canescens, Ericameria nauseosa*, and *Opuntia* spp. Less commonly, the shrub layer will include *Vanclevea stylosa, Eriogonum leptocladon*, or *Sarcobatus vermiculatus*. *Coleogyne ramosissima, Ephedra viridis*, and *Ephedra torreyana* are generally absent or have only trace cover. The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that are consistently present include *Achnatherum hymenoides* and *Bromus tectorum*; some sites may have *Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus*, and *Vulpia octoflora*. Forbs vary among sites but are typical of sandy habitats, including *Abronia fragrans*, *Lepidium montanum, Oenothera pallida, Salsola tragus*, and *Sphaeralcea parvifolia*. Cryptogams may be absent or may provide up to 40% cover.

DISTRIBUTION

Pipe Spring National Monument

This association is known from sandy overbank deposits lining the diversion ditch that parallels the eastern boundary of the Monument west of the Visitor Center.

Globally

This sand sagebrush shrubland association is widespread on sandy sites in the Colorado Plateau of Utah, Colorado, Arizona and New Mexico.

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

The stand occurs on alluvial deposits of the valley floor at 1505 m (4932 feet) elevation. Bare soil covers most of the nearly level ground surface, with low cover by sand, litter and wood. Soils are deep, sandy and derived from alluvium.

Globally

This sand sagebrush shrubland is widespread on sandy sites in the Colorado Plateau of Utah, Colorado, Arizona and New Mexico. This common association occurs on sandy sites on valley floors, valley sides, stream terraces, stabilized dunes and sand sheets, benches, floodplains, terraces and alluvial fans. Most sites are level to gently sloping, with a few on moderate slopes (up to 21%), and may be oriented to any aspect, although there is a slight tendency to occur on warmer southerly aspects. Elevations range from 1122 to 1769 m (3680-5803 feet). Sand or bare soil covers most of the unvegetated ground surface, although cryptobiological soil crusts may have up to 40% cover. Soils are sandy to sometimes gravelly and derived from local sandstones, alluvium, or eolian deposits.

VEGETATION DESCRIPTION

Pipe Spring National Monument

This association is dominated by *Artemisia filifolia*. Total shrub cover is around 25%, and other shrubs scattered through the stand may include *Atriplex canescens, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia phaeacantha*. Young *Juniperus osteosperma* trees are invading part of the stand. The herbaceous layer is sparse but tends to be dominated by exotic species including *Bromus tectorum* and *Tribulus terrestris*. Mosses may also provide low cover where protected by shrub crowns.

Globally

Total vegetation cover ranges broadly, from sparsely vegetated disturbed and alluvial terrace sites with less than 5% total cover to more stable, well-developed communities with greater than 50% cover. Regardless of cover, the vegetation is characterized by an open shrub canopy of *Artemisia filifolia*, usually mixed with other shrubs, especially *Atriplex canescens, Ericameria nauseosa,* and *Opuntia* spp. Less commonly, the shrub layer will include *Vanclevea stylosa, Eriogonum leptocladon,* or *Sarcobatus vermiculatus*. *Coleogyne ramosissima, Ephedra viridis,* and *Ephedra torreyana* are generally absent or have relatively low cover (usually <1%). The herbaceous layer is moderate in terms of species composition and provides sparse to moderate cover. Graminoids that are consistently present include *Achnatherum hymenoides* and *Bromus tectorum*; some sites may also have *Hesperostipa comata, Pleuraphis jamesii, Sporobolus cryptandrus,* and *Vulpia octoflora*. Forbs vary among sites but are typical of sandy habitats, including *Abronia fragrans, Lepidium montanum, Oenothera pallida, Salsola tragus,* and *Sphaeralcea parvifolia*. Cryptogams may be absent or may provide up to 40% cover.

MOST ABUNDANT SPECIES

Pipe Spring National Monument

Stratum	Species
Short shrub/sapling	*Artemisia filifolia, Ericameria nauseosa*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia filifolia*

OTHER NOTEWORTHY SPECIES

Pipe Spring National Monument

Bromus tectorum (exotic)

Globally

Bromus rubens, Bromus tectorum, Halogeton glomeratus, Malcolmia africana, Salsola tragus

CONSERVATION STATUS RANK

Global Rank & Reasons: GNR (14-Aug-2001).

CLASSIFICATION COMMENTS

Pipe Spring National Monument

Data are not available.

Globally

This association is distinguished from other *Artemisia filifolia* shrubland associations by its restriction to the Colorado Plateau, the somewhat mixed shrub canopy that usually includes *Atriplex canescens,* a poorly-developed herbaceous layer and often a number of species that indicate disturbance or somewhat alkaline conditions. This association also occurs in a broader range of habitats than other *Artemisia filifolia* types. However, *Artemisia filifolia - Ephedra (torreyana, viridis)* Shrubland (CEGL002786) is poorly defined, and many stands of *Artemisia filifolia* Colorado Plateau Shrubland (CEGL002697) contain one or the other species of *Ephedra*; it is possible that these two associations should be combined.

CLASSIFICATION CONFIDENCE: 1 - Strong

ELEMENT SOURCES
Pipe Spring National Monument Inventory Notes: This association occurs on sandier sites than those that support rabbitbrush and fourwing saltbush. Sand sagebrush seedlings are present.
Pipe Spring National Monument Field Data: This description is based on 2007 field data (1 observation point: PISP.9003).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: J. Coles, mod. K.A. Schulz

REFERENCES: Cogan et al. 2004, Western Ecology Working Group n.d.

Atriplex canescens - Artemisia tridentata Shrubland
Fourwing Saltbush - Basin Big Sagebrush Shrubland

CODE	CEGL001282
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	ATRIPLEX CANESCENS SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert. Elevation ranges from 1160-2100 m (3800-6900 feet). Stands occur on level plains, valley bottoms, alluvial flats, stream terraces, low and midslopes . Slopes are typically less than 25%. It occurs on all aspects, Substrates are well-drained, typically fine-textured soils (silty loam and clay) but may include coarser-textured soils (loamy sand). The vegetation is characterized by a sparse to moderately dense (10-35% cover) short-shrub layer that is codominated by *Atriplex canescens* and *Artemisia tridentata*. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., and *Opuntia* spp. *Sarcobatus vermiculatus* and *Suaeda moquinii* may be present with low cover on more saline sites. The

sparse to moderate herbaceous layer (10-20% cover) is dominated by graminoids with scattered forbs. *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides,* and *Pascopyrum smithii* are common grasses. Forbs may include *Cirsium neomexicanum, Eriogonum inflatum, Eriogonum racemosum, Penstemon* spp., or *Sphaeralcea coccinea*. Introduced species are common in disturbed stands.

DISTRIBUTION

Pipe Spring National Monument

This association occurs only in the disturbed area northeast of the Visitor Center within the Monument.

Globally

This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert.

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

The sampled stand occupies a flat alluvial plain at an elevation of 1514 m (4963 feet). Bare soil covers most of the ground surface, with low cover by sand, litter and wood. The soil is deep and sandy, derived from alluvium.

Globally

This shrubland is found on the western slope of the Colorado Rocky Mountains, Colorado Plateau, Great Basin, and Mojave Desert. Elevation ranges from 1160-2100 m (3800-6900 feet). Stands occur on level plains, canyon floors, valley bottoms, alluvial flats, stream terraces, benches, low and midslopes. Slopes are typically less than 25%. It occurs on all aspects, but northwest-, east- and southeast-facing slopes are common. Substrates are well-drained, typically fine-textured soils (silty loam and clay) but may include coarser-textured soils (loamy sand). Some stands may be subject to periodic flooding. Evidence of erosion, such as rills and gullies, is common (Warren et al. 1982).

VEGETATION DESCRIPTION

Pipe Spring National Monument

This association is unique in the Monument, consisting of a canopy codominated by *Atriplex canescens* and *Artemisia tridentata* ssp. *tridentata*. Total shrub cover is around 15%. Other shrubs present may include *Artemisia filifolia, Chrysothamnus viscidiflorus, Ericameria nauseosa,* and *Gutierrezia sarothrae*. Exotic herbaceous species including *Tribulus terrestris* tend to dominate the herbaceous layer, but scattered *Aristida purpurea* bunchgrass provide sparse cover.

Globally

This association is characterized by a sparse to moderately dense (10-35% cover) short-shrub layer (1-2 m tall) that is codominated by *Atriplex canescens* and *Artemisia tridentata*. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Gutierrezia microcephala, Krascheninnikovia lanata, Lycium* spp., and *Opuntia* spp. (Warren et al. 1982, Roberts et al. 1992). *Sarcobatus vermiculatus* and *Suaeda moquinii* may be present with low cover on more saline sites. The sparse to moderately dense

(10-20% cover) herbaceous layer is dominated by graminoids with scattered forbs. *Achnatherum hymenoides, Bouteloua gracilis, Elymus elymoides, Pascopyrum smithii,* and *Sporobolus cryptandrus* are common grasses. Forbs may include *Abronia fragrans, Cirsium neomexicanum, Eriogonum inflatum, Eriogonum racemosum, Mentzelia multiflora, Penstemon* spp., *Rumex hymenosepalus,* or *Sphaeralcea coccinea*. Introduced species such as *Agropyron cristatum, Arctium minus, Bromus rubens, Bromus tectorum, Carduus nutans, Chenopodium album, Cirsium arvense, Convolvulus arvensis, Descurainia sophia, Erodium cicutarium, Lactuca serriola, Medicago sativa, Salsola tragus,* and *Tragopogon dubius* are common in disturbed stands. Cryptogams are generally sparse but one sampled plot had 25% cover.

MOST ABUNDANT SPECIES

Pipe Spring National Monument

Stratum	Species
Short shrub/sapling	*Artemisia tridentata* ssp. *tridentata*, *Atriplex canescens*

Globally

Stratum	Species
Short shrub/sapling	*Artemisia tridentata, Atriplex canescens*

OTHER NOTEWORTHY SPECIES

Pipe Spring National Monument
Data are not available.

Globally
Data are not available.

CONSERVATION STATUS RANK

Global Rank & Reasons: G4 (20-Sep-2000).

CLASSIFICATION COMMENTS

Pipe Spring National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Pipe Spring National Monument Inventory Notes: This association occurs in an area disturbed by sheetwash with many small channels present. Seedling forbs (probably exotic species) are abundant. Use by cottontail rabbits is high.
Pipe Spring National Monument Plots: This description is based on 2007 field data (1 observation point: PISP.9001).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz

REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, Cogan et al. 2004, Driscoll et al. 1984, Everett 1987, Howard 1999, Howard 2003, Roberts et al. 1992, Tirmenstein 1999c,

Warren et al. 1982, Western Ecology Working Group n.d., Wright 1980, Wright et al. 1979

Atriplex canescens Shrubland
Fourwing Saltbush Shrubland

CODE	CEGL001281
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Evergreen shrubland (III.A.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic evergreen shrubland (III.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic evergreen shrubland (III.A.5.N.)
FORMATION	Facultatively deciduous extremely xeromorphic subdesert shrubland (III.A.5.N.b.)
ALLIANCE	ATRIPLEX CANESCENS SHRUBLAND ALLIANCE (A.869) Fourwing Saltbush Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)
Sonora-Mojave Mixed Salt Desert Scrub (CES302.749)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY

Globally

This shrubland association is known from the Great Basin north into the southern Columbia Basin and east into Wyoming and the Colorado Plateau. It is common at middle elevations on alluvial fans and toeslopes in deep, sandy soils but will occur at lower elevations along alluvial benches where soils are often finer-textured and possibly saline/alkaline. Parent materials are variable. The vegetation is characterized by a sparse to moderately dense short-shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum,* or *Psorothamnus* spp. *Artemisia bigelovii, Artemisia tridentata,* and *Krascheninnikovia lanata*, *Ephedra viridis,* or *Purshia stansburiana* may be present but are not codominants. The herbaceous layer includes low cover of species such as *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii*, and *Sporobolus cryptandrus*. Introduced species, especially *Bromus tectorum, Bromus diandrus*, and *Salsola kali*, are common on disturbed sites and can create an herbaceous layer much denser than on undisturbed sites. Winter annual forb cover is variable depending on annual precipitation.

DISTRIBUTION

Pipe Spring National Monument

This is the most common and widespread association within the Monument, dominating the eastern, southern and western flats outside of the developed area.

Globally

This shrubland association may occur throughout much of the interior western U.S. It is known from the southern Columbia Basin and Great Basin east into Wyoming and the Colorado Plateau.

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

This association occupies the alluvial plain that comprises most of the Monument. Stands occur on level to gentle slopes and elevations range from 1502 to 1514 m (4925-4963 feet). Bare soil

covers most of the ground surface, with low cover by litter and wood. The soils are deep, sandy to loamy, and are derived from alluvium.

Globally
This widespread shrubland association occurs throughout much of the western U.S. and is found on bajadas, low stream terraces, valley floors and toeslopes. Sites are flat to gently sloping with any aspect. It is commonly found on deep, sandy soils at middle elevations (1235-2256 m [4050-7400 feet]) on the Colorado Plateau, but will occur at lower elevations (down to 610 m [2000 feet]) along alluvial benches where soils are often finer-textured and possibly saline/alkaline (Beatley 1976) in the Great Basin region. The unvegetated surface is predominantly bare soil and/or sand. Larger rocks and organic material are rare. Parent materials include volcanic tuff, shale and sandstone. At lower elevations, it may occur as a mosaic with *Lycium pallidum* - *Grayia spinosa*- or *Atriplex confertifolia*-dominated shrublands.

VEGETATION DESCRIPTION
Pipe Spring National Monument
This common association is somewhat variable. The shrub canopy is always dominated by *Atriplex canescens*, providing between 3 and 25% cover. Some stands contain low to moderate cover by *Chrysothamnus viscidiflorus* or *Ericameria nauseosa*. On sandy soils associated with the former drainage that cut the eastern side of the Monument, *Artemisia filifolia* is present to subdominant. Most stands include scattered *Gutierrezia sarothrae* and *Opuntia erinacea*; less common are individuals of *Shepherdia rotundifolia* and *Yucca angustissima* var. *kanabensis*. *Juniperus osteosperma* is invading stands in the northeastern corner of the park. In some years, exotic forbs such as *Tribulus terrestris* will dominate the herbaceous layer. Native species such as *Aristida purpurea, Hesperostipa comata, Pleuraphis jamesii,* and *Castilleja applegatei* ssp. *martinii* tend to be scattered and have low cover. Biotic crusts occur in some stands where protected by shrub canopies.

Globally
This broadly defined association is characterized by a sparse to moderately dense shrub layer (10-35% cover) dominated or codominated by *Atriplex canescens*, typically with a variable and often sparse herbaceous layer. Total vegetation cover ranges from sparse to moderate (5-56% cover). Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum nummulare, Ericameria nauseosa, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum, Psorothamnus fremontii,* or *Psorothamnus polydenius*. *Artemisia bigelovii, Artemisia tridentata, Ephedra viridis, Krascheninnikovia lanata,* or *Purshia stansburiana* may be present but are not codominants. *Artemisia filifolia* may be present to subdominant in a few stands. The typically sparse herbaceous layer includes low cover of semi-arid grasses such as *Achnatherum hymenoides, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii,* and *Sporobolus cryptandrus*. Common forb species on sandy sites include *Cymopterus ripleyi, Dalea searlsiae, Lesquerella ludoviciana,* and *Oenothera pallida*, and on disturbed sites *Cryptantha crassisepala, Descurainia pinnata, Erodium cicutarium, Lappula occidentalis, Lepidium montanum, Plantago patagonica,* and *Rumex hymenosepalus* may be present. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus diandrus, Salsola kali*, and *Tribulus terrestris* can be common on disturbed sites and may form a moderately dense herbaceous stratum.

MOST ABUNDANT SPECIES
Pipe Spring National Monument

Stratum	Species
Short shrub/sapling	*Chrysothamnus viscidiflorus*
Short shrub/sapling	*Atriplex canescens*

Globally

Stratum	Species
Short shrub/sapling	*Atriplex canescens*

OTHER NOTEWORTHY SPECIES
Pipe Spring National Monument
Bromus tectorum, Tribulus terrestris (exotics)

Globally
Data are not available.

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

CLASSIFICATION COMMENTS
Pipe Spring National Monument
Data are not available.

Globally
Data are not available.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Pipe Spring National Monument Inventory Notes: This association occurs on sites showing sheetwash erosion via many small, braided channels. Buffaloberry is scattered in one stand.
Pipe Spring National Monument Plots: This description is based on 2007 field data (2 observation points: PISP.9002, PISP.9004).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Drake, J. Coles, G. Kittel

REFERENCES: Beatley 1976, Bourgeron and Engelking 1994, Cogan et al. 2004, Driscoll et al. 1984, Howard 2003, Ostler et al. 2000, Western Ecology Working Group n.d.

Sarcobatus vermiculatus DisturbedShrubland
Black Greasewood Disturbed Shrubland

CODE	CEGL001357
PHYSIOGNOMIC CLASS	Shrubland (III)
PHYSIOGNOMIC SUBCLASS	Deciduous shrubland (III.B.)
PHYSIOGNOMIC GROUP	Extremely xeromorphic deciduous shrubland (III.B.3.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural extremely xeromorphic deciduous shrubland (III.B.3.N.)
FORMATION	Intermittently flooded extremely xeromorphic deciduous subdesert shrubland (III.B.3.N.b.)
ALLIANCE	SARCOBATUS VERMICULATUS INTERMITTENTLY FLOODED SHRUBLAND

ALLIANCE (A.1046) Black Greasewood Intermittently Flooded Shrubland Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Greasewood Flat (CES304.780)
Inter-Mountain Basins Wash (CES304.781)
Inter-Mountain Basins Playa (CES304.786)

USFWS WETLAND SYSTEM: Palustrine

CONCEPT SUMMARY

Globally

This shrubland association occurs on saline soils of terraces, swales, alluvial fans, valley floors, toeslopes and ridges throughout the Colorado Plateau and Great Basin. It is distinguished from other *Sarcobatus vermiculatus* associations in that disturbance has removed most or all of the native herbaceous understory. Black greasewood will increase in density at the expense of grasses such as *Sporobolus airoides* under conditions of heavy grazing, since the shrub is only moderately palatable and is somewhat poisonous to livestock. Soil textures in these communities range from sandy loam to silty clay and may have a white salt crust on the soil surface. *Sarcobatus vermiculatus* dominates the sparse to moderately dense shrub layer, usually with a minor component of *Ericameria nauseosa, Suaeda moquinii (= Suaeda torreyana), Opuntia polyacantha, Atriplex canescens,* or *Atriplex confertifolia*. If *Artemisia tridentata* is present, it is with very low cover. The understory ranges from sparse to dense in cover, but native species typically have very low cover. The dominant herbaceous species tend to be weedy and/or exotic; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Salsola tragus, Alyssum desertorum,* and *Halogeton glomeratus* are typical understory species.

DISTRIBUTION

Pipe Spring National Monument

This association occurs on the mesa slope north of the Fort, between a belt of large junipers and the sandstone top of the mesa.

Globally

This association is likely to be widespread on floodplains and valley floors throughout the interior western United States. It is currently documented from the Uinta Basin (eastern Utah), Great Basin (central Utah, central Nevada, eastern California), northwestern New Mexico (Francis 1986) and Colorado Plateau (western Colorado).

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

This association occupies a rocky slope separating mesa from plain. The sampled stand covers most of the moderate southeast-facing slope at approximately 1529 m (5015 ft.). Bare soil covers most of the ground surface, with low cover by litter small rocks. The soils are a deep, sandy loam, and are derived from sandstone and shale.

Globally

This widespread but patchy shrubland association occurs on terraces, swales, coppice dunes, alluvial fans, valley floors, toeslopes and ridges throughout the Colorado Plateau and Great Basin. Elevations range between 1200 and 2073 m (3940-6800 feet), and slopes tend to be gentle. Soils are typically derived from mixed alluvium. Soil textures range from sandy loam to

silty clay and tend to be alkaline, often with a white salt crust on the soil surface. Biological soil crusts may provide up to 25% cover in some stands. Bare ground values tend to be high, up to 80%, unless *Bromus tectorum* is a major component of the system, in which case litter cover values are high. *Sarcobatus vermiculatus* is a very salt-tolerant species, although it will also grow on non-saline and non-alkaline soils (Shantz and Piemeisel 1940). *Sarcobatus vermiculatus* stands develop best where subsurface moisture is readily available. It is commonly found on floodplains that are either subject to periodic flooding or have a high water table at least part of the year.

VEGETATION DESCRIPTION

Pipe Spring National Monument

This association is unusual in that it is a floodplain community occupying a moderate slope. The shrub canopy is dominated by *Sarcobatus vermiculatus*, providing approximately 35% cover. *Atriplex canescens* shrubs are scattered throughout the shrubland. Openings contain mats of *Opuntia phaeacantha* and a few *Gutierrezia sarothrae*. A high level of foot traffic from a nature trail contributes to a paucity of herbaceous species in the understory.

Globally

This shrubland association occurs where conditions support *Sarcobatus vermiculatus*, but disturbance has removed most or all of the native herbaceous understory. *Sarcobatus vermiculatus* dominates the sparse to moderately dense shrub layer with a cover of 10-60%. Other shrubs commonly present include *Atriplex gardneri, Ericameria nauseosa, Grayia spinosa, Suaeda torreyana, Opuntia polyacantha, Atriplex canescens,* and *Atriplex confertifolia*. If *Artemisia tridentata* is present, it is with very low cover. The understory ranges from sparse to dense in cover, but native species typically have very low cover. The herbaceous species tend to be weedy and/or exotic; *Vulpia octoflora, Bromus tectorum, Descurainia pinnata, Salsola tragus, Alyssum desertorum,* and *Halogeton glomeratus* are typical understory dominants.

MOST ABUNDANT SPECIES

Pipe Spring National Monument

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatus, Atriplex canescens*
Dwarf shrub	*Opuntia phaeacantha*

Globally

Stratum	Species
Short shrub/sapling	*Sarcobatus vermiculatuss*

OTHER NOTEWORTHY SPECIES

Pipe Spring National Monument

N/A

Globally

Data are not available.

CONSERVATION STATUS RANK

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

CLASSIFICATION COMMENTS
Pipe Spring National Monument
Data are not available.

Globally
Stands included in this association are often affected by livestock grazing, and either lack an understory or possess an understory dominated by weedy or exotic herbaceous species.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES
Pipe Spring National Monument Inventory Notes: This association occurs on a slope within the Sevier Fault fracture zone; presumably groundwater is more available on this slope than it is on the plain below.
Pipe Spring National Monument Plots: This description is based on 2008 field data (1 plot: PISP.0003).
Local Description Authors: J. Coles
Global Description Authors: J. Coles, mod. K.A. Schulz
REFERENCES: Bourgeron and Engelking 1994, Brotherson et al. 1986, Dastrup 1963, Donovan et al. 1996, Driscoll et al. 1984, Francis 1986, Ganskopp 1986, Graham 1937, Groeneveld and Crowley 1988, NVNHP 2003, Shantz and Piemeisel 1940, Western Ecology Working Group n.d., Young et al. 1986

Pleuraphis jamesii Herbaceous Vegetation
James' Galleta Herbaceous Vegetation

CODE	CEGL001777
PHYSIOGNOMIC CLASS	Herbaceous Vegetation (V)
PHYSIOGNOMIC SUBCLASS	Perennial graminoid vegetation (V.A.)
PHYSIOGNOMIC GROUP	Temperate or subpolar grassland (V.A.5.)
PHYSIOGNOMIC SUBGROUP	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
FORMATION	Short sod temperate or subpolar grassland (V.A.5.N.e.)
ALLIANCE	PLEURAPHIS JAMESII HERBACEOUS ALLIANCE (A.1287) James' Galleta Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

USFWS WETLAND SYSTEM: Not applicable

CONCEPT SUMMARY
Globally
This widespread grassland association is found on alluvial flats, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Landforms vary from mesa tops and slopes to basin floors. Stands may be small woodland parks or more extensive grasslands on the plains. Soils in bottomland stands tend to be fine-textured; however, stands also occur on a variety of substrates. Vegetation is characterized by a relatively sparse to moderately dense (10-60% cover) perennial herbaceous layer that is strongly dominated by the warm-season grass *Pleuraphis jamesii*. Low cover of other grasses, such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides,* or *Sporobolus cryptandrus,* may be present. Forb cover is usually sparse and includes species of

Plantago, Gilia, Lappula, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present; however, they are not dense enough to form a shrub layer. Some stands have high cover of cryptogams on the soil surface.

DISTRIBUTION

Pipe Spring National Monument

This association was sampled on the north face of the Navajo Sandstone-capped mesa, near the western boundary fence. It extends east along the escarpment to the West Cabin.

Globally

This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S.

ENVIRONMENTAL DESCRIPTION

Pipe Spring National Monument

This association occupies a moderately steep (28-degree) slope partially covered by colluvial deposits at an elevation of 1530 m (5015 feet). Large and small rocks cover most of the ground surface; litter and bare soil have low cover. The slope is underlain by Moenave Formation; the colluvium is derived from the Navajo and Kayenta sandstones that cap the mesa above. The soil is a rapidly drained sandy loam.

Globally

This widespread grassland association is found on a variety of sites, including alluvial flats, toeslopes, valley floors, benches, hillsides, washes, colluvial slopes, plateau parks, mesas and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Elevation ranges from 1220-1930 m, with a few sites on the western edge of the southern Rocky Mountains extending to 2400 m. Landforms vary from mesa tops and slopes to basin floors. Sites are flat to moderately steep (up to 53% slope). Stands may be small woodland parks or more extensive on the plains. Soils are variable. In bottomland stands, soils tend to be fine-textured; however, stands also occur on sandy loams derived from sandstone, remnant lava flows, basaltic cobbles, black or red cinders, or alluvium derived from relict Pleistocene river cobbles, sandstone, sand, or clay soils.

VEGETATION DESCRIPTION

Pipe Spring National Monument

This association has the appearance of a sparse grassland with scattered shrubs. *Pleuraphis jamesii* is the dominant species with 10% cover; *Hesperostipa comata* and *Achnatherum speciosum* contribute an additional few percent cover. Native forb species such as *Artemisia campestris* and *Eriogonum inflatum* are scattered throughout the community. Shrubs are present, and increase in cover to the east of the plot, but do not have enough cover to constitute a stratum. Shrubs present include *Artemisia bigelovii, Eriogonum corymbosum, Ephedra viridis, Rhus trilobata* var. *trilobata, Atriplex canescens, Chrysothamnus viscidiflorus, Ericameria nauseosa, Gutierrezia sarothrae,* and *Opuntia erinacea*.

Globally

This association is characterized by a sparse to moderately dense perennial herbaceous layer (5-60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low

cover of other grasses, such as *Aristida* spp., *Achnatherum hymenoides, Achnatherum speciosum, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides*, or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes *Artemisia campestris, Cymopterus newberryi, Eriogonum inflatum, Phacelia crenulata, Plantago patagonica, Sphaeralcea parvifolia*, and *Townsendia annua* along with species of *Gilia, Lappula, Zinnia*, and prickly-pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present, but they are not abundant enough to form a shrub layer. Woody species may include *Artemisia bigelovii, Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Brickellia oblongifolia, Ephedra torreyana, Ephedra viridis, Ericameria nauseosa, Fallugia paradoxa, Gutierrezia* spp., *Krascheninnikovia lanata, Tetradymia* spp., and occasional *Juniperus* spp. trees. The widespread introduced annual grass *Bromus tectorum* and several other exotic species, such as *Salsola kali, Bassia scoparia*, and *Sisymbrium altissimum*, may be present to abundant, especially on disturbed sites. Some stands have high cover of cryptogams on the soil, including *Collema tenax, Tortula ruralis, Buellia papillata*, and *Fulgensia bracteata*.

MOST ABUNDANT SPECIES

Pipe Spring National Monument

Stratum	Species
Short shrub/sapling	*Eriogonum corymbosum*
Short shrub/sapling	*Artemisia bigelovii*
Herb (field)	*Pleuraphis jamesii*

Globally

Stratum	Species
Herb (field)	*Pleuraphis jamesii*

OTHER NOTEWORTHY SPECIES

Pipe Spring National Monument
Data are not available.

Globally
Bassia scoparia, Bromus tectorum, Salsola kali, Sisymbrium altissimum (exotics)

CONSERVATION STATUS RANK

Global Rank & Reasons: G2G4 (23-Feb-1994).

CLASSIFICATION COMMENTS

Pipe Spring National Monument
Data are not available.

Globally
This association is defined by the dominance of *Pleuraphis jamesii* in the graminoid layer without codominance of other grass species or the presence of a shrub layer.

CLASSIFICATION CONFIDENCE: 2 - Moderate

ELEMENT SOURCES

Pipe Spring National Monument Inventory Notes: This association is restricted to an escarpment above alluvial plains of fourwing saltbush. The threeleaf sumac shrubs were well-browsed.

Pipe Spring National Monument Plots: This description was derived from 2007 field data (1 plot: PISP.0001).
Local Description Authors: J. Von Loh, mod. J. Coles
Global Description Authors: K.A. Schulz, mod. J. Coles and G. Kittel

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Appendix G

ILLUSTRATED KEY TO THE VEGETATION OF PIPE SPRING NATIONAL MONUMENT

The vegetation of Pipe Spring National Monument was sampled during the summer of 2007 under the USGS-NPS Vegetation Mapping Program. This dichotomous key, illustrated with field photographs, has been prepared to assist in the identification of native and cultivated perennial vegetation present at Pipe Spring National Monument. The key is designed to be effective using one or more dominant species with environmental characteristics. In ecotones (areas where plant associations mix), it may be difficult to determine a definitive association name. This key also allows the user to crosswalk plant associations to the Pipe Spring National Monument vegetation map. In general, each map class represents one association, with two exceptions. The *Atriplex canescens* Shrubland association is split between two map classes based on its ecological condition and the *Artemisia filifolia* Shrubland association is split based on the presence or absence of *Atriplex canescens*.

HOW TO USE THE KEY:

The key approaches plant association identification at two levels. The first level is physiognomic (forest, woodland, tall shrubland, shrubland, dwarf-shrubland, graminoid, or forb). The second level allows identification to plant association based on the dominant species, and to a lesser extent, habitat characteristics. Photographs demonstrating variation within vegetation types are shown below association names.

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

1. You are observing vegetation that you think is an herbaceous or shrubland community, but it has some tree cover. In this case, try keying the vegetation through the woodland side of the key as well as the herbaceous or shrubland parts of the key. In general with any layer, if it does not cover at least 10% (tree layer) or 5% (shrub or herbaceous layers), it is ignored. The exception is in very sparse communities where the total vegetation cover is less than 10% (see #3).

2. You can follow a key to a certain point, but you clearly have something not described in the key. This is to be expected – very likely you have an association that was not found during the sampling phase of the project. In this case, simply record "Unclassified pinyon-juniper (or whatever type of vegetation you have) association".

3. Communities that are sparsely vegetated (i.e., < 10% total vascular plant cover) should be run through multiple keys. Even though they contain trees or shrubs, they may not fall cleanly into a “woodland “or “shrubland” category.

A Key to the Vegetation of Pipe Spring National Monument

1a) Vegetation woody or appearing woody; predominantly trees, shrubs, or shrub-like herbs; total vegetation cover may be sparse to dense **(2)**

1b) Vegetation dominated by grasses; total vegetation cover may be sparse to dense. Although some shrub species may be present, they have lower relative cover than the dominant grass, *Pleuraphis jamesii* – ***Pleuraphis jamesii*** **Herbaceous Vegetation (James' Galleta Herbaceous Vegetation) [Map Class 51]**

2a) (1) Woodland vegetation in which the canopy is dominated by *Juniperus, Pinus, Populus, Ulmus, Ailanthus,* or *Gleditsia* **(3)**

2b) Woody vegetation dominated by tall or short shrubs or subshrubs. Canopies may interlock but are more commonly less dense. Some trees may be present with low relative cover. Characteristic genera include: *Atriplex, Artemisia, Shepherdia, Ericameria, Purshia, Sarcobatus, Salix,* and *Quercus* **(10)**

3a) (2) Woodlands dominated by the native, evergreen coniferous species *Juniperus* and/or *Pinus* **(4)**

3b) Forests or woodlands dominated by planted or cultivated deciduous species, especially *Ailanthus, Populus* (both native and non-native species), *Ulmus,* and *Robinia* **(6)**

4a) (3) Open woodlands dominated by the native evergreens *Juniperus osteosperma* and *Pinus edulis*, located on the sloping mesa underlain by Navajo Sandstone. The understory contains a diversity of shrubs, but *Quercus turbinella* is always present to co-dominant. Other common shrubs include *Amelanchier utahensis, Yucca, Purshia stansburiana, Opuntia, Rhus trilobata,* and

Shepherdia rotundifolia. Herbaceous species have relatively low cover, and bedrock is often exposed at the surface - ***Pinus edulis - Juniperus osteosperma / Quercus turbinella*** **Woodland (Two-needle Pinyon – Utah Juniper / Sonoran Scrub Oak Woodland) [Map Class 21]**

4b) Open juniper woodlands on the slopes and flats surrounding the sandstone mesa; soils are deep and *Pinus edulis* is absent **(5)**

5a) (4) Open, invasive woodlands dominated by *Juniperus osteosperma,* located on the plains surrounding the sandstone mesa. The trees are becoming established in shrub communities dominated by *Atriplex canescens, Artemisia tridentata,* and *Artemisia filifolia* – ***Juniperus osteosperma / Atriplex*** **spp. Woodland (Utah Juniper / Saltbush species Woodland) [Map Class 23]**

5b) Open woodlands of *Juniperus osteosperma* with very large crowns, growing along the Sevier Fault spring line at the base of the escarpment. The understory is primarily herbaceous and *Juncus balticus* is conspicuous – ***Juniperus osteosperma / Juncus balticus*** **Woodland (Utah Juniper / Baltic Rush Woodland) [Map Class 22]**

6a) (3) Deciduous woodlands of native Fremont cottonwood, mostly planted in the staff housing area. The understory is a variable mix of native and exotic species – ***Populus fremontii*** **Woodland (Fremont Cottonwood Woodland) [Map Class 10]**

6b) Deciduous woodlands of non-native species of *Populus, Ulmus, Ailanthus,* or *Robinia* **(7)**

7a) (6) Deciduous woodlands dominated by Siberian elm with an understory of beaten earth, located near the Fort – ***Ulmus pumila*** **Woodland (Siberian Elm Woodland) [Map Class 13]**

7b) Deciduous woodland dominated by exotic species of *Populus, Ailanthus,* or *Robinia* **(8)**

8a) (7) Deciduous woodlands dominated by *Ailanthus altissima*; most are in the vicinity of the staff housing area and the maintenance shop - ***Ailanthus altissima*** **Woodland (Tree of Heaven Woodland) [Map Class 11]**

8b) Deciduous woodlands of *Robinia* or exotic species of *Populus* **(9)**

9a) (8) Deciduous woodlands of *Robinia pseudoacacia*; most are in the vicinity of the garden and the orchard - ***Robinia pseudoacacia*** **Woodland (Black Locust Woodland) [Map Class 12]**

9b) Deciduous woodlands of *Populus alba* and *P. nigra*, planted as shade trees near the Fort - ***Populus alba*** **Woodland (White Poplar Woodland) and** ***Populus nigra*** **Woodland (Black Poplar Woodland) [Map Class 12]**

10a) (2) Thickets and hedgerows of edible berry shrubs, including gooseberry and American plum, planted adjacent to corrals and the orchard - ***Prunus*** **spp. Thicket and** ***Ribes*** **spp. Thicket (American Plum Thicket and Gooseberry Thicket) [Map Class 43]**

10b) Shrublands dominated by native species, occurring in natural or semi-natural habitats; characteristic species include *Artemisia, Ericameria, Atriplex, Sarcobatus,* and *Salix* **(11)**

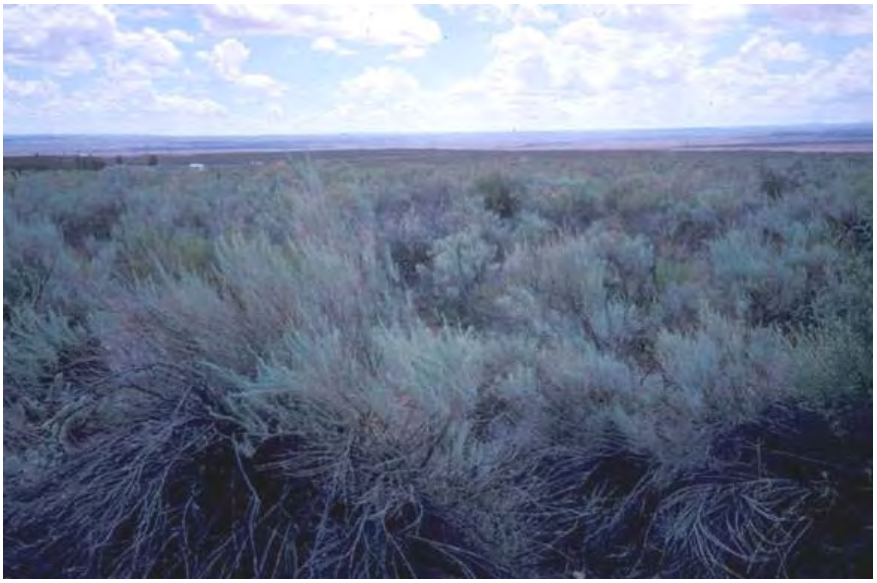
11a) (10) Xeric upland shrublands dominated by species of *Artemisia* or *Atriplex* **(12)**

11b) Shrublands associated with drying springs or seepage and dominated by species of *Salix, Sarcobatus*, or *Ericameri**a*** **(14)**

12a) (11) Open shrublands clearly dominated by fourwing saltbush. This is the most common upland community on the plains surrounding the Fort. The most representative stands have an understory dominated by James' galleta; degraded stands have high cover by bare ground, snakeweed, species of rabbitbrush and prickly pear - ***Atriplex canescens*** **Shrubland (Fourwing Saltbush Shrubland) [Map Classes 31 and 35 (degraded)]**

12b) Upland shrublands dominated or co-dominated by species of *Artemisia; Atriplex* may be present to co-dominant **(13)**

13a) (12) Open to closed shrublands dominated or co-dominated by sand sagebrush. In some stands, fourwing saltbush is co-dominant in the canopy - ***Artemisia filifolia*** **Shrubland (Sand Sagebrush Shrubland) [Map Classes 32 and 33 (with saltbush)]**



13b Open shrublands co-dominated by basin big sagebrush and fourwing saltbush. The understory is dominated by weedy annual species - ***Atriplex canescens - Artemisia tridentata*** **Shrubland (Fourwing Saltbush – Big Sagebrush Shrubland) [Map Class 34]**

14a) (11) Shrublands associated with groundwater seepage and dominated by either *Ericameria nauseosa* or *Sarcobatus vermiculatus* **(15)**

14b) Decadent stands of the tall riparian shrub coyote willow at a site of a now-dry spring near the southern boundary of the Monument*;* the understory includes weedy mesic species such as horehound. The formerly continuous stand is now broken into non-regenerating clumps - ***Salix (exigua, interior)*** **Temporarily Flooded Shrubland Alliance ([Coyote, Interior] Willow Temporarily Flooded Shrubland Alliance) [Map Class 41]**

15a) (14) Dense stand of black greasewood associated with a now-dry springline upslope from Winsor Castle. The understory contains significant cover by prickly pear cactus - ***Sarcobatus vermiculatus*** **Disturbed Shrubland (Black Greasewood Disturbed Shrubland) [Map Class 44]**

15b) Linear stands of rubber rabbitbrush lining the banks of the slope draining West Spring - ***Ericameria nauseosa*** **Shrubland Alliance (Rubber Rabbitbrush Shrubland Alliance) [Map Class 42]**

INDEX TO THE NATURAL AND INTRODUCED VEGETATION TYPES OF PIPE SPRING NATIONAL MONUMENT

Appendix H

Modified Anderson Land Use-Land Cover Classification

This classification was applied to all polygons in the Pipe Spring National Monument vegetation mapping area

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1.0 Water	1.1 Open Water	1.11 Stream/river			
		1.12 Canal/ditch	1.121 Lined canal/ditch		
			1.122 Unlined canal/ditch		
		1.13 Lake/pond			
		1.14 Reservoir			
		1.15 Bay/estuary			
		1.16 Sea/ocean			
	1.2 Perennial Ice/Snow	1.21 Snowfield			
		1.22 Glacier			
2.0 Developed	2.1 Residential	2.11 Single-family residential			
		2.12 Multi-family residential			
	2.2 Non-residential Developed	2.21 Commercial / Light Industry	2.211 Major Retail		
			2.212 Mixed/Minor Retail and Services		
			2.213 Office		
			2.214 Light industry		
		2.22 Heavy Industry	2.221 Petro-chemical Refinery		
		2.23 Communications and Utilities			
		2.24 Institutional	2.241 Schools		
			2.242 Cemeteries		
		2.25 Agricultural Business	2.251 Aquiculture		
			2.252 Confined feeding		
		2.26 Transportation	2.261 Airport		
		2.27 Entertainment/ Recreation	2.271 Golf Course		
			2.272 Urban Parks		
	2.3 Mixed Urban				
3.0 Bare	3.1 Transitional				
	3.2 Quarries/Strip mines/Gravel pits				
	3.3 Bare Rock/Sand				
	3.4 Flats				

Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	3.5 Disposal				
4.0 Vegetated	4.1 Woody	4.11 Forested	4.111 Deciduous		
			4.112 Evergreen		
			4.113 Mixed		
		4.12 Shrub land	4.121 Deciduous		
			4.122 Evergreen		
			4.123 Mixed		
			4.124 Desert scrub		
		4.13 Orchards/vineyards/groves	4.131 Irrigated Orchard/ vineyards/groves		
			4.132 Citrus		
			4.133 Non-managed Citrus		
		4.14 Mixed Forest/Shrub			
	4.2 Herbaceous	4.21 Natural Herbaceous	4.211 Natural Grassland		
		4.22 Planted/cultivated	4.221 Fallow/Bare Fields		
			4.222 Small Grains	4.2221 Irrigated small grains	
			4.223 Row Crops	4.2231 Irrigated row crops	
				4.2232 Sugar Cane	
			4.224 Planted grasses	4.2241 Pasture/ hay	4.22411 Irrigated Pasture/hay
				4.2242 Other grass	4.22421 Irrigated Other grass
			4.225 Irrigated Planted/ cultivated		
	4.3 Wetlands	4.31 Woody wetlands			
		4.32 Emergent wetlands			

Classification Definitions

1.0 WATER - area covered by water, snow, or ice with less than 25% vegetated or developed cover, unless specifically included in another category

1.1 Open Water - all areas of open water with less than 25% vegetative or developed cover

1.11 Stream/river - a natural body of flowing water. Includes streams and rivers that have been channelized in order to control flooding or erosion or to maintain flow for navigation.

1.12 Canal/ditch - a man-made open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft. Collection should include the right of ways and associated dikes and levees.

1.121 Lined canal/ditch - a canal or ditch lined with concrete or other impervious material preventing passage of water into underlying strata

1.122 Unlined canal/ditch - a canal or ditch constructed with dirt or other porous material allowing water to drain

1.13 Lake/pond - a non-flowing, naturally-existing, body of water. Includes water impounded by natural occurrences and artificially regulated natural lakes. The delineation of a lake is based on the areal extent of water at the time the imagery was acquired.

1.14 Reservoir - any artificial body of water, unless specifically included in another category. It can lie in a natural basin or a man-constructed basin. The delineation of a reservoir is based on the areal extent of water at the time the imagery was acquired. (The water control structures are classified as Communications/Utilities)

2.0 DEVELOPED - Areas of the earth that have been improved by man. Includes all "built-up" and urban areas of the landscape. Does NOT include mining lands, croplands, or waste-disposal areas (dumps). This land use category takes precedence over a land cover category when the criteria for more than one category are met.

2.1 Residential - lands containing structures used for human habitation

2.11 Single-family Residential - Lands used for housing residents in single-family dwelling units. Includes trailer parks, mobile home parks, and entire "farmsteads" when there is a home in the complex. (If no home is in the complex, it should be classified as Agricultural Business.) Single-family residential buildings located within another category, such as military family housing, should be identified in this category.

2.12 Multi-family Residential - All lands devoted to housing more than one family on a permanent or semi-permanent basis, group living situations, and their associated grounds. Includes apartments, apartment complexes, duplexes, triplexes, attached row houses, condominiums, retirement homes, nursing homes, and residential hotels. Residential buildings located within another category, such as barracks and dormitories, should be identified in this category when possible, (except residential buildings within convents and monasteries - include these with Institutional).

2.2 Non-residential Developed - Any "developed" area or feature that is used for a purpose other than habitation.

2.21 Commercial/Light Industry - structures and associated grounds used for the sale of products and services, for business, or for light industrial activities. Includes all retail and wholesale operations. Include "industrial parks" and other features that cannot be clearly classified as either a retail service or light industry, such as heavy equipment yards, machinery repair, and junkyards.

2.211 Major Retail - This category includes shopping malls, retail "outlet centers," and "superstores" that draw clientele from a regional area. Major retail centers consist of extremely large single buildings or a complex of large buildings and their parking lots. Malls usually house one or two major department stores and numerous

small retail stores. Includes outlet centers, “superstores”, multi-plex movie theaters, and huge warehouse-type stores. The structures themselves are often several acres in size and have extensive parking lots.

2.212 Mixed/Minor Retail and Services - Includes individual stores and services of various sizes and associated grounds and parking. Includes neighborhood strip malls and shopping centers, veterinarian services, small movie theaters, gas stations and auto repair shops, garden centers, motels, small auto dealerships, public parking lots, lumber yards, art galleries, farm supply stores, flea-markets, bars and restaurants, grocery stores, and commercial “truck stops”. Many small office buildings will have no features to distinguish them from retail stores and will fall in this category.

2.213 Office - structures and their associated grounds and parking, that provide financial, professional, administrative, and informational type services. Includes administrative government offices (e.g., IRS and State Motor Vehicles offices) trade schools, professional medical office complexes, research facilities/centers, and banks. Usually only office buildings in office complexes or in downtown areas will be distinguishable as offices. Small, single-story office buildings may blend in with minor retail.

2.214 Light industry - structures and their associated grounds and facilities that are used primarily to produce or process some finished product; or as a wholesale distribution center. Activities include design, assembly, finishing, packaging, warehousing or shipping of products rather than processing raw materials. The materials used in light industry have generally been processed at least once. They are generally “clean” industries that do not produce lots of waste materials. Use this category as a default for those facilities with semi-truck and trailer activity around loading docks, but that cannot be classified as either retail services or heavy industry. Includes electronic firms, clothing and furniture manufacture, grain elevators, printing plants, commercial bakeries, shipping and distribution centers, sand/gravel sorting facilities, secondary buildings associated with a mining or quarrying site, and generic warehouses.

2.22 Heavy Industry - structures and their associated grounds used for heavy fabrication, manufacturing and assembling parts that are, in themselves, large and heavy; or for processing raw materials such as iron ore, timber, and animal products. Accumulated raw materials are subject to treatment by mechanical, chemical, or heat processing to render them suitable for further processing, or to produce materials from that finished products are created. Heavy industries generally require large amounts of energy and raw materials and produce a significant amount of waste products. Indicators of heavy industry may be stockpiles of raw materials, energy producing sources and fuels, waste disposal areas and ponds, transportation facilities capable of handling heavy materials, smokestacks, furnaces, tanks, and extremely large buildings that are complex in outline and roof structure. Include associated waste piles and waste ponds. Heavy industry is usually located away from residential areas. Includes steel mills, paper mills, lumber mills, cotton gins, chemical plants, cement and brick plants, smelters, rock crushing machinery, and ore-processing facilities associated with mining.

2.23 Communications and Utilities - structures or facilities and associated grounds

used for the generation of power and communications, the treatment or storage of drinking water, waste management, flood control, or the distribution and storage of gas and oil not associated with a unique feature. Includes pumping stations (oil, gas, or water), tank farms, power plants, electric substations, sewage treatment facilities and ponds, garbage collection facilities (not the final dumping ground - these are included in Bare), dams, levees, and spillways of appropriate dimensions, filtration plants, and heavy concentrations of antennas or satellite dishes; along with the related operational buildings.

2.24 Institutional - specialized government or private features that meet the educational, religious, medical, governmental, protective, and correctional needs of the public. Parking lots and associated grounds are included with these features. Includes public and private schools (not day care), state capitols, city halls, courthouses, libraries, churches, convents, monasteries, hospitals and training hospitals, post offices, police and fire departments, prisons, and military bases. Only the military-business areas of a military base are classified here; residential, airport, athletic fields, and vegetated areas are classified in the appropriate category.

2.241 Schools/Universities - public and private schools, seminaries, university campuses, and associated lands. Include the entire "core campus" area, along with athletic fields and vegetated areas. This category does not include day care centers or commercial trade schools, both of that are commercial uses.

2.242 Cemeteries - structures and lands devoted to burial of the dead. Includes mausoleums, service areas, and parking lots.

2.25 Agricultural Business - structures and all associated grounds used for raising plants or animals for food or fiber. Includes fish farms and hatcheries, feedlots, poultry farms, dairy farms, temporary shipping and holding pens, animal breeding or training facilities, and greenhouses. (Farmsteads including a dwelling are classified as residential, not agricultural business.)

2.251 Aquiculture site - a set of pools of water and related structures used for producing fish, shellfish, or aquatic plants

2.252 Confined feeding operation - structures and associated pens, storage facilities, waste areas, and ponds that are used for raising meat and dairy cattle, hogs, poultry, or other animals. These features must have a relatively permanent and high animal population density. Temporary holding pens and thoroughbred horse farms usually do not qualify.

2.26 Transportation - Roads, railroads, airports, port facilities, and their associated lands. Roads and railroads include the right-of-way, interchanges, and median strips. Category includes railroad stations, railroad yards, bus stations, highway maintenance yards, school bus parking and service yards, and park-and-ride lots. Port facilities include loading and unloading facilities, docks, locks and, temporary storage areas. Associated warehousing and transfer stations for truck or rail are included only if they appear to be an integral part of the airport or port facility. Nearby but separate warehouses will be classified as light industry.

2.27 Entertainment and Recreational - areas and structures used predominantly for athletic or artistic events, or for leisure activities, and all associated lands and developed parking areas. Includes outdoor amphitheaters, drive-in theaters, campgrounds, zoos,

sports arenas (including indoor arenas), developed parks and playgrounds, community recreation centers, museums, amusement parks, public swimming pools, fairgrounds, and ski complexes (not the ski slopes). Marinas with over 25% of water surface covered by docks and boats are included here.

2.271 Golf Course - structures, associated grounds, driving ranges, and interspersed natural areas used for the game of golf.

2.272 Urban Parks - designated open space in urban settings used for outdoor recreation. Include grass fields and associated structures, parking lots, and facilities. Includes city parks, "green-belt" urban parks, and athletic fields not associated with a school. Does not include undeveloped "open space" on the periphery of urban areas or undeveloped regional, state, or national park areas.

2.3 Mixed Urban - developed areas that have such a mixture of residential and non-residential features where no single feature meets the minimum mapping unit specification. This category is used when more than one-third of the features in an area do not fit into a single category. Often applicable in the central, urban-core area of cities.

3.0 BARE - undeveloped areas of the earth not covered by water that exhibit less than 25% vegetative cover or less than 5% vegetative cover if in an arid area. The earth's surface may be composed of bare soil, rock, sand, gravel, salt deposits, or mud.

3.1 Transitional Bare - areas dynamically changing from one land cover/land use to another, often because of land use activities. Includes all construction areas, areas transitioning between forest and agricultural land, and urban renewal areas that are in a state of transition.

3.2 Quarries/Strip Mines/Gravel Pits - areas of extractive mining activities with significant surface disturbance. Vegetative cover and overburden are removed for the extraction of deposits such as coal, iron ore, limestone, copper, sand and gravel, or building and decorative stone. Current mining activity does not need to be identifiable. Inactive or unreclaimed mines and pits are included in this category until another land cover or land use has been established. Includes strip mines, open-pit mines, quarries, borrow pits, oil and gas drilling sites, and gravel pits with their associated structures, waste dumps, and stockpiles.

3.3 Bare Rock/Sand - includes bare bedrock, natural sand beaches, sand bars, deserts, desert pavement, scarps, talus, slides, lava, and glacial debris.

3.4 Flats - A level landform composed of unconsolidated sediments of mud, sand, gravel, or salt deposits. Includes coastal tidal flats and interior desert basin flats and playas.

3.5 Disposal - designated areas where refuse is dumped or exists, such as landfills, trash dumps, or hazardous-waste disposal sites. Reclaimed disposal areas or those covered with vegetation do not qualify.

4.0 VEGETATED - areas having generally 25% or more of the land or water with vegetation. Arid or semi-arid areas may have as little as 5% vegetation cover.

4.1 Woody Vegetation - land with at least 25% tree and (or) shrub canopy cover

4.11 Forested - land where trees form at least 25% of the canopy cover

4.111 Deciduous Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that loose all their leaves for a specific season of the year.

4.112 Evergreen Forest - area dominated by trees where 75% or more of the canopy cover can be determined to be trees that maintain their leaves all year.

4.113 Mixed Forest - areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the canopy cover.

4.12 Shrub land - areas where trees have less than 25% canopy cover and the existing vegetation is dominated by plants that have persistent woody stems, a relatively low growth habit, and that generally produce several basal shoots instead of a single shoot. Includes true shrubs, trees that are small or stunted because of environmental conditions, desert scrub, and chaparral. In the eastern US, include former cropland or pasture lands that are now covered by brush to the extent that they are no longer identifiable or usable as cropland or pasture. Clear-cut areas will exhibit a stage of shrub cover during the regrowth cycle. Some common species that would be classified as shrub land are mountain mahogany, sagebrush, and scrub oaks.

4.121 Deciduous Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that loose all their leaves for a specific season of the year

4.122 Evergreen Shrub land - areas where 75% or more of the land cover can be determined to be shrubs that keep their leaves year round.

4.123 Mixed Shrub land - areas dominated by shrubs where neither deciduous nor evergreen species represent more than 75% of the land cover

4.124 Desert Scrub - land areas predominantly in arid and semi-arid portions of the southwestern U.S. Existing vegetation is sparse and often covers only 5-25% of the land. Example species include sagebrush, creosote, saltbush, black greasewood, and cactus.

4.13 Planted/Cultivated Woody (Orchards/Vineyards/Groves) - areas containing plantings of evenly spaced trees, shrubs, bushes, or other cultivated climbing plants usually supported and arranged evenly in rows. Includes orchards, groves, vineyards, cranberry bogs, berry vines, and hops. Includes tree plantations planted for the production of fruit, nuts, Christmas tree farms, and commercial tree nurseries. Exclude pine plantations and other lumber or pulp wood plantings that will be classified as Forest.

4.131 Irrigated Planted/Cultivated Woody - orchards, groves, or vineyards where a visible irrigation system is in place to supply water

4.14 Mixed Forest/Shrub – areas dominated by forest and shrub where neither species represent more than 75 % of the canopy cover.

4.2 Herbaceous Vegetation - areas dominated by non-woody plants such as grasses, forbs, ferns and weeds, either native, naturalized, or planted. Trees must account for less than 25% canopy cover while herbaceous plants dominate all existing vegetation.

4.21 Natural Herbaceous - areas dominated by native or naturalized grasses, forbs, ferns and weeds. It can be managed, maintained, or improved for ecological purposes such as weed/brush control or soil erosion. Includes vegetated vacant lots and areas where it cannot be determined whether the vegetation was planted or cultivated such as in areas of dispersed grazing by feral or domesticated animals. Includes landscapes dominated by grass-like plants such as bunch grasses, Palouse grass, palmetto prairie areas, and tundra vegetation, as well as true prairie grasses.

4.211 Natural Grasslands - natural areas dominated by true grasses. Includes

undisturbed tall-grass and short-grass prairie in the Great Plains of the U.S.

4.22 Planted/Cultivated Herbaceous - areas of herbaceous vegetation planted and/or cultivated by humans for agronomic purposes in developed settings. The majority of vegetation in these areas is planted and/or maintained for the production of food, feed, fiber, pasture, or seed. Temporarily flooded are included in this category. Do not include harvested areas of naturally occurring plants such as wild rice and cattails.

4.221 Fallow/Bare Fields - areas within planted or cultivated regions that have been tilled or plowed and do not exhibit any visible vegetation cover

4.222 Small Grains - areas used for the production of grain crops such as wheat, oats, barley, graham, and rice. Category is difficult to distinguish from cultivated grasses grown for hay and pasture. Indicators of small grains may be a less than 10% slope, annual plowing and seeding, distinctive field patterns and sizes, different timing of green-up and harvest, different harvesting practices, a very "even" texture and tone, or regional variations discovered during field checks.

4.223 Row Crops - areas used for the production of crops or plants such as corn, soybeans, vegetables, tobacco, flowers and cotton. Fields that exhibit characteristics similar to row crops, but that do not have any other distinguishing features for a more specific category may be included.

4.2231 Irrigated Row Crops - areas used for the production of row crops where a visible irrigation system is in place to supply water

4.224 Cultivated grasses - areas of herbaceous vegetation, including perennial grasses, legumes, or grass-legume mixtures that are planted by humans and used for erosion control, for seed or hay crops, for grazing animals, or for landscaping purposes

4.2241 Pasture/Hay - areas of cultivated perennial grasses and/or legumes (e.g., alfalfa) used for grazing livestock or for seed or hay crops. Pasturelands can have a wide range of cultivation levels. It can be managed by seeding, fertilizing, application of herbicides, plowing, mowing, or baling. Pastureland has often been cleared of trees and shrubs, is generally on steeper slopes than cropland, is intended to graze animals at a higher density than open rangeland, and is often fenced and divided into smaller parcels than rangeland or cropland. Hay fields may be more mottled than small grain fields as they are not plowed annually and may be harvested and baled two or three times a year in some locations.

4.22411 Irrigated Pasture/Hay - areas used as pasture or hay fields where a visible irrigation system is in place to supply water

4.2242 Other planted grasses - areas of other cultivated grass such as turf and sod farms.

4.22421 Irrigated other grasses - areas of other cultivated grasses where a visible irrigation system is in place to supply water

4.225 Irrigated Planted Herbaceous - land that is growing some indistinguishable crop or grass, but is obviously irrigated

4.3 Vegetated Wetland - areas where the water table is at, near, or above the land surface for a significant part of most years and vegetation indicative of this covers more than 25% of the land surface. Wetlands can include marshes, swamps situated on the shallow margins of

bays, lakes, ponds, streams, or reservoirs; wet meadows or perched bogs in high mountain valleys, or seasonally wet or flooded low spots or basins. Do not include agricultural land that is flooded for cultivation purposes.

4.31 Woody Wetland - areas dominated by woody vegetation. Includes seasonally flooded bottomland, mangrove swamps, shrub swamps, and wooded swamps including those around bogs. Wooded swamps and southern flood plains contain primarily cypress, tupelo, oaks, and red maple. Central and northern flood plains are dominated by cottonwoods, ash, alder, and willow. Flood plains of the Southwest may be dominated by mesquite, saltcedar, seepwillow, and arrowweed. Northern bogs typically contain tamarack or larch, black spruce, and heath shrubs. Shrub swamp vegetation includes alder, willow, and buttonbush.

4.32 Emergent Herbaceous Wetlands - areas dominated by wetland herbaceous vegetation that is present for most of the growing season. Includes fresh-water, brackish-water, and salt-water marshes, tidal marshes, mountain meadows, wet prairies, and open bogs.

Appendix J

Map Class Descriptions for Pipe Spring National Monument

Introduction

This document provides a visual guide and description of the map classes created for the Pipe spring National Monument Vegetation Mapping Project. Twelve natural vegetation, eight introduced vegetation and six developed land use map classes were delineated and are described in this guide. Each of the map classes associated with this project is documented by:

- ground photographs (if available)
- a list of component NVC associations and ecological systems
- common plant species
- a description of the ecology and distribution of the map class throughout the Monument
- polygon statistics report (polygon number, size, area and proportion)

This guide does not attempt to show all variations within each vegetation map class; only the most common or significant representations are included. These should be sufficient to give the user a feel for the imagery and an understanding of the relationships between the vegetation classification and mapping.

Map Class 10
Fremont Cottonwood Woodland
(L-COTT)

Photo credit: NCPNS

L-COTT Map Class Statistics

Type	Alliance
Frequency	Project polygons = 3
Area	Project area = 0.68 ha / 1.68 acres
Average Size	Project polygons = 0.23 ha / 0.56 acres
Proportion	1.9% of mapping area

Ecological System
Not assigned

Associations
Populus fremontii Temporarily Flooded Forest Alliance [A.313]

Common species
Populus fremontii

Distribution/Ecology/Composition
Fremont cottonwood trees have been planted for shade and screening around the housing area in the southern part of the Monument as well as along a diversion ditch that drains the east side of the Monument. Although Fremont cottonwood (*Populus fremontii*) is native to this area, the existing trees were planted and therefore this is considered a land cover map class. The trees in the housing area are approaching maturity; those along the diversion ditch are still growing.

Map Class 11
Tree-of-Heaven Woodland
(L-HEAV)

L-HEAV Map Class Statistics

Type	Alliance
Frequency	Project polygons = 1
Area	Project area = 0.13 ha / 0.32 acres
Average Size	Project polygons = 0.13 ha / 0.32 acres
Proportion	0.4% of mapping area

Ecological System
Not assigned

Associations
No NVC associations

Common species
Ailanthus altissima

Distribution/Ecology/Composition
Tree-of-Heaven (*Ailanthus altissima*) is an undesirable exotic tree that nonetheless grows quickly and provides shade. It was originally planted in the housing area; it is spreading by root suckers and could become a management issue as it will certainly spread into irrigated areas such as the orchard.

Map Class 12
Black Locust Woodland
(L-LOCU)

Photo credit: NPS

L-LOCU Map Class Statistics

Type	Alliance
Frequency	Project polygons = 2
Area	Project area = 0.08 ha / 0.2 acres
Average Size	Project polygons = 0.04 ha / 0.1 acres
Proportion	0.2% of mapping area

Ecological System
Not assigned

Associations
No NVC associations

Common species
Robinia pseudoacacia

Distribution/Ecology/Composition
Black locust (*Robinia pseudoacacia*) was planted as a shade tree. This is normally a long-lived species that has not established well at PISP; many of the current generation of trees are dead or dying.

Map Class 13
Siberian Elm Woodland
(L-SELM)

Photo credits: NPS

L-SELM Map Class Statistics

Type	Alliance
Frequency	Project polygons = 1
Area	Project area = 0.11 ha / 0.27 acres
Average Size	Project polygons = 0.11 ha / 0.27 acres
Proportion	0.3% of mapping area

Ecological System
Not assigned

Associations

No NVC associations

Common species

Ulmus pumila

Distribution/Ecology/Composition

These trees, planted near Winsor Castle for shade, are showing signs of environmental stress, dropping their leaves before the end of the growing season. Because the trees are growing adjacent to Winsor Castle, there generally is no understory except beaten dirt.

Map Class 14
White and Black Poplar Woodland
(L-POPL)

Photo credit: NPS

L-POPL Map Class Statistics

Type	Alliance
Frequency	Project polygons = 1
Area	Project area = 0.31 ha / 0.76 acres
Average Size	Project polygons = 0.31 ha / 0.76 acres
Proportion	0.9% of mapping area

Ecological System
Not assigned

Associations
No NVC associations

Common species

Populus alba *Populus nigra*

Distribution/Ecology/Composition

This map class represents trees planted around Winsor Castle and the adjacent ponds for shade that are now nearing the end of their life span.

Map Class 21
Pinyon-Juniper / Scrub Oak-Bitterbrush Woodland (W-PJQT)

Photo credit: NCPN

W-PJQT Map Class Statistics

Type	Association
Frequency	Project polygons = 2
Area	Project area = 4.46 ha / 11.03 acres
Average Size	Project polygons = 2.23 ha / 5.5 acres
Proportion	12.6% of mapping area

Ecological System
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations
Pinus edulis - Juniperus osteosperma / Quercus turbinella Woodland [CEGL004007]

Common species

Pinus edulis
Quercus turbinella
Purshia stansburiana
Shepherdia rotundifolia
Juniperus osteosperma
Amelanchier utahensis
Yucca spp.
Rhus trilobata

Distribution/Ecology/Composition
This is the dominant woodland on the Navajo Sandstone mesa top. Trees root in cracks in the bedrock. Sonoran scrub oak is the most consistent species in the understory, but may share

dominance in any given spot with Utah serviceberry, bitterbrush, and roundleaf buffaloberry. This is one of the few parts of the Monument that retains a presettlement feeling; there is little evidence of human disturbance other than the cutting of a few Utah junipers for fence posts. The density of vegetation is limited by the availability of rooting sites in cracks in the sandstone. In many places the vegetation has the appearance of a wooded shrubland, with dwarfed trees scarcely exceeding some of the shrubs in height.

Map Class 22
Juniper / Baltic Rush Woodland
(W-JUBR)

Photo credit: NPS

W-JUBR Map Class Statistics

Type	Association
Frequency	Project polygons = 2
Area	Project area = 0.43 ha / 1.05 acres
Average Size	Project polygons = 0.21 ha / 0.52 acres
Proportion	1.2% of mapping area

Ecological System
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Associations
No NVC association

Common species
Juniperus osteosperma *Juncus balticus*

Distribution/Ecology/Composition
This unusual community occurs along the Sevier Fault spring line north of the Fort. Scattered very large Utah juniper have an understory of mesic species, among which Baltic rush is prominent. This community has the appearance of one where the spring has dried, but the existing vegetation is capable to access the water table.

Map Class 23
Juniper / Saltbush Woodland
(W-JUSB)

Photo credit: NPS

W-JUSB Map Class Statistics

Type	Complex
Frequency	Project polygons = 6
Area	Project area = 1.59 ha / 3.93 acres
Average Size	Project polygons = 0.27 ha / 0.66 acres
Proportion	4.5% of mapping area

Ecological System
Colorado Plateau Pinyon-Juniper Woodland (CES304.767)

Association
No NVC association

Common species
Juniperus osteosperma *Atriplex canescens*
Bromus tectorum

Distribution/Ecology/Composition
This map class represents areas where Utah junipers occupying rocky slopes to the west are invading the saltbush shrubland on the valley floor. Trees are young and scattered, and a number of seedings are present.

Map Class 31
Fourwing Saltbush Shrubland
(S-FWSB)

Photo credit: NCPN

S-FWSB Map Class Statistics

Type	Association
Frequency	Project polygons = 11
Area	Project area = 16.3 ha / 40.2 acres
Average Size	Project polygons = 1.5 ha / 3.7 acres
Proportion	46% of mapping area

Ecological System
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

Associations
Atriplex canescens Shrubland [CEGL001281]

Common species
Atriplex canescens

Distribution/Ecology/Composition
This is the most widespread and abundant map class within the Monument occupying most of the lowland plains that are not developed. Shrub cover is consistently between 15 and 25%, but the understory varies significantly. Many stands reflect chronic severe disturbance in that the herbaceous layer consists mostly of exotic annual grasses and forbs. Other stands have a low but consistent cover of native grasses such as needle-and-thread or galleta as the result of restoration efforts dating to the 1970s. Juniper trees are becoming established in stands in the northeastern corner of the Monument, as documented by map class W-JUSB (#23).

Map Class 32
Sand Sagebrush Shrubland
(S-SASA)

Photo credits: NPS

S-SASA Map Class Statistics

Type	Association
Frequency	Project polygons = 6
Area	Project area = 1.12 ha / 2.76 acres
Average Size	Project polygons = 0.19 ha / 0.46 acres
Proportion	3.2% of mapping area

Ecological System

Southern Colorado Plateau Sand Shrubland (CES304.793)

Associations

Artemisia filifolia Colorado Plateau Shrubland [CEGL002697]

Common species

Artemisia filifolia *Ericameria nauseosa*

Distribution/Ecology/Composition

The canopy of this shrubland is dominated by native species, but understory has largely been removed by grazing and replaced by exotic annual grasses and forbs. Stands range from open to relatively dense, and are restricted to deep sandy soils associated with the drainage that cuts the east side of the Monument. Water that formerly flowed in this natural drainage is now diverted into a drainage ditch, thereby removing the means by which sand eroded from the Monument could be replaced. As wind redistributes fine-textured material over the sand, this community may eventually give way to fourwing saltbush (see map class 33).

Map Class 33
Fourwing Saltbush – Sand Sagebrush Shrubland
(S-FWSS)

Photo credit: NCPN

S-FWSS Map Class Statistics

Type	Alliance
Frequency	Project polygons = 1
Area	Project area = 0.19 ha / 0.47 acres
Average Size	Project polygons = 0.19 ha / 0.47 acres
Proportion	0.5% of mapping area

Ecological System

Southern Colorado Plateau Sand Shrubland (CES304.793)

Associations

Artemisia filifolia Colorado Plateau Shrubland [CEGL002697]

Common species

Atriplex canescens *Artemisia filifolia*

Distribution/Ecology/Composition

This community represents a mixing zone where both sand sagebrush and saltbush are present but neither is a consistent dominant. This situation largely reflects the underlying soils, which are sandy alluvium covered by a veneer of finer-textured, wind-blown, alkaline loess.

Map Class 34
Basin Big Sagebrush – Fourwing Saltbush Shrubland (S-ATFW)

Photo credit: NPS

S-ATFW Map Class Statistics

Type	Complex
Frequency	Project polygons = 2
Area	Project area = 0.32 ha / 0.78 acres
Average Size	Project polygons = 0.16 ha / 0.39 acres
Proportion	0.9% of mapping area

Ecological System
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

Associations
Atriplex canescens - *Artemisia tridentata Shrubland* [CEGL001282]

Common species
Artemisia tridentata ssp. *tridentata* *Atriplex canescens*

Distribution/Ecology/Composition
Basin big sagebrush is unusual in this area. Its presence suggests soil conditions that are less alkaline than those supporting fourwing saltbush and slightly less well-drained than those supporting sand sagebrush.

Map Class 35
Fourwing Saltbush – Rabbitbrush Degraded Shrubland (S-FWRR)

Photo credit: NCPN

S-FWRR Map Class Statistics

Type	Association
Frequency	Project polygons = 6
Area	Project area = 3.82 ha / 9.43 acres
Average Size	Project polygons = 0.64 ha / 1.6 acres
Proportion	10.8% of mapping area

Ecological System
Inter-Mountain Basins Mixed Salt Desert Scrub (CES304.784)

Association
Atriplex canescens Shrubland [CEGL001281]

Common species
Atriplex canescens
Artemisia filifolia
Chrysothamnus viscidiflorus
Gutierrezia sarothrae

Distribution/Ecology/Composition
This community represents the most degraded sites; larger fourwing saltbush shrubs are scattered, there is high cover by rabbitbrush and snakeweed, and high cover of bare ground and exotic annual herbaceous species.

Map Class 41
Coyote Willow Shrubland
(S-WILL)

Photo credit: NPS

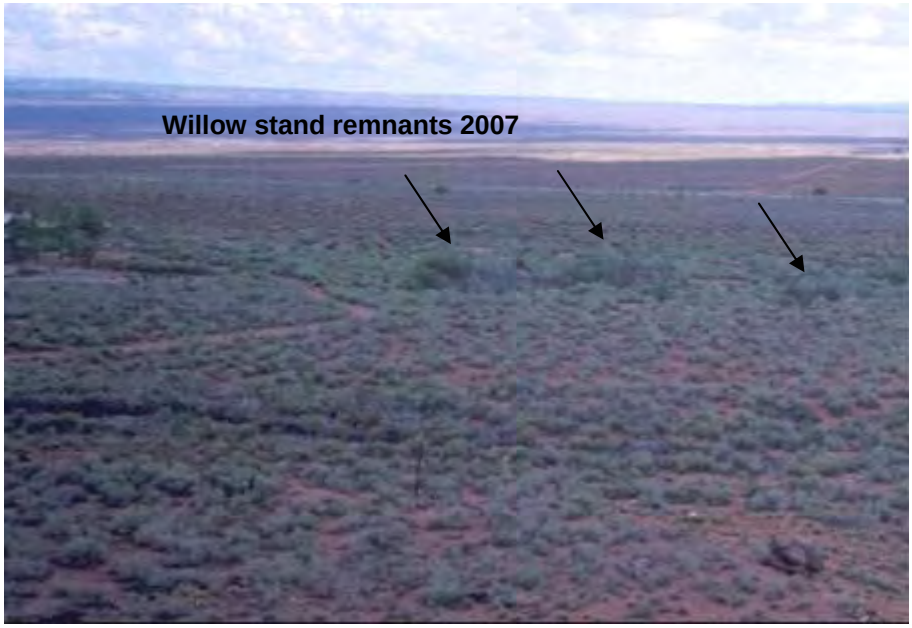


Photo credit: NCPN

Photo credit: NCPN

S-WILL Map Class Statistics

Type	Association
Frequency	Project polygons = 1
Area	Project area = 0.2 ha / 0.48 acres
Average Size	Project polygons = 0.2 ha / 0.48 acres
Proportion	0.6% of mapping area

Ecological System

Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland (CES306.821)

Association

Salix (exigua, interior) Temporarily Flooded Shrubland Alliance [A.947]

Common species

Salix exigua

Glycyrrhiza lepidota

Distribution/Ecology/Composition

This map class consists of a stand of coyote willow shrubs in the southwest corner of the Monument. The stand was maintained by spring flow and runoff; recent lowering of the water table has caused large parts of the stand to die, leaving scattered remnant clumps of coyote willows that show no sign of vegetative reproduction. The understory of this stand consists of weedy forbs, including wild licorice and horehound.

Map Class 42
Rubber Rabbitbrush Shrubland
(S-RURA)

Photo credit: NPS

S-RURA Map Class Statistics

Type	Association
Frequency	Project polygons = 1
Area	Project area = 0.23 ha / 0.56 acres
Average Size	Project polygons = 0.23 ha / 0.56 acres
Proportion	0.6% of mapping area

Ecological System
Inter-Mountain Basins Wash (CES304.781)

Association
Ericameria nauseosa Shrubland Alliance [A.835]

Common species
Ericameria nauseosa
Iva axillaris
Juncus balticus
Mentha arvensis

Distribution/Ecology/Composition
One example of this community occupies the banks of a drainage flowing along the base of the escarpment southwest of the Fort. The drainage carries runoff from West Cabin Spring, although flows are now intermittent with recent lowering of the water table. Historic photos from the early 20th century show a row of trees lining the drainage; a photo from the 1930s shows that the drainage was channelized, bridged, and without woody vegetation. The current understory includes Baltic rush, field mint, and povertyweed.

Map Class 43
Edible Berry Shrubland
(L-BERR)

L-BERR Map Class Statistics

Type	Mosaic
Frequency	Project polygons = 2
Area	Project area = 0.14 ha / 0.34 acres
Average Size	Project polygons = 0.07 ha / 0.17 acres
Proportion	0.4% of mapping area

Ecological System
Not assigned

Association
Prunus virginiana - (Prunus americana) Shrubland [GECL001108]

Common species
Prunus americana *Ribes aureum*

Distribution/Ecology/Composition
This land-use map class represents plantings of American plum and golden currant adjacent to the housing area, the picnic area, and the orchard. It was not sampled, as stands were too small to contain a standard vegetation plot.

Map Class 44
Black Greasewood Shrubland
(S-BLGR)

Photo credit: NCPN

S-BLGR Map Class Statistics

Type	Mosaic
Frequency	Project polygons = 1
Area	Project area = 0. ha / 0. acres
Average Size	Project polygons = 0. ha / 0. acres
Proportion	0.% of mapping area

Ecological System
Inter-Mountain Basins Greasewood Flat (CES304.780)

Association
Sarcobatus vermiculatus Disturbed Shrubland [GECL001357]

Common species
Sarcobatus vermiculatus *Opuntia phaeacantha*

Distribution/Ecology/Composition
This map class represents a community normally found on floodplains with a perched water table, but here occurring on a rocky slope where groundwater emerges along the Sevier Fault. Black greasewood dominates the relatively closed shrub canopy, with scattered fourwing saltbush and rabbitbrush. The dwarf shrubs *Opuntia phaeacantha* and *Gutierrezia sarothrae* characterize the dwarf shrubs in the community. Most of the unvegetated surface is bare soil.

Map Class 51
James Galleta Grassland
(H-GALL)

Photo credit: NCPN

H-GALL Map Class Statistics

Type	Association
Frequency	Project polygons = 2
Area	Project area = 1.90 ha / 4.70 acres
Average Size	Project polygons = 0.95 ha / 2.35 acres
Proportion	5.4% of mapping area

Ecological System
Inter-Mountain Basins Semi-Desert Grassland (CES304.787)

Association
Pleuraphis jamesii Herbaceous Vegetation [CEGL001777]

Common species
Pleuraphis jamesii
Achnatherum speciosum
Artemisia bigelovii
Eriogonum corymbosum

Distribution/Ecology/Composition
This map class is restricted to the south-facing slope of the escarpment in the northwest corner of the Monument. The hot southern exposure and shale substrate favor the growth of grasses over woody plants. Although galleta has the highest cover of any species, the total community cover is relatively sparse and includes scattered shrubs of Bigelow sagebrush, Mormon-tea, threeleaf sumac, and crispleaf buckwheat. The shrubs are densest at the east end of the stand near the West

Cabin, where the community is probably better characterized as a mixed colluvial slope shrubland.

Map Class 210
Corrals
(L-CORR)

L-CORR Map Class Statistics

Type	Land Use
Frequency	Project polygons = 3
Area	Project area = 0.66 ha / 1.63 acres
Average Size	Project polygons = 0.22 ha / 0.54 acres
Proportion	1.9% of mapping area

Description:

This map class represents areas within fenced corrals that are either bare ground or vegetated with nonnative species including horehound depending on how recently they were used to hold livestock. Three corrals are associated with the housing area, the maintenance area, and the Fort.

Map Class 220
Dirt Roads and Staging Areas
(L-DIRT)

L-DIRT Map Class Statistics

Type	Land Use
Frequency	Project polygons = 6
Area	Project area = 1.13 ha / 2.80 acres
Average Size	Project polygons = 0.19 ha / 0.47 acres
Proportion	3.2% of mapping area

Description:

This map class represents large areas of bare, packed dirt, including dirt roads and pullouts within the Monument as well as areas that receive high levels of foot traffic, such as around the garden and picnic area.

Map Class 230
Parking Lot
(L-PARK)

L-PARK Map Class Statistics

Type	Land Use
Frequency	Project polygons = 1
Area	Project area = 0.35 ha / 0.88 acres
Average Size	Project polygons = 0.35 ha / 0.88 acres
Proportion	1.0% of mapping area

Description:

This map class represents the paved parking lot east of the Visitor Center, including landscaped islands within the parking lot.

Map Class 240
Dumpster Area
(L-DUMP)

L-DUMP Map Class Statistics

Type	Land Use
Frequency	Project polygons = 1
Area	Project area = 0.04 ha / 0.10 acres
Average Size	Project polygons = 0.04 ha / 0.10 acres
Proportion	0.11% of mapping area

Description:

This map class represents the cleared area south of the Visitor Center that contains the commercial-sized dumpster for the Monument.

Map Class 250
Buildings
(L-BUIL)

L-BUIL Map Class Statistics

Type	Land Use
Frequency	Project polygons = 7
Area	Project area = 0.35 ha / 0.86 acres
Average Size	Project polygons = 0.05 ha / 0.12 acres
Proportion	1.0% of mapping area

Description:

This map class includes historic and NPS structures, such as the Fort, East, and West cabins, Visitor Center, employee housing, and maintenance buildings. It is included for reference only. It is not intended to replace the survey-quality GIS layer of Monument facilities. Not all buildings are mapped.

Map Class 260
Orchard
(L-ORCH)

L-ORCH Map Class Statistics

Type	Land Use
Frequency	Project polygons = 1
Area	Project area = 0.41 ha / 1.0 acres
Average Size	Project polygons = 0.41 ha / 1.0 acres
Proportion	1.2% of mapping area

Description:

This map class represents the irrigated orchard that lies between the housing area and the picnic area. The small, dark, irregularly-sized crowns of the fruit trees are in rows.

Map Class 270
Garden
(L-GARD)

L-GARD Map Class Statistics

Type	Land Use
Frequency	Project polygons = 1
Area	Project area = 0.15 ha / 0.36 acres
Average Size	Project polygons = 0.15 ha / 0.36 acres
Proportion	0.9% of mapping area

Description:

This map class includes the fenced, irrigated garden east of Winsor Castle and north of the picnic area. Rows of cultivated herbaceous plants are clearly visible.

Map Class 310
Pipe Springs Road (Paved)
(L-ROAD)

L-ROAD Map Class Statistics

Type	Land Use
Frequency	Project polygons = 1
Area	Project area = 0.32 ha / 0.78 acres
Average Size	Project polygons = 0.32 ha / 0.78 acres
Proportion	1.7 % of mapping area

Description:

This map class includes the paved road accessing the Monument from State Highway 389. It also includes adjacent related features including pullouts, ditches, shoulders and road cuts.

Index to the Map Classes of Pipe Spring National Monument

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National Park Service
U.S. Department of the Interior

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