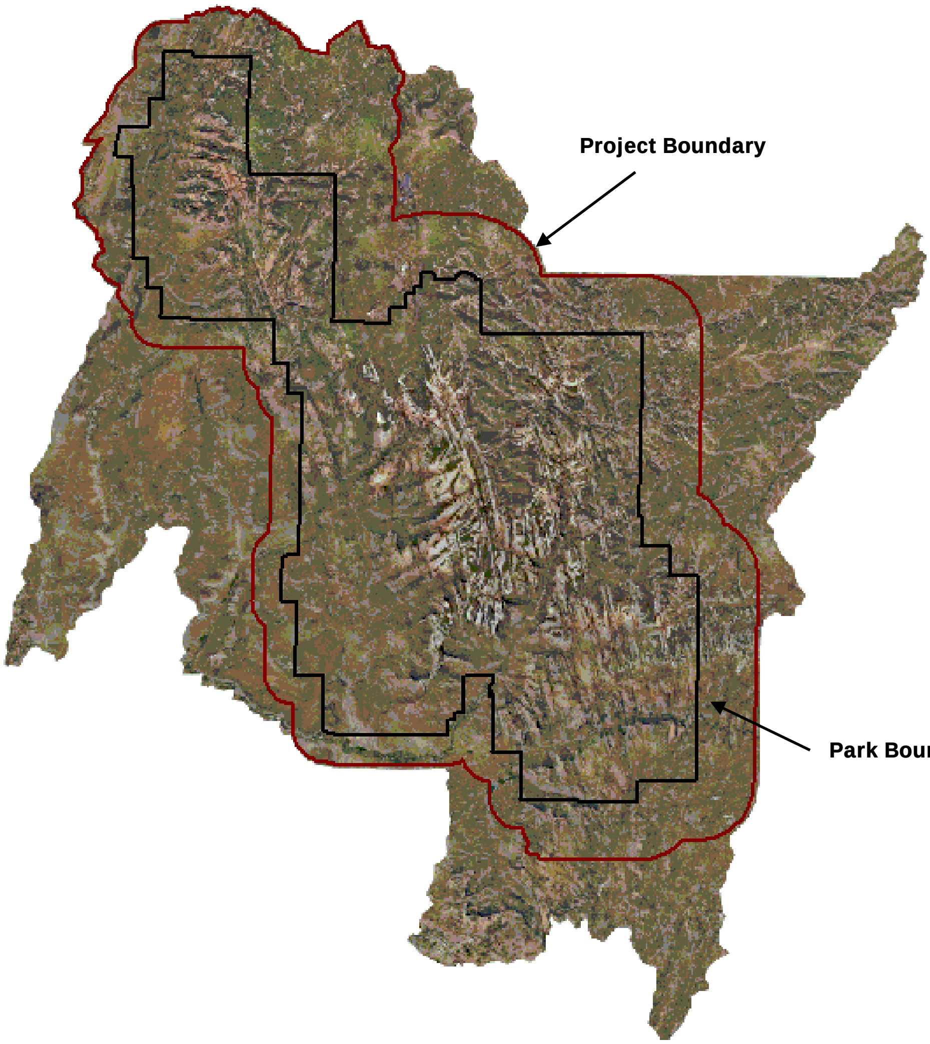
Zion National Park, Utah
1999-2003 VEGETATION MAPPING PROJECT



FINAL REPORT -- MARCH 31, 2004

WATER RESOURCES MANAGEMENT.....FOR THE FUTURE

Technical Memorandum 8260-03-01

Remote Sensing and GIS Group
Technical Service Center
Bureau of Reclamation
Denver, Colorado

USGS-NPS VEGETATION MAPPING PROGRAM

Zion National Park, Utah

Dan Cogan
Program Lead
Bureau of Reclamation
Remote Sensing and GIS Group
Denver, Colorado

Marion Reid
NVC Lead
Senior Regional Ecologist NatureServe
Boulder, CO

Keith Schulz
NVC Ecologist
Vegetation Ecologist NatureServe
Boulder, CO

Mike Pucherelli
Group Manager
Bureau of Reclamation
Remote Sensing and GIS Group
Denver, Colorado

Report Produced by:
U.S. Bureau of Reclamation
Technical Service Center
Remote Sensing and GIS Group
Mail Code D-8260 Denver Federal Center Building 56
Denver, Colorado 80225

Program Managed by:
U.S. Geological Survey
Center for Biological Informatics
Denver Federal Center, Building 810
Room 8000, MS 302
Denver, Colorado 80225-0046

In Cooperation with:

U.S. National Park Service

U.S. Geological Survey

NatureServe (formerly ABI)

This report was prepared for the U.S. National Park Service and the U.S. Geological Survey's Center for Biological Informatics by the Remote Sensing and Geographic Information Group of the Bureau of Reclamation's Technical Service Center, Denver, Colorado
Technical Memorandum No. 8260-03-01.

U.S. Department of the Interior
Mission Statement

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to tribes.

Mission of U. S. Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

The Remote Sensing and Geographic Information Group, organized in 1975, provides assistance and advice regarding the application of remote sensing and geographic information systems (GIS) technologies to meet the spatial information needs of the Bureau of Reclamation and other governmental clients.

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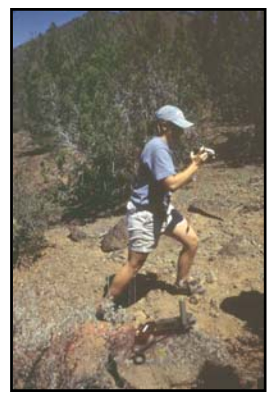
U. S. Department of the Interior
United States Geological Survey -
Biological Resources Division

Karl Brown
Program Coordinator - USGS-NPS Vegetation Mapping Program
U.S. Geological Survey
Center for Biological Informatics
P.O. Box 25046
Denver, Colorado 80225-0046
Phone (303) 202-4240
E-Mail: karl_brown@usgs.gov
Website: http://biology.usgs.gov/cbi

Contributors: Susan Stitt and Tom Owens



NatureServe

Jim Drake
Midwest Regional Office
Project Manager
1313 Fifth Street, S.E. #314
Minneapolis, Minnesota 55414
Phone: (612) 331-0729
E-Mail: jim_drake@natureserve.org

Marion Reid
Western Regional Office
Senior Regional Ecologist
2060 Broadway Suite 230
Boulder, Colorado 80302
Phone: (303) 541-0342
E-Mail: marion_reid@natureserve.org

Keith Schulz
Vegetation Ecologist
Phone: (303) 541-0356
Email: keith_schulz@natureserve.org

U. S. Department of the Interior
U.S. National Park Service

Mike Story
NPS Program Coordinator
NPS-WASO Natural Resource Information
Division I&M Program
Phone: 303-969-2746
E-mail: mike_story@nps.gov
Website:
http://biology.usgs.gov/npsveg/index.html

Jeff Bradybaugh
Research and Resource Management Supervisor
Zion National Park
SR 9
Springdale, UT 84767-1099
Phone: 435-772-0208
E-Mail: jeff_bradybaugh@nps.gov
Website: http://www.nps.gov/zion

Henry Bastian
Fire Effects, Zion Fire Program
Phone: 435-772-0193
E-mail: henry_bastian@nps.gov

Contributors: Dan Cohan, Elena Robisch, Denise Louie

U. S. Department of the Interior
Bureau of Reclamation

Michael Pucherelli
Group Manager
Remote Sensing and Geographic Information Group
Mail Code D-8260 Denver Federal Center
Building 56
Denver, Colorado 80225
Phone: (303) 445-2267
E-mail: mpucherelli@do.usbr.gov
Website: http://www.usbr.gov/tsc/rsgis

Trudy Meyer
Lead GIS Specialist
Phone: 303-445-2278
Email: tmeyer@do.usbr.gov

Dan Cogan
Program Lead
Phone: (303) 445-2291
E-mail: dcogan@do.usbr.gov

Contributors: Alan Bell, Janet Coles, Doug Crawford, Jean Pennell,

Other Contributors (Various affiliations):

Dr. Stanley Welsh
Dr. Duane Atwood
(Brigham Young University)
Jim Von Loh
Dr. William Reid
Susan Hobbs
Julie Thompson
Kelly Lewelling
Steve Chubback
Buddy Smith

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Dramatic and awe inspiring Zion National Park with its colossal sandstone cliffs, isolated towers, and deep, narrow canyons is a naturalist's dream but a mapper's nightmare. Undaunted by the task of classifying and mapping an area with what is called "the richest diversity of plants in Utah" were a top-notch team of assembled ecologists, botanists, park personnel, GIS and mapping professionals, and numerous support staff. Although a rather informal and dynamic bunch, the "Zion Veg Mapping Team" achieved their objective of classifying and mapping Zion's plant communities-- and to all of them goes my warmest heartfelt thanks.

I feel very privileged to have worked on this project with the following people and would like to personally thank them and their respective organizations for their assistance:

-Dan Cohan formerly with Zion now with the U.S. Fish and Wildlife Service, was an immense help with the GIS, GPS, and logistical support at Zion. Without Dan, the helicopter trip would never have gotten off the ground, literally.

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-Bill Reid not only helped collect plot data, but also wrote progress reports, interpreted images, took extensive notes, entered data, wrote a newspaper article and provided much-needed comic relief, all from a guy who just wanted to be a volunteer.

-Becky Morton and the dependable staff at Horizons Inc., Rapid City, SD for obtaining excellent aerial photography and imagery.

-Keith Schulz, Marion Reid, and Michael Schindel of NatureServe and The Nature Conservancy were integral to the gradsect analysis, collecting plot data, writing/reviewing this report, and creating the National Vegetation Classification System for Zion.

-Tom Owens, Karl Brown of the USGS and Mike Story with the NPS for bringing this project to the BOR and then being there for help with coordination, logistics, and financial matters.

-The entire staff of BOR RSGIS (both past and present) for so many things especially Trudy Meyer for making sense of all my line-work and Kurt Wille for his help with ArcGis and 3D graphics.

- dan.

LIST OF ABBREVIATIONS AND ACRONYMS

AA	Accuracy Assessment
AML	Arc Macro Language
BOR	Bureau of Reclamation (also USBR)
BRD	Biological Resource Division (of the USGS)
CBI	Center for Biological Informatics (of the USGS/BRD)
CIR	Color Infrared Photography
DEM	Digital Elevation Model
DLG	Digital Line Graph
DRG	Digital Raster Graphic
DOQQ	Digital Orthophoto Quarter Quadrangle
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System(s)
GPS	Global Positioning System
MMU	Minimum Mapping Unit
NPS	U.S. National Park Service
NAD	North American Datum
NBII	National Biological Information Infrastructure
NRCS	Natural Resources Conservation Service (formerly the Soil Conservation Service)
NVC	National Vegetation Classification
NVCS	National Vegetation Classification System
NWI	National Wetland Inventory
PLGR	Precision Light-Weight GPS Receiver
RSGIS	Remote Sensing and Geographic Information Group
TNC	The Nature Conservancy
USBR	United States Bureau Of Reclamation (also BOR)
USDA-SCS	U.S. Dept. Of Agriculture – Soil Conservation Service
USFS	United States Forest Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
ZION	Zion National Park

EXECUTIVE SUMMARY

Zion National Park (ZION) encompasses 229 square miles in Southwest Utah, stretching across portions of the Colorado Plateau, Great Basin, and Mojave Desert regions of the United States. Between 1999 and 2003 an ambitious project was conducted to accurately classify and map ZION's unique assemblage of plant associations. This report documents those efforts.

To complete the daunting task of mapping the diverse vegetation at ZION, a multi-year program was initiated. This consisted of two linked phases: (1) vegetation classification using the National Vegetation Classification System (NVCS) and (2) digital vegetation map production directed by NatureServe and the U.S. Bureau of Reclamation's (BOR) Remote Sensing and GIS group, respectively. To classify the vegetation, we sampled 346 representative plots located throughout the 246,452-acre (99,738 ha) project area (park + environs) during the summers of 1999 and 2000. Analysis of the plot data using ordination and clustering techniques produced 95 distinct plant associations, 44 of which were newly described at ZION.

To produce the digital map, we used a combination of 1999 1:12,000-scale true color aerial photography, 1999 1:12,000-scale true color ortho-rectified imagery, and 3 years of gound-truthing to interpret the complex patterns of vegetation and land-use at ZION. In the end, 76 map units were developed and directly cross-walked or matched to corresponding plant associations and land-use classes. All of the interpreted and remotely sensed data were converted to Geographic Information System (GIS) databases using ArcInfo© software. Draft maps created from the vegetation classification were field-tested and revised before independent ecologists conducted an assessment of the map's accuracy during 2001-2003. The accuracy assessment revealed an overall database accuracy of 82%.

Products developed for Zion National Park are described and presented in this report and are stored on the accompanying CD-Rom, these include:

- A Final Report that includes a vegetation key, accuracy assessment information, and a photo interpretation key;
- A Spatial Database containing vegetation, plots, accuracy assessment, and flight line index layers;
- Digital Photos (scanned from 35mm slides) of each vegetation type along with representative ground photos and miscellaneous Park views;
- Printable Graphics of all spatial database coverages;
- Federal Geographic Data Committee-compliant metadata for all spatial database coverages and field data.

In addition, ZION and the USGS CBI both received copies of:

- 9x9 inch Aerial Photos;
- Uncompressed Digital Orthophotos;
- Digital data files and hard copy data sheets of the observation points, vegetation field plots, and accuracy assessment sites;
- Hardcopy, paper vegetation maps.

The CD-Rom attached to this report contains text and metadata files, keys, lists, field data, spatial data, the vegetation map, graphics, and ground photos. The USGS will post this project on its website: http://biology.usgs.gov/npsveg/index.html

For more information on the NVCS and NVC associations in the U.S. please go to NatureServe's website: http://www.natureserve.org.

For more for information on other projects completed by the BOR, visit http://www.usbr.gov/tsc/rsgis.

1. INTRODUCTION

1.1 Background

USGS-NPS Park Vegetation Mapping Program

In 1994, the U.S. Geological Survey (USGS) and National Park Service (NPS) formed a partnership to map National Parks in the United States using the National Vegetation Classification System (NVCS). The goals of the USGS-NPS Vegetation Mapping Program are to provide baseline ecological data for park resource managers, create data in a regional and national context, and provide opportunities for future inventory, monitoring, and research activities (FGDC 1997, Grossman et al. 1998, http://biology.usgs.gov/npsveg/index.html).

Central to fulfilling the goals of this national program is the use of the National Vegetation Classification System (NVCS) as the standard vegetation classification system. This system:

- is vegetation based;
- uses a systematic approach to classify a continuum;
- emphasizes natural and existing vegetation;
- uses a combined physiognomic-floristic hierarchy;
- identifies vegetation units based on both qualitative and quantitative data;
- is appropriate for mapping at multiple scales.

The use of standard national vegetation classification system and mapping protocols facilitate effective resource stewardship by ensuring compatibility and widespread use of the information throughout the NPS as well as by other federal and state agencies. These vegetation maps and associated information support a wide variety of resource assessment, park management, and planning needs, and provide a structure for framing and answering critical scientific questions about vegetation communities and their relationship to environmental processes across the landscape.

The NVC has primarily been developed and implemented by The Nature Conservancy (TNC) and the network of Natural Heritage Programs over the past twenty years (Grossman et al. 1998). Currently it is maintained and updated by NatureServe (formally ABI-Association for Biological Information). Additional support has come from federal agencies, the Federal Geographic Data Committee (FGDC), and the Ecological Society of America. Refinements to the classification occur in the process of application, leading to ongoing proposed revisions that are reviewed both locally and nationally. TNC and now NatureServe has made available a 2-volume publication presenting the standardized classification, providing a thorough introduction to the classification, its structure, and the list of vegetation types found across the United States as of April 1997 (Grossman et al. 1998). This publication can be found on the Internet at: http://www.natureserve.org/publications/library.jsp.

NatureServe has since superceded Volume II of the publication (the classification listing), providing regular updates to ecological communities in the United States and Canada. This online database server, NatureServe Explorer®, can also be found on the Internet at: http://www.natureserve.org/explorer.

Zion National Park Vegetation Mapping Project

The specific decision to map the vegetation at Zion National Park (ZION) as part of the U.S. Vegetation Mapping Program was made in response to the NPS Natural Resources Inventory and Monitoring Guidelines issued in 1992. Under these guidelines, Zion was viewed as a top-priority Park based on its need for the program's vegetation map products. Driving this need was the Park's inability to spatially analyze the vegetation at a fine enough scale to accurately predict various management issues. Central to their concerns were the need for modeling the spread and intensity of fire and calculating habitat for endangered and threatened species.

In 1999 the USGS Center for Biological Informatics (CBI) kicked-off this project by asking the U.S. Bureau of Reclamation's Remote Sensing and Geographic Information Group (RSGIS) to undertake the mapping portion of this project. At this time NatureServe was also contracted to conduct both the fieldwork and classification stages. As the project progressed, other contracted and volunteer botanists, ecologists, geologists, and various Park personnel were incorporated.

NatureServe, BOR RSGIS, and the Park ultimately formed a three-part vegetation team each responsible for a specific portion of the project as outlined by CBI (**Appendix A**). NatureServe became primarily responsible for collecting standardized field samples and using them to classify ZION's vegetation types and also to conduct an accuracy assessment on the final vegetation map. RSGIS took on the role of the mapping team responsible for aerial photo interpretation and creation of a digital vegetation map. Finally ZION staff provided logistical and technical support, helped coordinate fieldwork, and reviewed and evaluated draft data.

As a team, our objectives were to produce final products consistent with the national program's mandates. These included:

- Vegetation and map unit classifications based on the National Vegetation Classification System and ZION-specific requirements;
- A spatial database of ZION's vegetation, using remote sensing and Geographic Information System (GIS) techniques;
- Digital and hard copy vegetation maps with a minimum 80% accuracy.

1.2 Scope of Work

Vegetation mapping for ZION occurred over a 246,452-acre project boundary, encompassing both the executive boundary of Zion National Park and a 1-2 mile environ radius or buffer. The final area of interest was based mainly on reconciliation between ZION's management needs (e.g. water basin boundaries), financial constraints, and reasonable time limitations. Part of the compromise involved acquiring aerial photography and ortho-imagery for a larger area surrounding ZION than would be mapped (**Figure 1**).

1.3 Zion National Park

Located in the southwestern corner of Utah, Zion National Park stretches over 148,016 acres, ranging in elevation from 3,666 ft (1,128 m) at Coalpits Wash in the southwest corner to 8,726 ft (2,660 m), at Horse Ranch Mountain in the Kolob Canyons section. The Park lies in Washington, Iron, and Kane Counties with primary access restricted to three entrances occurring in the north along Interstate 15 (Kolob Canyons), South via Utah 9 through the town of Springdale, and from the East on Utah 9 (**Figure 3** and **Figure 4**).

Zion is well known for its massive sandstone cliffs, deep canyons, arches, and monoliths such as the Alter of Sacrifice, The Narrows, The Great Arch, and The Great White Throne. The Park draws over 2 million annual visitors to the Park, primarily visiting along the main Park roads and trails (Zion National Park Website: http://www.nps.gov/zion). ZION is a relatively large national park based on 2-dimensional land area; however it is truly immense if you consider surface area or its 3-dimensional size. The magnitude of ZION is best described by reviewing its major abiotic and biotic components as follows.

Topography

Zion National Park occurs on the Colorado Plateau in the Southwest Region of the United States. John Wesley Powell first named this area the "Colorado Plateaus", and recently the Plateau has come to be understood as a 130,000 square mile basin ringed by highlands and filled with many plateaus. Subtle environmental forces including wind and water erosion have combined to carve this area's sedimentary geological layers into a series of high plateaus, narrow sandstone canyons, and isolated towers (Hamilton, 1995) (**Figure 2**).

Occurring on the western edge of the Colorado Plateau, ZION contains many distinct geologic features common to this region. Two of the more popular are Zion Canyon in the south-central region of the Park and Kolob Canyons in the northwest (**Figure 3**). Here, the down cutting of the Virgin River, LaVerkin Creek and other tributaries have created sheer canyon walls rising over 2000 feet.

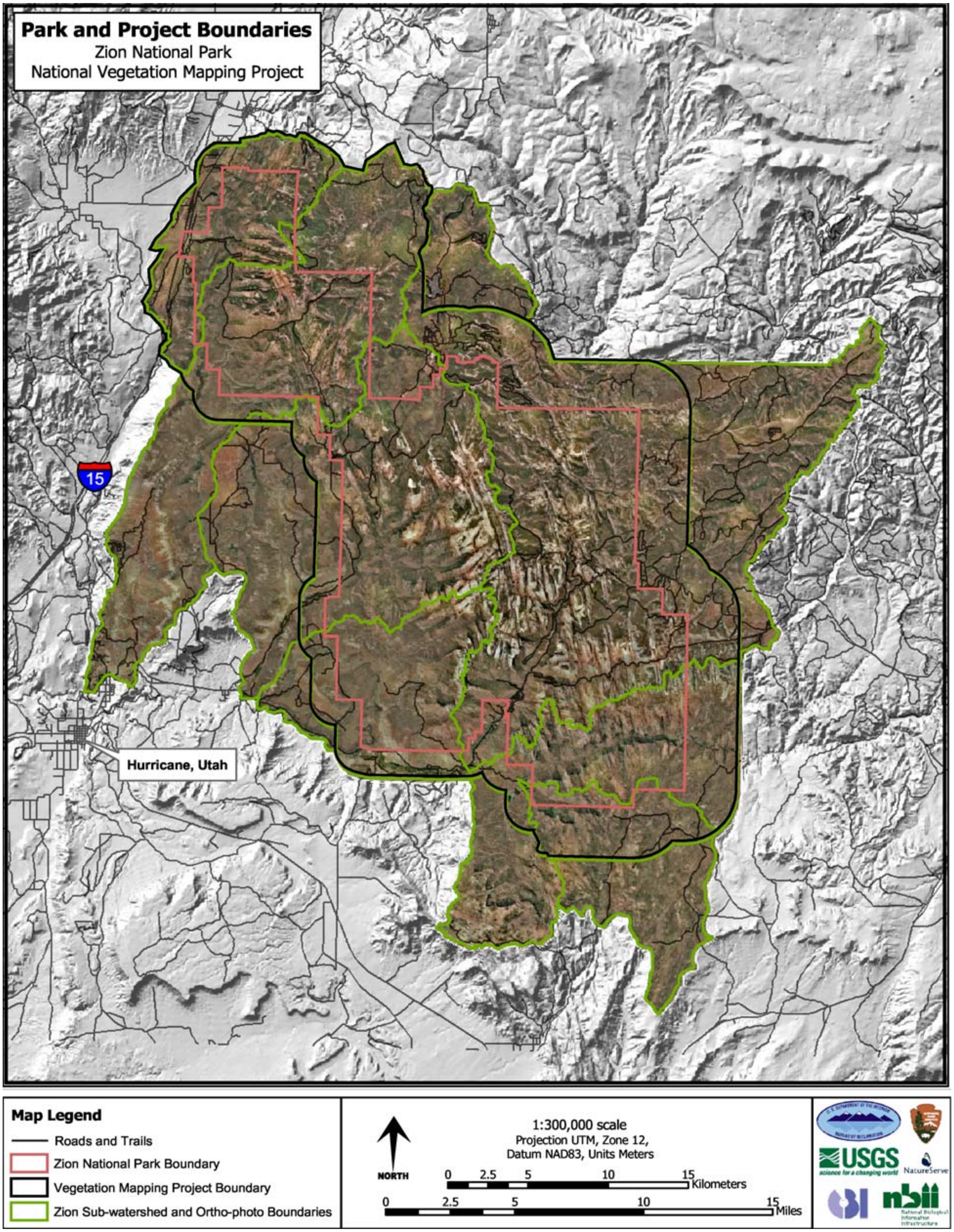


Figure 1. Vegetation Mapping Project and Park Boundaries.
(Color background image is a mosaic of the new Zion Orthophoto created for this project.)

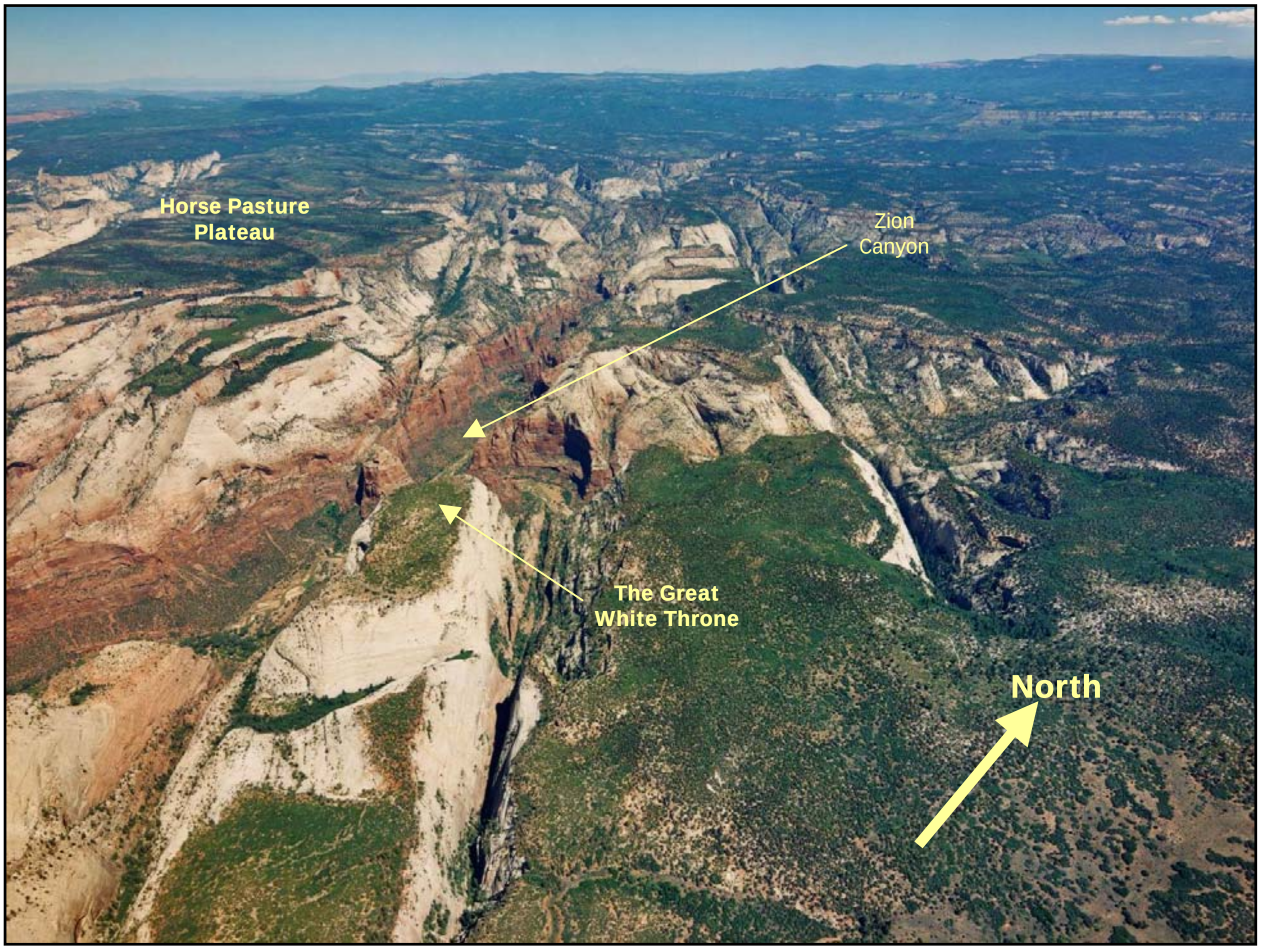


Figure 2. Oblique aerial photo of Zion National Park.
Notice the down-cutting of the Virgin River and its tributaries creating Zion Canyon, isolated towers and large plateaus.
(obtained and modified from Horizon's Inc.)

Looking at Zion by geographical sections, the South is bordered by low desert mesas intermingled with rubble-filled canyons and washes. To the North and East, ZION transitions into high plateaus covered by dense forests and tall shrublands. A mix of sandstone or slick-rock features including hoo-doos, slot canyons, and small mesas are common in the Center, and finally the West contains talus slopes covered with Pinyon–Juniper woodlands.

Geology

ZION provides a case study in identifying the nine geologic formations from the Colorado Plateau's Mesozoic era. Originally created from ancient sediments, ZION's geology has been under constant siege by erosion and volcanic events for millennia. By examining the canyon walls, one can go through time, from when this area was a vast sea, to a highly volcanic region, to an arid, sandy desert. Also apparent are the continuous processes still at work, such as wind erosion on Checkerboard Mesa, down-cutting by the Virgin River, and cinder cones and lava flows on the west side of the Park (Hamilton, 1995).

The nine major geologic formations at ZION include from oldest to youngest: Kaibab, Moenkopi, Chinle, Moenave, Kayenta, Navajo, Temple Cap, Carmel and Dakota formations. Within these formations, the Chinle is separated into the Petrified Forest and Shinarump members and the Navajo contains distinctive brown, red, and white sandstones. Also interspersed are layers of alluvium, volcanic rocks and lake, pond and slide deposits (see **Figure 5**)

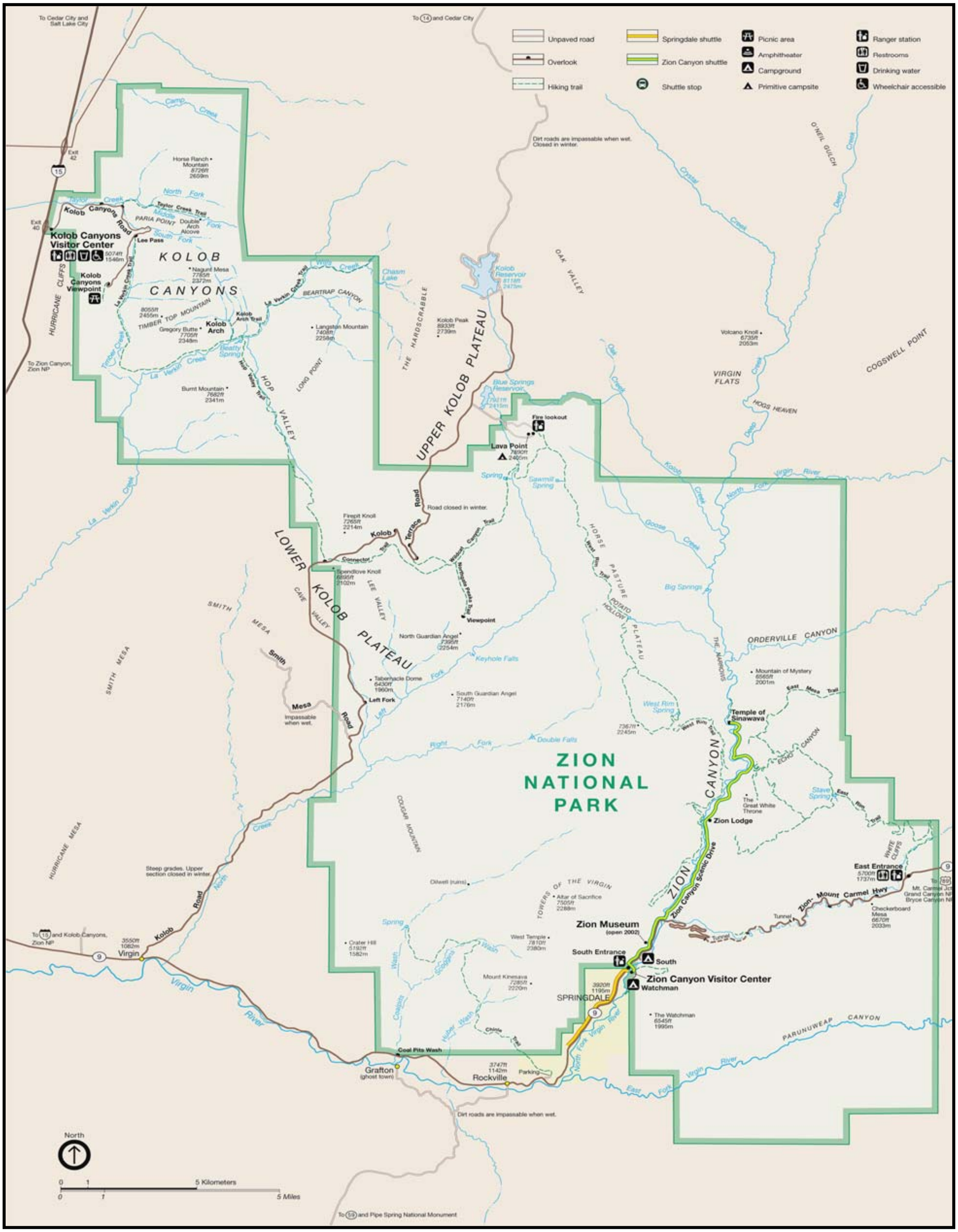


Figure 3. Zion National Park Map (1).
(obtained and modified from Zion National Park Website http://www.nps.gov/zion

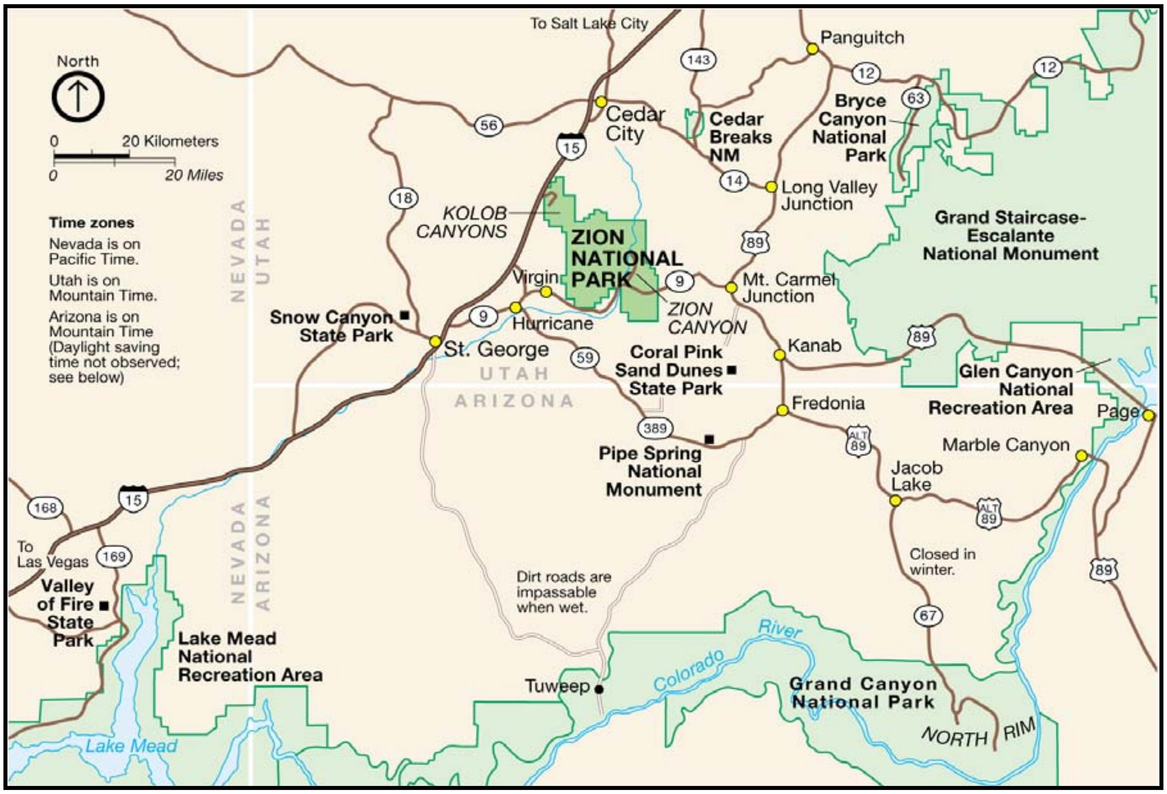


Figure 4. Zion National Park Map (2).
(obtained and modified from Zion National Park Website http://www.nps.gov/zion)

Hydrology

The Virgin River is one of the last relatively free flowing systems in the West and is the primary drainage for ZION. The North, Middle, and East Forks of the Virgin River all occur in ZION with the prominent North Fork forming Zion Canyon and the East Fork creating Parunuweap Canyon. Other important tributaries include Shunes, LaVerkin, Deep, Goose, and North Creeks (**Figure 3**).

Surface water in ZION comes primarily from runoff occurring within the watershed. Heavy rainfalls are common during the summer and can form flash floods in ZION's narrow canyons. Other sources of water in the Park include isolated seeps and springs. Within the porous Navajo sandstone formation, seeps produce waterfalls and support hanging garden vegetation.

Climate

ZION's semiarid climate can noticeably change both during the day, across elevations and between seasons. During the day temperatures can fluctuate over 30°F between mid-day heat and overnight cooling. Seasonal changes are also extreme with a majority of precipitation in the spring followed by hot, dry summers interrupted by prevalent monsoons or afternoon thunderstorms between late July and mid-September. Elevation creates heavy snowfalls in the winter for the northern portions of the Park.

As reported on ZION's website (http://www.nps.gov/zion), average yearly precipitation ranges from 14 inches in Zion Canyon to between 16 and 20 inches for the high country. Yearly temperatures for ZION vary from around 100°F highs in July to 30°F lows for December and January. Generally snowfall is very light in the lower elevations during the winter but can increase dramatically with elevation.

Vegetation

ZION's extreme range in elevation coupled with its topographic complexity creates a myriad of niches supporting a wide range of plants and plant ecosystems. During the course of this study we found that species could be grossly separated by life zones based on geography. The resulting pattern contains a range from low elevation desert shrubland communities with Mojave Desert elements, to mid-elevation shrublands and pinyon-juniper woodlands typical of the Colorado Plateau and Great Basin, to montane forests/oak-brush shrublands at higher elevations. Tucked in the many canyons are also important riparian, wetland, and unique environments such as hanging gardens.

At the lower elevations cryptobiotic soil covers much of ZION forming large crusts on very sandy soils. Vegetation here is generally sparse and low in stature due to lack of moisture. Semi-arid desert species such as blackbrush (*Coleogyne ramosissima*), Four-wing saltbush (*Atriplex canescens*), and pockets of Mesquite (*Prosopis glandulosa*) are common.

As you travel north in the park, frequency of riparian species becomes more pronounced along streams and rivers. Typical tree species include Fremont's cottonwood (*Populus fremontii*), boxelder (*Acer negundo*), and velvet ash (*Fraxinus velutina*). Coyote willow (*Salix exigua*) and seepwillow (*Baccharis emoryi*) are common shrubs. Narrow floodplains and sandy slopes next to waterways support a variety of shrubs and trees. These include predominately pinyon pines (*Pinus edulis, P. monophylla*) and one-seed juniper (*Juniperus osteosperma*), sand and big sagebrush (*Artemisia filifolia*, *A. tridentata*), and rabbitbrush (*Ericameria nauseosa*). Interspersed with these are pockets of grasses, mainly sand dropseed (*Sporobolus cryptandrus*) and Kentucky bluegrass (*Poa pratensis*).

Steep, rocky talus slopes form transitions between floodplains and Navajo sandstone formations throughout much of the Park. On these sites silver buffaloberry (*Shepherdia rotundifolia*) is prevalent along with live oak (*Quercus turbinella*) shrubs and pinyon and juniper trees. In the center of the Park and extending east are large areas of slickrock (Navajo sandstone) and its derived soils. Here, ponderosa pine (*Pinus ponderosa*) becomes more common along with opportunistic shrubs such as greenleaf manzanita (*Arctostaphylus patula*) and dwarf or littleleaf mountain mahogany (*Cercocarpus intricatus*). In mesic canyons, ravines, and north-facing benches, Douglas fir trees (*Pseudotsuga menziesii*) form lush stands.

As the Park rises in elevation to the north, semi-arid shrub dominance shifts to more mesic montane types. Ponderosa pine, aspen (*Populus tremuloides*) and white fir (*Abies concolor*) are common dominants. Tall shrubs consisting of Gambel oak (*Quercus gambelii*), common serviceberry (*Amelanchier alnifolia*), and bigtooth maple (*Acer grandidentatum*) are also usually present in great quantities.

Several problematic non-native and invasive plant species are found within the Park and are being actively controlled. These include salt cedar (*Tamarix ramosissima*), and Russian-olive (*Elaeagnus angustifolia*).

Historical agricultural or semi-natural lands are common on old homestead sites in and around ZION. Typically the disturbed sites occur on relatively flat land. Common species in these areas include a variety of non-native and native species especially suited to thrive on disturbed soils. These include cheatgrass (*Bromus tectorum*), wheatgrasses (*Agropyrum* spp.) and rabbitbrush. Also, ripgut brome (*Bromus rigidus*) is common on riparian benches and terraces, while smooth brome (*Bromus inermis*) and Kentucky bluegrass (*Poa pratensis)* are common in mesic areas.

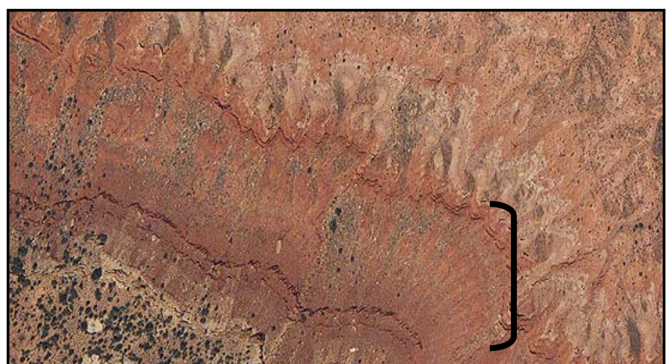
Wildlife

According to ZION's website (http://www.nps.gov/zion), the Park supports over 285 species of birds, 75 species of mammals, 32 reptiles and amphibians and 8 fish. Documented rare and endangered species include the peregrine falcon, Mexican spotted owl, southwest willow flycatcher, desert tortoise, and the endemic Zion snail. Mule deer, rock squirrels, lizards, and desert cottontail were some of the more common animals seen during this project.

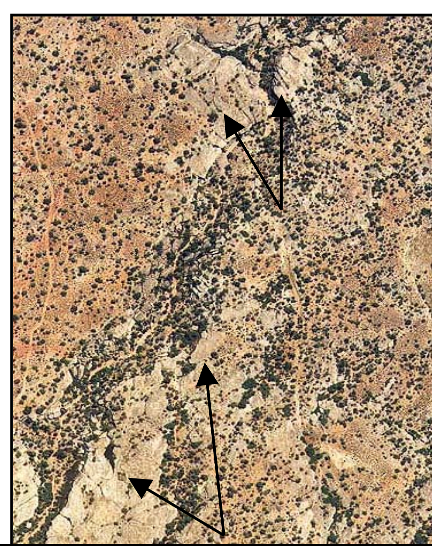
Figure 5. Zion National Park Photo-interpretation Geologic Formation Reference.

Oldest

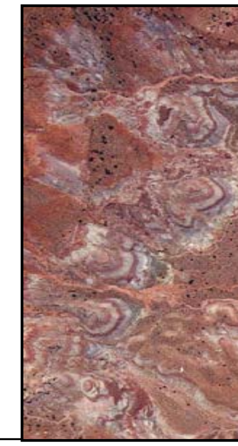
Kaibab (White to Yellow) occurs only in two areas in the NW corner along the Hurricane Fault.



Moenkopi (Dark Red to Pink) occurs in SW and NW corner of Zion, low elevations.

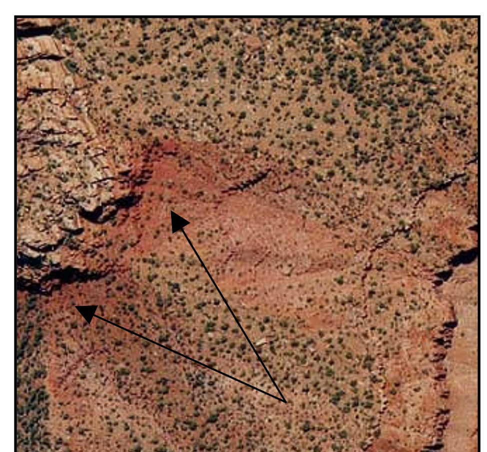


Chinle Shinarump (Light Tan to White) occurs in the low elevations. Forms cracked ledges.



Chinle Petrified Forest (Gray, Purple, White, and Pink Bands) occurs in the low elevations.

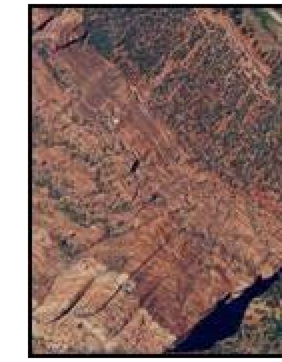
Moenave (Red, Purple, or Pink) talus slopes, mainly in southern half of Zion.



Kayenta (Red and Mauve) forms talus slopes at the base of the Navajo Sandstone.

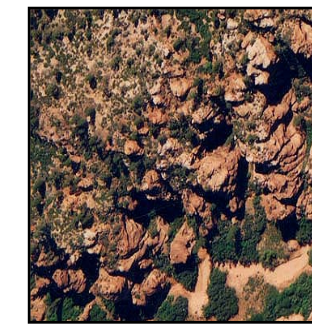
Youngest

Fractured



Brown

Pink and White



Fractured HooDoo's

Navajo (White, Pink, Brown) most extensive rock formation in Zion. Occurs as canyon walls and steep near-vertical cliffs.

Temple Cap (Orange and Red) cap rock directly above the Navajo formation at high altitudes.

Carmel (white, light gray, light tan) formation occurs at Zion in the highest elevations especially around Horse Ranch Mountain.

Dakota (no photo) (white, gray) only occurs as a small area in the NW corner.

(All aerial photos were clipped from 1:12,000 scale true-color aerial photographs obtained from Horizon's

2. METHODS

Based on the overall project scope and the assignment of responsibilities, the project was divided into six major steps following the USGS flowchart (**Appendix A**):

1. Plan, gather data, and coordinate tasks;
2. Survey ZION to understand and sample the vegetation;
3. Classify vegetation using field data to NVCS standards and crosswalk to recognizable map units;
4. Acquire aerial photography and interpret using the classification scheme and crosswalk;
5. Transfer the interpreted data to a digital form;
6. Ground-truth and assess the accuracy of the final map product.

All protocols for this project as outlined in the following sections can be found in documents produced by The Nature Conservancy (1994a, 1994b, and 1994c) for the USGS-NPS Vegetation Mapping Program and found at this website: http://biology.usgs.gov/npsveg.

2.1 Planning, Data Gathering and Coordination

A scoping meeting was held in February 1999 and attended by RSGIS, NPS, NatureServe and CBI staff. The goals of this meeting were to (1) inform the Park staff and interested neighbors about the program, (2) learn about the Park's management issues and concerns, (3) review existing data, (4) develop a schedule and assign tasks, (5) get a commitment from the Park, (6) define possible cooperation with others, and (7) define a project boundary.

The scoping meeting was followed-up with a sampling design meeting held in April 1999 to further discuss the project boundary and define variables for a stratified random sampling approach.

Both meetings helped determine three important project decisions:

1. The project boundary was defined as 1-mile buffer or 'environs' extending around the Park. This was enlarged in the northwest corner to 2-miles to encompass important upstream watersheds (**Figure 1**).

2. New 1:12,000-scale true-color aerial photography would be required since the Park's previous sets were out-dated. Also, new 1-12,000 true-color orthophoto base maps would be acquired for the Park to help with the digital transfer.

3. Assignment of work responsibilities to the participants as follows:

BOR Responsibilities

- Help with overall project facilitation and coordination;
- Acquire new 1:12,000 scale true-color aerial photography and ortho-rectified imagery;
- Verify vegetation and land use/land cover signatures on the aerial photographs;
- Develop map units linked to the NVC;
- Provide NatureServe with information gleaned from the aerial photography regarding the distribution and characteristics of vegetation types within ZION;
- Interpret and delineate vegetation and land use types using aerial photographs;
- Transfer and automate interpreted data to a digital spatial database;
- Produce spatial coverages of plot and accuracy assessment site locations;
- Assist with the accuracy assessment;
- Provide a final report describing all aspects of the project;
- Provide a visual guide to the photo signatures of each map unit;
- Document FGDC-compliant metadata for all vegetation data.
- Create a CD-ROM with reports, metadata, guides, vegetation classification, plot data, spatial data, the vegetation database (map), graphics, and ground photos.

NPS Responsibilities

- Provide program oversight in conjunction with CBI;
- Supply RSGIS with the Park and Project boundary in digital format;
- Supply RSGIS with ancillary data;
- Assist with fieldwork and logistical considerations.

NatureServe Responsibilities

- Collect representative plot data for the vegetation classification and local NVC descriptions;
- Develop a vegetation classification for the study area based on the NVC using collected field data;
- Provide guidance regarding the ecology and floristic composition of the vegetation types;
- Provide global and park-specific vegetation descriptions and keys to the vegetation;
- Collect accuracy assessment ground data to be used for analysis of the thematic accuracy of the GIS vegetation layer.

Work began by gathering copies of maps, soil surveys, reports, and other documents describing the Park and its environmental setting. ZION provided species lists, National Wetland Inventory data, previous vegetation maps, geology maps, and other relevant information. NatureServe provided a list of potential plant associations.

At this time, we also evaluated existing plot data from previous studies at ZION as to its usefulness in the vegetation classification and mapping. Of particular consideration was the plot data and study methodology from Harper (1980) used in an earlier ZION vegetation map. Upon review, all previous data for ZION, including Harper's, were judged as being useful only for gross classification and cursory verification of the vegetation. Reasons for rejecting this data included questionable positional accuracy of the plots and a lack of detail in reporting species and their cover.

2.2 Field Survey

Overall, the field methods used by NatureServe for developing the classification and conducting the accuracy assessment at ZION followed the methodology outlined by the USGS-BRD/NPS Vegetation Mapping Program (Grossman *et al.* 1994). A summary of the methodology, as it was applied at ZION, is presented below.

As the 1999 field season approached, preparations were made by NatureServe for collecting sample plot data at ZION. This involved creating a preliminary list of vegetation associations and alliances from the NVC in February 1999. We agreed upon a total of 74 associations (68 existing NVC and 6 proposed by Zion staff) for the preliminary classification in May 1999 after several meetings. The preliminary classification was initially used to set targets for data collection. Each association was targeted for 3-5 plots. Associations that were relatively well known and described from other areas were given fewer plots, and those that were thought to be new to ZION or known from elsewhere, but not well characterized were given more. The preliminary classification was a working document that was refined as new information became available from the vegetation sampling.

Sampling Design: Stratified Random Gradsect

Our ultimate goal at ZION was to obtain a thorough description for the range of plant communities, both the common/extensive and the rare/unique (Austin and Heyligers 1991). To this end we felt that an unbiased census of all the vegetation (*i.e.* a complete enumeration of the population) would not be achievable or practical for such a large, remote Park. As a result, to cost-effectively capture the full spectrum of vegetation we felt it necessary to optimally locate sampling plots using "Gradsect Sampling" (GRADient-directed tranSECTs) (Gillison and Brewer 1985).

Gradsects are a survey method that addresses 1) the need for representative sampling based on environmental stratification, 2) the need for a compromise between statistical sampling, practical logistical problems, and costs, and 3) the value of replicated and randomized sampling (Austin and Heyligers 1991, Gillison and Brewer 1985). We assumed that a modified Gradsect methodology would allow field crews to visit the full spectrum of physical environments and thus most of the vegetation types.

For ZION, we decided that a spatial-historical model coupled to a 30-meter digital elevation model (DEM) of the Park would be more predictive of vegetative diversity and more efficient than a linear transect approach. A working group of USGS, NPS, and NatureServe ecologists/botanists familiar with the region selected the model's driving variables; those thought to influence vegetation response. During this process, practical constraints were also considered including the lack of time and money to develop new digital data layers.

For ZION's modified gradsect, geology, solar insolation, hydrology and fire history were chosen (elevation was omitted except for volcanic substrates because of its close correlation to the sedimentary geologic layers that characterize the Park) as the key abiotic factors (**Table 1**). We then split each gradsect variable into logical classes to best reflect the vegetation distribution and created digital map layers using ArcView GIS (**Table 1**). These GIS layers were then added together to generate a map coverage of all combinations occurring in ZION, with each unique combination representing a Biophysical Unit (BPU).

At ZION there were 70 BPU types within the Park that formed a mosaic of 18,000 polygons. We selected a subset of these BPUs using a cost-surface analysis, which favored polygons that were more accessible, of adequate size, and spatially dispersed. This resulted in 2-3 polygons of each type for a total of 170 polygons selected for possible sampling during the initial field season. At Zion, polygons averaged from 1-10 ha in size, although the overall range was 0.18-110 ha. This cost-surface process for selecting sampling locations was especially important for ZION, due to access difficulties caused by the steep, vertical nature of the Park.

For more detailed information on the Zion National Park Analysis - Sample Site Selection Methodology see **Appendix B**.

Table 1. Environmental variables and classes used in the modified Gradsect analysis for ZION.
The combination of variable classes is called a Biophysical Unit or BPU.
Example: *upland, unburned, partial shade, Dakota formation* (**2235**).

HYDROLOGY	FIRE HISTORY	SOLAR INSOLATION	GEOLOGY
1000-Hydric 2000-Uplands	100-Burned 200-Unburned	10-Full Shade 20-Partial Sun 30-Partial Shade 40-Full Sun	1-Alluvium 2-Carmel 3-Chinle/Moenkopi/Kaibab 4-Slide/Kayenta/Moemave 5-Dakota 6-Navajo/Temple Cap 7-Volcanics 3600-5300 ft. 8-Volcanics 5301-7000 ft. 9-Volcanics 7001-Summit

Data Collection: Relevé Plots

The BPU polygons selected in the sampling design only provided guidance to possible sampling locations for the field crews and were not the targets. Rather, it was the vegetation found on and in the vicinity of a particular BPU polygon that was actually sampled. Once they reached a selected BPU location, field crew(s) located vegetation plots in areas that were relatively homogeneous and representative of the vegetation to be sampled. Field crews were instructed to avoid areas where vegetation was transitional between types, such as ecotones.

Plot locations were recorded from plot centers using Rockwell **PLGR** (Precision Light-Weight GPS Receiver) GPS units provided by the Park. UTM X-Y coordinates and elevation were recorded both manually on the plot forms and stored as waypoints in the GPS unit. All readings were downloaded from the units, including the accuracy estimates, and transferred to an Access database. Average error ranged between ±5-10 meters with more error associated in canyons and dense canopy.

We recorded all plot information on a standard plot form (**Appendix D**). Environmental information recorded included: elevation, slope, aspect, landform, topographic position, soil texture and drainage, surficial geology, hydrologic (flooding) regime and evidence of disturbance or wildlife use. Pick lists of environmental variables were provided to help standardize naming (**Appendix D**). Vegetation structure and species composition were sampled using plots that varied in size depending on the dominant physiognomy of the vegetation. Forest, woodland and shrubland plots were 400 m^2, while dwarf-shrubland and herbaceous vegetation plots were 100 m^2. Plot shapes were typically square or circular, but were modified to best represent the vegetation, e.g., narrow, linear rectangles for riparian vegetation. Plot dimensions were recorded.

Within each plot, we visually divided the vegetation into strata, and the height and canopy cover of vegetation was estimated for each stratum. Physiognomic class, leaf phenology, and type of dominant stratum were recorded. The species of each stratum were then listed and percent canopy cover estimated using a twelve-point cover scale (<1%, 1-5%, >5-15% ...) (Daubenmire 1959). Additional species within the vegetation unit that occurred outside of sampled plots were listed separately. Non-vascular species cover was summed as either lichen or moss depending on life-form. No attempt was made to identify individual non-vascular plants. The plant species lists may not be exhaustive for all plots but they do include all major and most minor species. Species that were not identifiable in the field were collected for later identification. Species were recorded by scientific epithet familiar to researchers and synonymized with the nomenclature of Kartesz (1999).

For plots with trees, the diameter at breast height (DBH) was measured and recorded for trees with DBH greater than 10 cm. Trees with stems 5-10 cm DBH were tallied. Multi-stemmed trees such as *Quercus gambelii* were also measured and recorded as such. Finally, a provisional vegetation type was assigned to the plot. Please see **Appendix C** for more information on the plot data collection.

Plot Data Collection at ZION

Data Collection: Fire Specific Data

At Zion, fire-modeling data was also collected in tandem at many of the vegetation plots. In 1999, Zion fire program personnel accompanied the vegetation field crew to collect fire-modeling data and in 2000 a member of the field crew was trained to collect fire data. Data such as height to live crown, fuel types and fuel amount were collected in each plot.

Data Collection: Plots

Our field sampling goals were to have 3-5 plots per plant association with less well-understood and more diverse associations receiving more sampling. All plots were to be spread across ZION to capture diversity within each association. Plot sampling was conducted during the summer of 1999 and spring-summer of 2000. The 1999 sampling period was relatively short, occurring from July 21 – August 27 after NatureServe contracted a 2-person field crew. This effort resulted in **91** plots located in areas that were relatively accessible.

The 2000 field season consisted of 3 sampling periods. The first was a short early spring reconnaissance trip conducted by BOR (April 1-4) to help jump-start the data collection and increase the number of sample plots. Due to the early timing, we sampled mostly in low elevation communities producing **16** plots. Following this effort, the main field season ran from May 18 - August 17 using one, 2-person field crew contracted by NatureServe. This effort resulted in **161** plots. Many of the plots collected at this time were sampled in less accessible areas.

Subsequent evaluation of the distribution of the plots by BOR and ZION revealed large remote areas devoid of data (**Figures 6 and 7**). In order to provide better coverage we ran a final period from August 21-24 concentrating on backcountry and isolated mesas. A quick feasibility study using The Bureau of Reclamation's helicopter was conducted by BOR and presented to ZION. ZION approved the use of the helicopter and was instrumental in obtaining the necessary permits, finding volunteers and providing safety personnel (*i.e* heli-techs).

Using four to five 2-person field crews, including Utah Flora (1993) authors Dr. Stanley Welsh and Dr. Duane Atwood, we were able to access and sample 31 relatively inaccessible and pristine areas of Zion (**Figure 6**). The four days of helicopter-assisted work (24 flight hours) resulted in **78** vegetation plots and 9 more general, observation points (See **Appendix G** for more details). Due to "one-shot" accessibility some of the plots were held back and used as accuracy assessment points.

Shuttling of field crews using the BOR Helicopter at ZION.

2.3 Plot Data Management and Classification Analysis

Upon completion of the field work, all information from the 346 plots at ZION were entered into the NPS PLOTS database (TNC 1997), a MS Access-derived program. PLOTS was developed expressly for the NPS vegetation and mapping program so that the electronic data entry fields exactly mirror the standard field forms (see **Appendix D**). This was facilitated by assigning each plant species an unique, standardized code and name based on the PLANTS database developed by National Resources Conservation Service in cooperation with the Biota of North America Program (http://plants.usda.gov). After data entry, we checked for any errors such as duplicate entries or erroneously selected plant names (from database pick-lists), based on distribution and Park species lists. Unknown species, especially those with high cover, were resolved, as were other taxonomic issues such as grouping some subspecies and varieties judged to be ecologically similar.

By manipulating these data, NatureServe was able to sort and classify the vegetation associations as they related to the NVC. In some cases obvious qualitative sorting into groups based on vegetation structure and composition allowed for simple assignment to existing associations. However, most of the plots needed thorough quantitative analysis using ordination and classification programs.

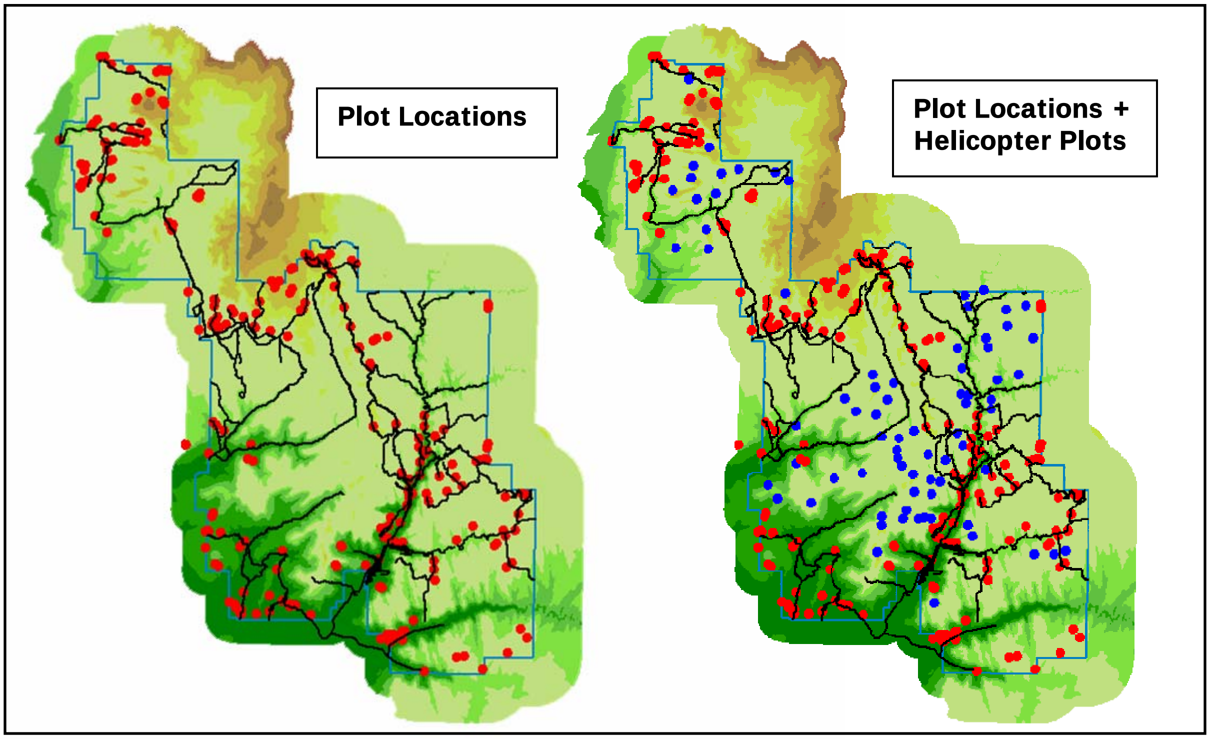


Figure 6. Comparison of plot sample distribution before and after the use of the BOR helicopter.
(Red dots indicate plot locations, blue dots indicate helicopter-assisted plot locations, and lines are major roads and trails. Please note that some of the plots were held back from the photo-interpreters and used as accuracy assessment points.)

Quantitative analysis involved preparing the species and environmental data by formatting them for use in the analytical programs. For species data this meant grouping species into species-by-strata cover value combinations to address species occurring in multiple strata. Environmental data were also manipulated to improve analysis by grouping both landform/geology and aspect classes into fewer, more ecological-meaningful categories (*e.g.* sunny/hot aspects E-NW and shady/cool aspects NNW-NE).

After formatting, the data were analyzed in a series of runs in PC-ORD Multivariate Analysis software package (McCune and Mefford 1997). The process involved partitioning the larger data set into smaller sets until sufficient resolution was achieved to classify stands into an existing NVC association or develop a new type. Specifically, this was accomplished by using several multivariate procedures, including Detrended Correspondence Analysis, or DCA (Hill and Gauch 1980) and Two-Way Indicator Species Analysis, or TWINSPAN (Hill 1979). CANOCO was also used to perform (partial) (detrended) (canonical) correspondence analysis (Ter Braak 1987-1992), relating species and samples to environmental variables.

In short, we used DCA to ordinate both species and samples simultaneously based on floristic patterns. These ordinations were then reviewed and assessed for perceived environmental gradients (*e.g.* moisture gradients, aspect, soil textures, soil depth, etc.). (See **Figure 8a**, for an example of a DCA ordination expressing a moisture gradient). To complement the ordinations of DCA, we used TWINSPAN to successively divide the plots into groups that were similar in species composition. This provided us with a table showing plots ordered by indicator species.

During analysis, small groups of plots very dissimilar to all the others (*i.e.* outliers) were removed in an iterative fashion from the larger data set before it could be partitioned into major groups for further analysis. Most of these outlier plots corresponded to existing NVC associations, and included wetlands, a lowland grassland, dry shrublands, a riparian shrubland, and wet meadows. The major remaining groups were pinyon and juniper woodlands and

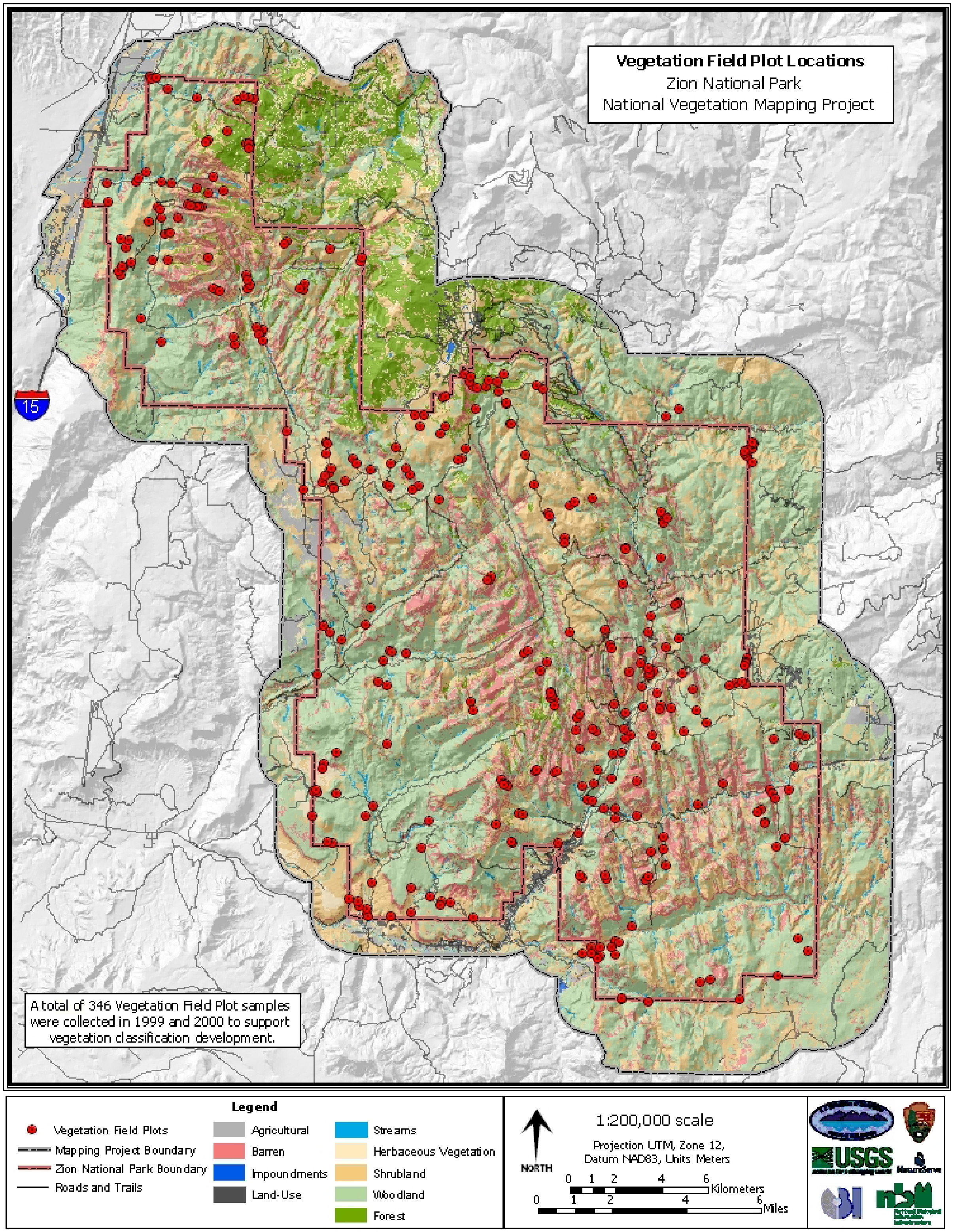


Figure 7. Location of all vegetation plots collected at ZION.

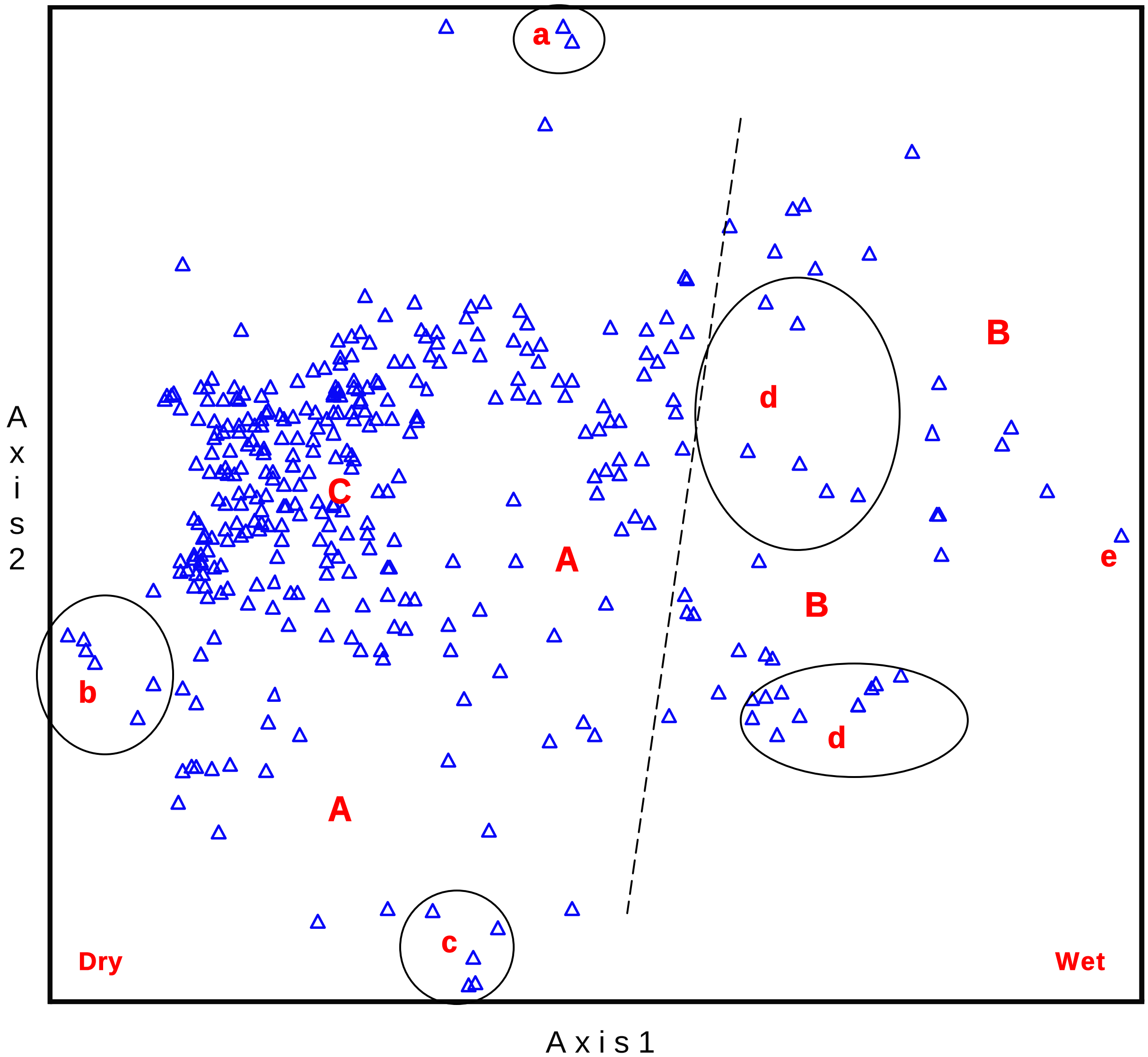


Figure 8a. DCA ordination of complete Zion dataset (346 plots).

This plot shows the distribution of plots on a dry to wet environmental gradient (Axis 1). Note how dry shrubland and grassland plots (A) and wet meadow, riparian shrubland and forest plots (B) were partitioned (dashed line) from each other and from a dense mass of woodland and montane shrubland plots (C). Distinctive groups include smooth brome grassland (a), blackbrush shrublands (b), sand sagebrush shrublands (c), Fremont cottonwood riparian forests (d), and a sedge wetland (e).

montane vegetation. We further divided the montane vegetation into montane shrublands, ponderosa pine, other montane conifers, aspen, and riparian forests and woodlands. **Figures 8a-d** demonstrate this process of identifying outlier plots and successively partitioning the datasets into distinctive, smaller groups of plots. These groups were then analyzed separately and compared with the NVC (Grossman *et al.* 1998). Throughout, care was taken not to over-emphasize local variations found at Zion compared to more extensive information compiled at the regional level. Nevertheless, several type in the NVC were revised based on these analyses and new associations were identified from ZION's data.

A complete list of NVC plant associations for ZION was created (**Table 3**) and sent to Julie Thompson, our field crew leader. Julie drafted local descriptions for each association based on the data contained in the plots and her

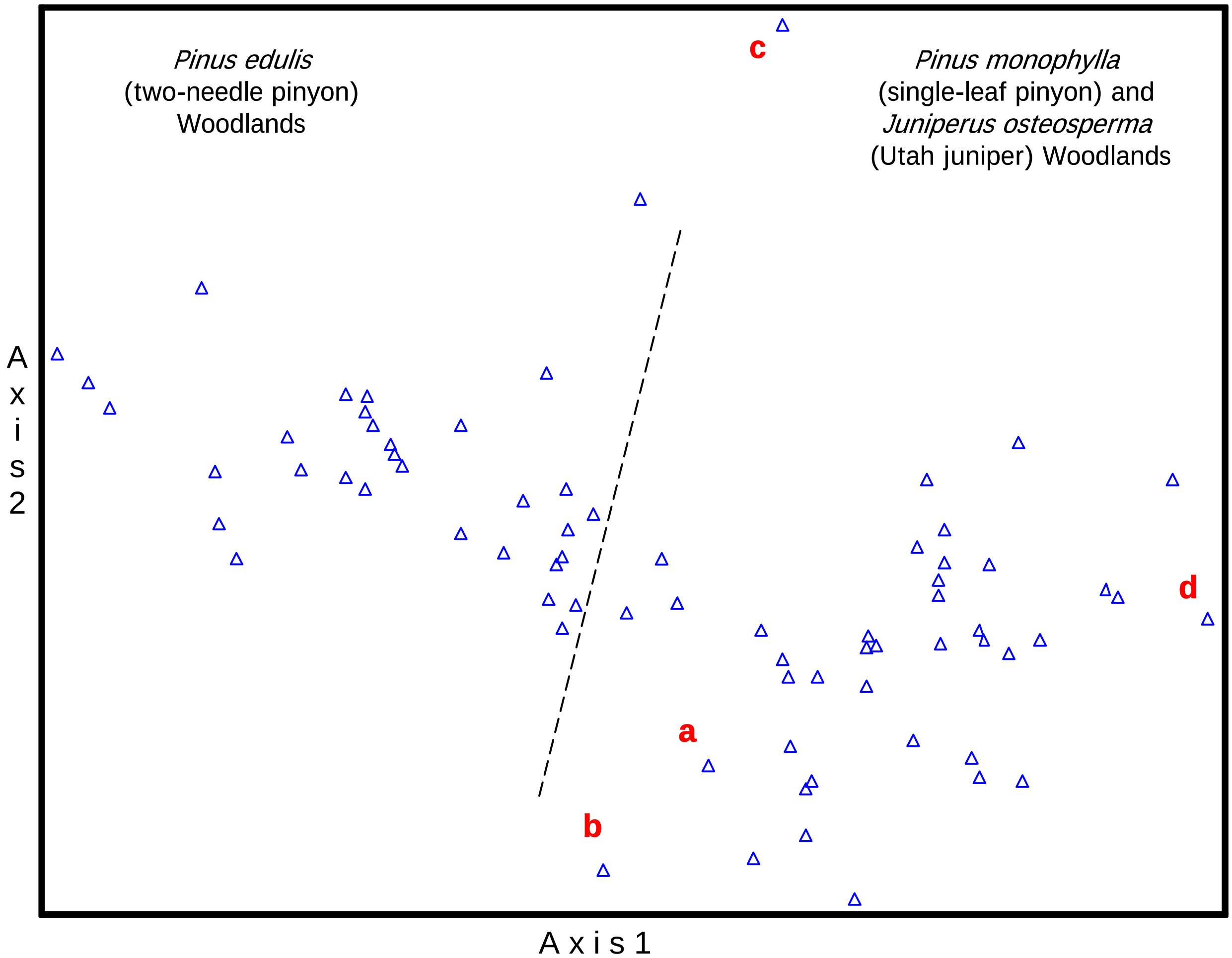


Figure 8b. DCA ordination of plots preliminarily in the Zion pinyon-juniper woodland dataset (73 plots).

This figure shows the distribution of *Pinus edulis* (two-needle pinyon) and *Pinus monophylla* (single-leaf pinyon) woodlands separated by a dashed line. *Juniperus osteosperma* and *Pinus monophylla* woodlands typically occur at lower elevations and on southern exposures, whereas *Pinus edulis* woodlands occur at higher elevations often with montane shrubs. A *Pinus edulis - Juniperus osteosperma* Woodland stand (a) was grouped with *Pinus monophylla* woodlands perhaps because of similar understorys. Three outlier plots (b), (c) and (d) were later classified as *Symphoricarpos longiflorus* shrubland, *Quercus gambelii / Amelanchier utahensis* shrubland and *Pleuraphis jamesii* grassland, respectively.

experience. The final ZION classification, containing both the global and local elements, was then sent to ZION for review and their subsequent approval (**Appendix F**).

Once the associations were finalized, a dichotomous key was developed for use during the Accuracy Assessment (**Appendix E**). Finally we cross-walked or linked the final associations to map classes (**see Section 3.3**) for use in the photo-interpretation and mapping portions of the project.

2.4 Aerial Photography and Orthophotos

Mapping Challenges

Experience told us that ZION's steep canyons would create shadow and scale distortion on the aerial photography. Specifically, we expected the canyon walls to block light from reaching canyon bottoms resulting in large shadows obscuring vegetation and hindering photo-interpretation (**Figure 9a**). This would be compounded by the extreme change in elevation (greater than 2000 feet in some cases) from

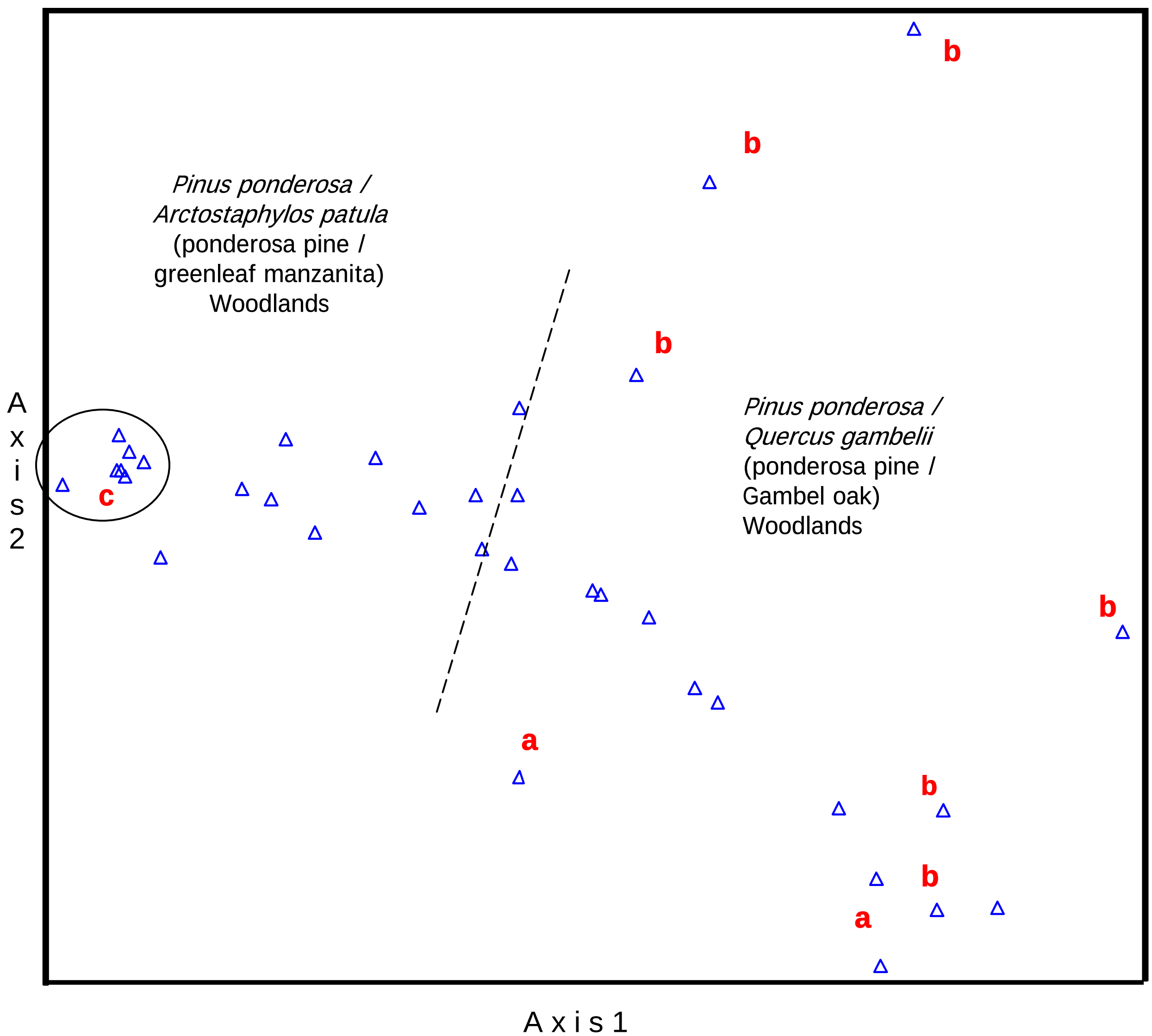


Figure 8c. DCA ordination of a subset of Zion plots preliminarily classified as Pinus ponderosa (ponderosa pine) woodlands (35 plots).

This figure shows the distribution of two common associations separated by a dashed line and plots later classified as other *Pinus ponderosa* woodlands (a); *Psuedotsuga menziesii, Abies concolor or Quercus gambelii* woodlands (b), or *Arctostaphylos patula* shrublands with scattered *Pinus ponderosa* trees.

the canyon floor to the mesa tops (**Figure 9b**). Photos taken at a steady, mean elevation will thus vary greatly in scale from the highest point to the lowest point on the landscape. To help overcome these obstacles we implemented a new approach to photo interpretation that deviated from past projects. This approach hinged on acquiring multiple sets of aerial photography across many flightlines and using these to produce new digital orthophoto base maps.

Aerial Photography

Horizons, Inc. (Rapid City, SD) flew true-color aerial photography for ZION at scales of 1:12,000 and 1:40,000 on June 22 and 23, 1999 (**Figure 9a**). We chose true-color film because of its ability to penetrate shadows allowing shapes of vegetation to be discerned through dim light (**Figure 9b**). At the 1:40,000 scale, Horizon's exposed approximately 135 frames along 16 flightlines to cover the project area.

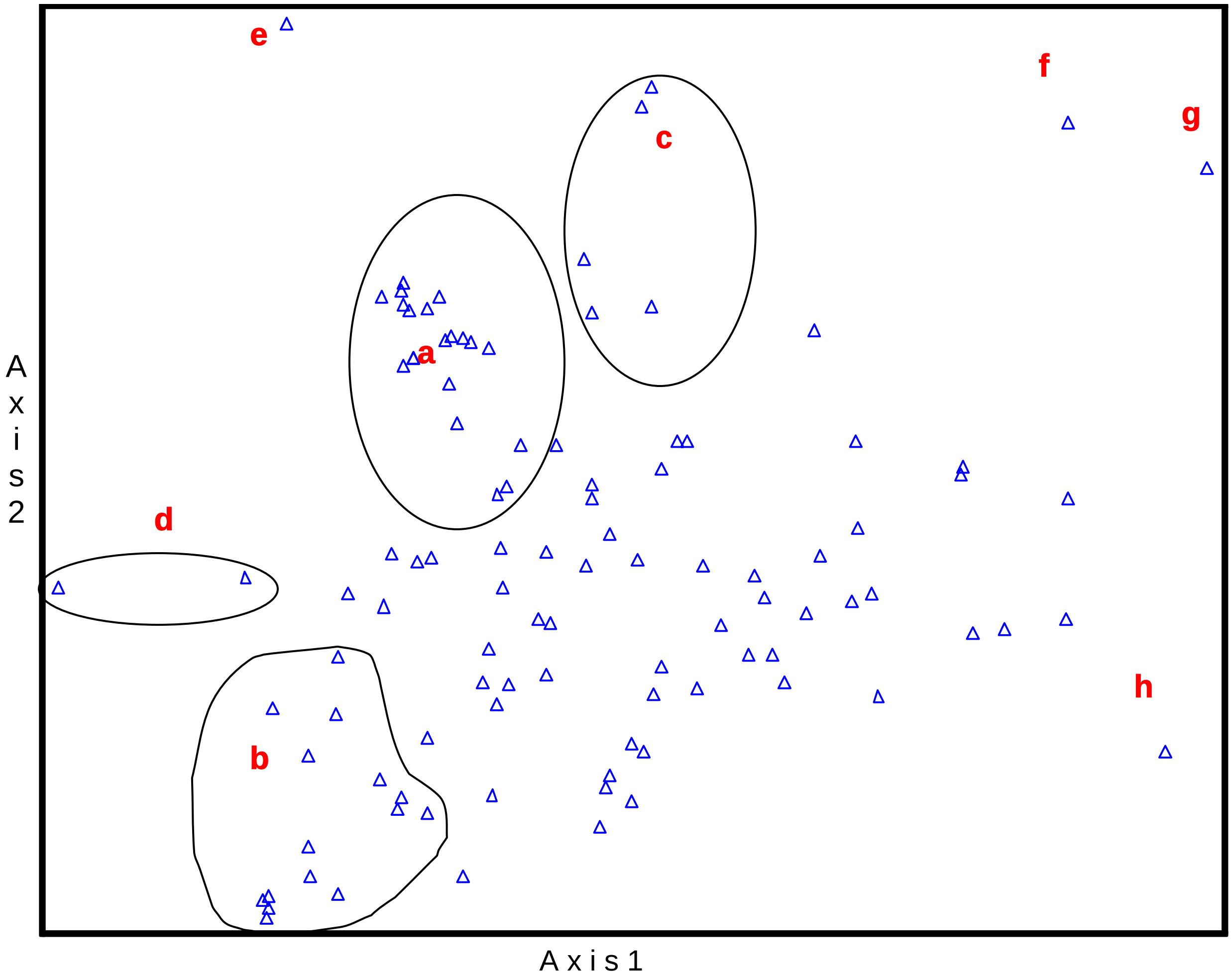


Figure 8d. DCA ordination of plots preliminarily classified as Zion Montane shrublands (103 plots).

This figure shows the distribution of four groups of plots: *Arctostaphylos patula* shrublands (a), *Quercus gambelii* mixed shrublands (b), *Artemisia nova* dwarf shrublands (c), and *Artemisia tridentata ssp. vaseyana / Hesperostipa comata* shrublands (d). Outlier plots include *Quercus gambelii / Juniperus osteosperma* shrubland (e), *Poa pratensis* semi-natural grassland (f), *Artemisia tridentata* ssp. *tridentata / Pascopyrum*

At the larger scale of 1:12,000, it took over 1150 frames along 35 flightlines (**Figure 10**) to cover the same area. This included additional overhead flights taken directly following the direction of ZION's larger canyons to minimize sun angle (**Figure 9c**). Frame overlap on both sets of photography was between 50% and 60% along the flight lines and 20% to 30% between the flight lines.

1:12,000 True Color Orthophotos

In addition to 9x9 inch prints of the 1:12,000-scale aerial photography, we also had Horizons Inc. develop new orthophotography from the 1:40,000 scale aerial photos. This was delivered to us as both digital files and hardcopy plots. Getting new orthophotos was based on a cost analysis comparing the price of the processing versus the amount of time saved in the digital transfer stage. Basically, we determined that the orthophotos would save the project more money in the long run by dramatically reducing digitizing labor costs.

Horizon's created the orthophotos by removing the distortion caused by the tilting of the camera and scale variation in the terrain. This was achieved by digitally scanning the photos and creating a mosaic. The digital mosaic was then magnified to 1:12,000 and rectified or corrected through a mathematical process that warps and stretches the image between known control points. For ZION, control points were gleaned from 10-meter and 30-meter digital elevation models (DEMs). The end result was a true-color digital image (1-meter pixels) that had an uniform scale of 1:12,000 (**Title Page; Figure 11**). Further, since the mosaic was created by cropping only the best portions of the aerial photos, much of the shadows were removed. Unlike aerial photos, the orthophotos made it possible to measure directly on them allowing UTM XY coordinates and other measurements to be accurately located.

2.5 Photo-interpretation and Map Units

Photo-interpretation

To take advantage of reduction in distortion and shadow we interpreted directly from paper copies of the orthophotos. This deviated from other vegetation mapping efforts where the actual 9x9 inch aerial photos were interpreted. However, at ZION we felt that photo interpretation of the vegetation could be conducted far more efficiently and as accurately using the aerial photographs only in an ancillary role. This was accomplished by interpreting in two stages. The preliminary interpretation identified patches of readily identifiable homogenous vegetation (areas with similar tone, texture, color, and landscape position) on the orthophotos. We then used the 9x9 inch aerial photos in stereo-magnification in a second interpretation to map the final NVC-derived map units (detailed).

For both levels of interpretation, we split the orthophoto into 27, 1:12,000 scale sheets and printed them on photographic paper with a 1,000 meter UTM grid. These were then covered with translucent (semi-frosted) Mylar, fastened together, and backlit on a light table. All UTM grid points were marked on the overlays and the initial polygons were delineated using a 0.5 mm lead pencil.

Once all the obvious vegetation and land-use classes were delineated we proceeded into the second stage. In this round of interpretation we used a stereoscope to help recognize complex photo signatures and three-dimensional features on the 9X9 aerial photos.

Additional Mylay overlays on each aerial photo allowed us to make notes and delineate polygons. We then manually transferred these to the orthophotos (**Figure 11**). Finally, in order to insure completeness and accuracy, digital transfer specialists reviewed all of the interpreted orthophotos for consistency and recommended changes where necessary.

Map Units

The map units delineated on the orthophotos were derived from the NVC classification as constrained by the limitations of the photography. We combined the preliminary NVC classification with the aerial photo signatures to determine how many plant associations could be recognized on the photos. In most instances, one NVC association corresponded to one map unit. However, sometimes a plant association could not be recognized consistently on the photos or we could see more detail than was recognized by the classification. These problems were overcome by using two separate but related classifications: 1) the NVC for the plot data and 2) map units for the GIS database. The two were related or "crosswalked" by noting when plant associations were lumped into a single map unit or where when associations were split into multiple map units (**See Section 3.3**).

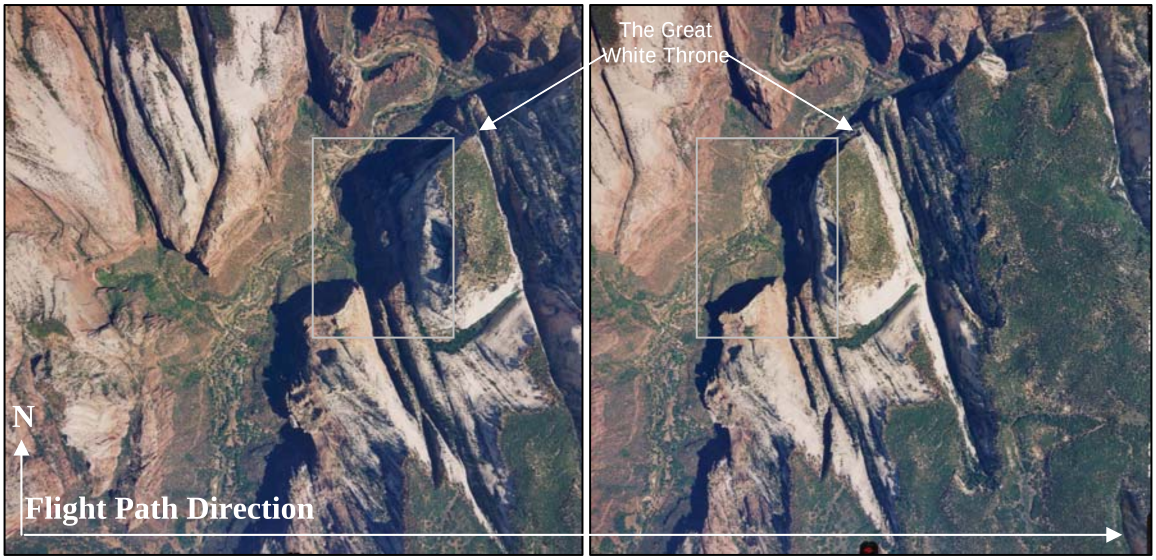


Figure 9a. Examples of 1:12,000-scale aerial photographs from the ZION Vegetation Mapping Project. (Examples are a stereo-pair of The Great White Throne. Notice the shadows and distortion in outlined area and its change between photos. -Examples are not printed to scale.)

Figure 9b. An enlargement of the Great White Throne at ZION showing discernable features in the shadow using true color photography.

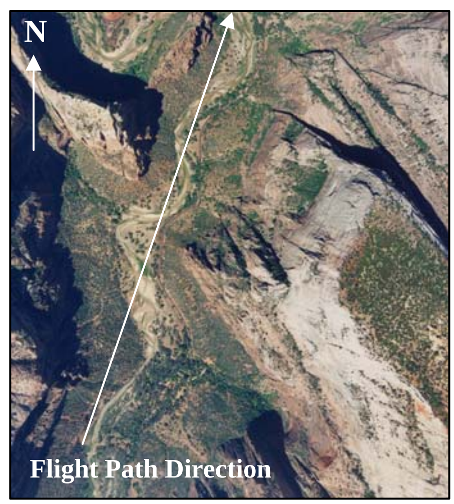


Figure 9c. An enlargement of the Great White Throne at ZION taken from a flight line that followed Zion Canyon, effectively eliminating any shadow.

We created map units for land-use types based on the system developed by Anderson (1976). This includes unvegetated lands not included in the NVC, such as roads, facilities, and agricultural fields. A third class of map units, "Park Specials", was defined especially for ZION to cover types that were easily mapped, wanted by the Park, but not included in either the NVC or Anderson. This included things like tinajas. A final list of the map units appears in **Table 3**.

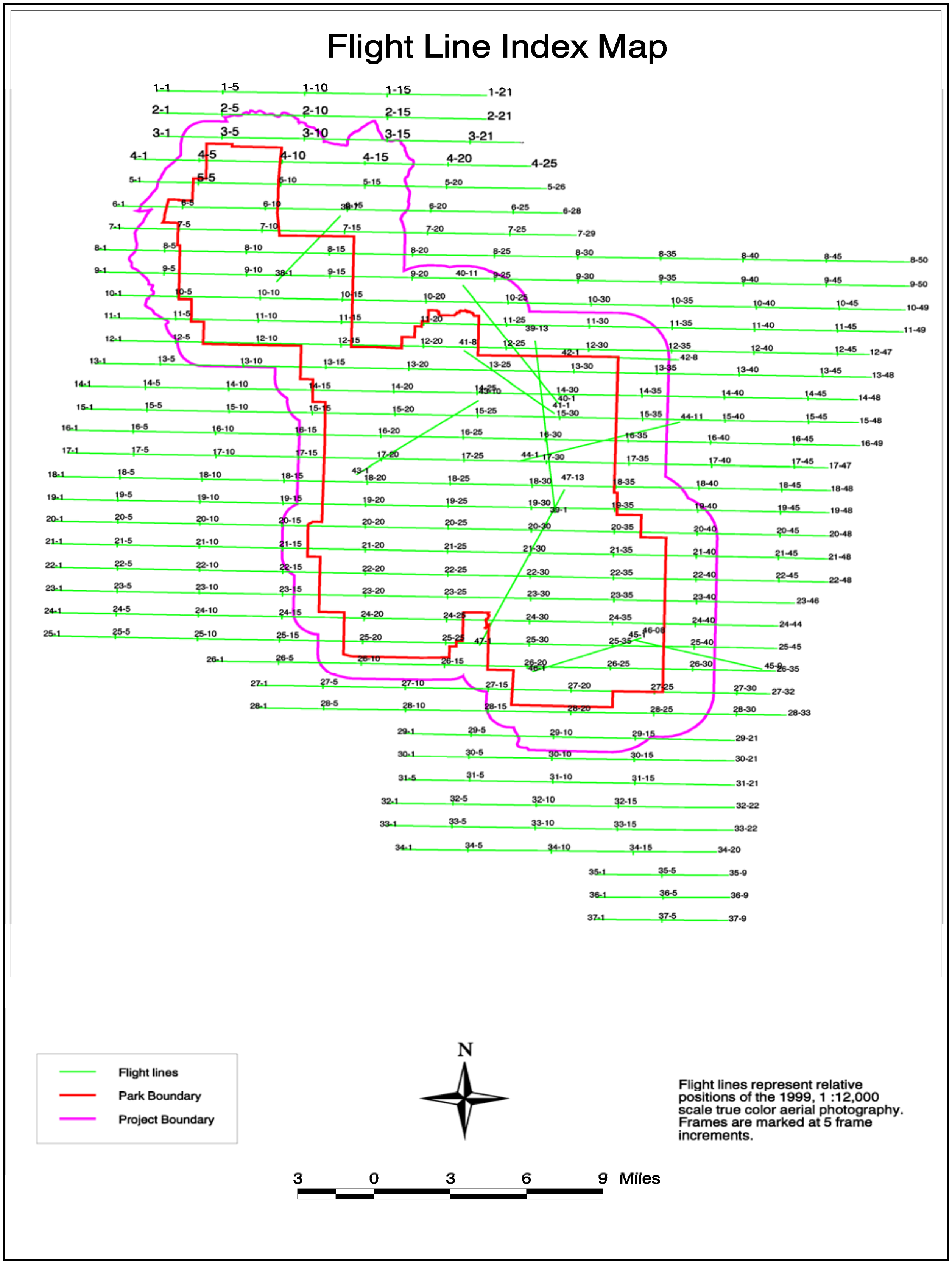


Figure 10. 1:12,000-scale Flightline Index Map for ZION.
(Note the extra, diagonal flightlines flown along the main canyons to help reduce shadows.)

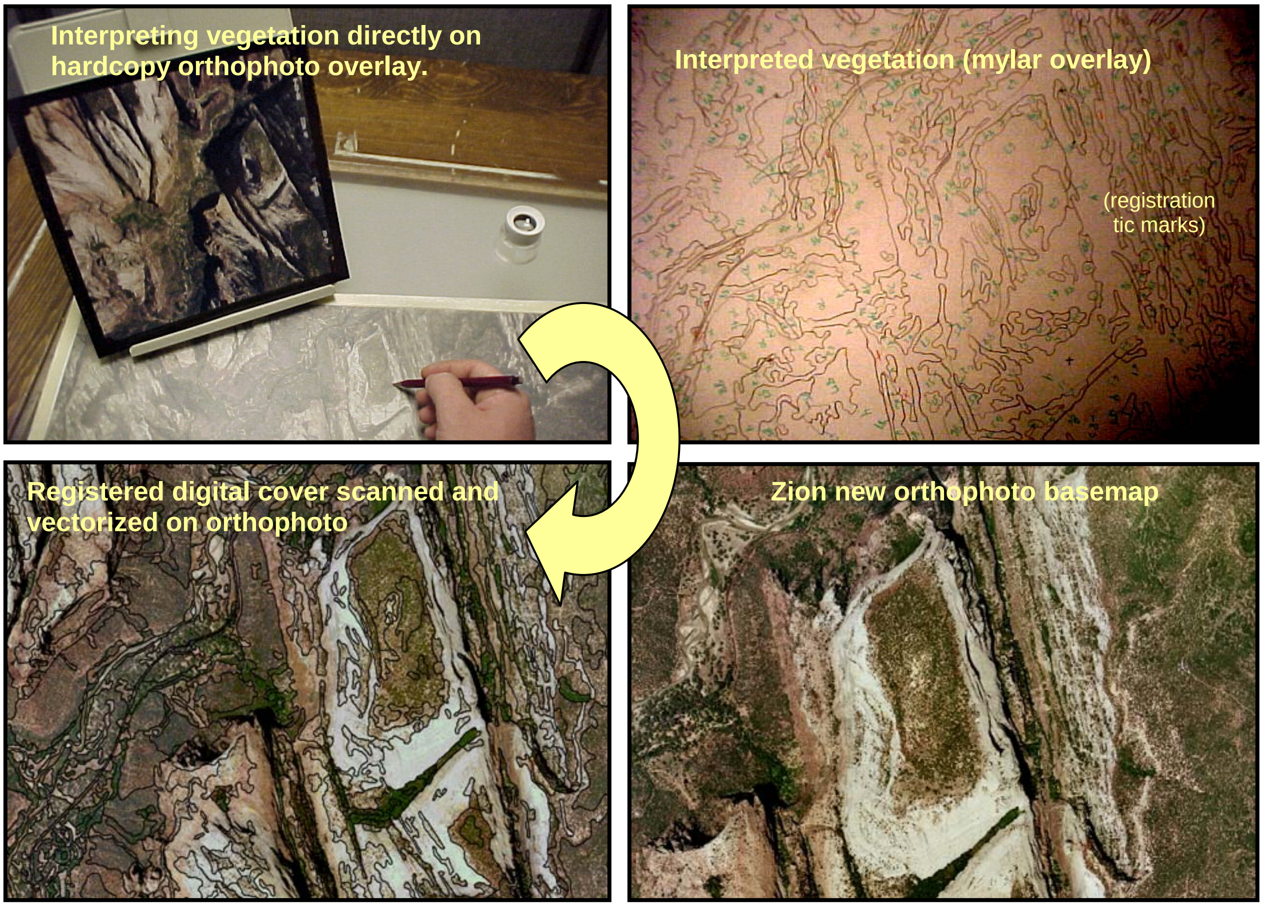


Figure 11. Color Orthophoto and USGS Quadrangle Reference Map for ZION.
[Note the lack of shadow and distortion on the orthophoto for the Great White Throne at ZION.]

2.6 Digital Transfer

The transfer process for ZION involved taking the interpreted line work and rendering it into a comprehensive digital network of attributed polygons. To accomplish this, we created an ArcInfo© GIS database using in-house protocols. The protocols consist of a shell (master file) of Arc Macro Language (AML) scripts and menus (nearly 100 files) that automate the transfer process, thus insuring that all spatial and attribute data are consistent and stored properly. The actual transfer of information from the interpreted orthophotos to a digital, geo-referenced format involved scanning, rasterizing, vectorizing, cleaning, building topology, and labeling each polygon.

The scanning technique involved a multi-step process whereby the Mylar overlay sheets produced by the photo interpreters were scanned into a digital form. The digital image file (tagged image format .tif) created from the scanned sheet was then converted from a raster image to a vector file using RSGIS-developed AMLs in ArcInfo©. The vector file was then geo-referenced to the matching digital version of the orthophoto. The essential principle of geo-referencing was to match control points (the UTM grid) as marked on the orthophotos to the same ones in the digital images. In this manner the transfer was 1-to-1.

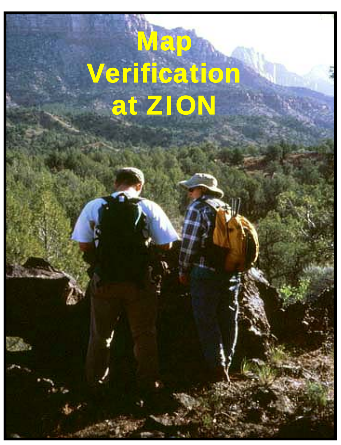
Once scanned and registered, we removed all erroneous information such as dangling lines. After cleaning we joined the lines into polygons by building topology in the GIS program. The resulting polygons were then edge matched with those from adjacent orthophotos. Finally, we created labels for each polygon and use these to add the attribute information. Using this process we created one final coverage or spatial database for the entire project.

Attribution for all the polygons at ZION included information pertaining to map units, NVC associations, Anderson land-use classes, fire-specific designations, NWI classes, and other relevant data. Attribute items requested by the ZION fire program included height, density, and evidence of recent fire (e.g. Hgt_class, CC_Tree, Fire (Yes/NO) etc.). All of the attribute items are listed in **Table 2** and are referenced in the ZION vegetation look-up table included on the accompanying CD-ROM. Attribute data were taken directly from the interpreted photos or were added later using the orthophotos as a guide.

2.7 Map Verification and Accuracy Assessment

Map Verification

As we completed the orthophoto interpretation and digital transfer for sections of the Park, draft 1:12,000-scale hard copy vegetation maps were printed for review. In all cases we checked these draft maps against the interpreted photographs to ensure that the polygons were labeled properly and to locate any extra or missing lines. We also compared the map labels to the plot data if they fell in the same location. Copies of the revised draft map were then sent to the Park for review and taken into the field by the photo interpreters for ground-truthing. During the ground-truthing process, we collected more general observation points using the standard observation point form (**Appendix D)** and verified aerial photograph signatures using landmarks and GPS waypoints. The map and map units were then modified to correct any mistakes.



Accuracy Assessment

The AA at ZION occurred in three stages. The initial stage was conducted during the helicopter-assisted work. This involved holding back from the photo interpreters **24** plots taken throughout the course of the week-long effort. Although not an ideal way of collecting AA data, we decided that since these areas could only be accessed by helicopter we would only have "one-shot" at getting the maximum amount of data. Plots held back represented common associations that were still used in the classification but had no bearing on the mapping.

After the spatial database for ZION was created and verified it was turned over in pieces to NatureServe for assessment of the thematic accuracy. NatureServe collected the field data for the accuracy assessment during the 2001 field season, with some additional points collected in 2002. We began with the southwestern portion of the Park and proceeded north, since this mimicked the photo interpretation process. The mapping and accuracy assessment proceeded in tandem throughout the season.

As AA fieldwork was being done on a portion of the Park, we would finish mapping another portion. AA data collection would then progress to the newly completed map section. In general, work flowed from low elevation environments to high.

To allocate the appropriate number of AA points per mapped vegetation type without a completed map was a complex task. Before sampling began ecologists and field crews derived a tabular matrix, which estimated the abundance and approximate range of each vegetation map unit. The 800 samples were then provisionally split between the vegetation types proportional to their percentage of cover in the Park. For example, type "A" was expected to cover one percent of the park so was assigned 8 samples. Type "A" is restricted to low elevation environments so it would receive all 8 of those samples early in the season (since the PI team mapped low elevation areas first). Type "B", which also covers about one percent of the Park, is found throughout many environments and would receive those same 8 samples doled out gradually throughout the season as its different habitats were mapped. As each portion of the map was completed the matrix was updated to reflect the new vegetation data.

The only polygons excluded from possible selection in the AA process were within areas deemed dangerous for travel. In general, some clustering of various target types within a localized area was allowed; otherwise the selection of AA points was random.

NatureServe contracted 2, two-person teams of ecologists to collect AA data at ZION during the 2001 field season. The field crews traveled to the AA sample sites and determined the vegetation association using the vegetation key (**Appendix E**), recording primary and secondary association names (if similar to another type). They also recorded basic vegetation strata and environmental data, and percent canopy cover of the major species in each stratum (see AA point form in **Appendix D**.). Finally, they recorded other nearby vegetation types within 50 meters of the AA point. A total of <u>817</u> Accuracy Assessment points were obtained in 2001.

Although <u>817</u> sampling points were initially generated for the accuracy assessment in 2001, <u>521</u> of these points fell into only 5 types. To correct this lop-sided distribution another round of AA data was collected in 2003. Again NatureServe contracted field ecologists (only 1-team of 2 this time), which traveled to the new target sites and collected data using methods identical to the first year. Rare and infrequent map units not receiving enough study in 2001 were targeted yielding another <u>438</u> AA sample points. Between the two years, a total of <u>1255</u> points were sampled and **Figure 12** shows their locations.

Upon completion of the fieldwork, all AA data were entered into the PLOTS database and reviewed for data entry errors. Incomplete data on the field sheets, including missing GPS coordinates were corrected if possible. Final AA points were viewed in ArcView in relation to the vegetation map coverage. Actual assessment consisted of comparing the determination made in the field for each AA point to the polygon map label. These comparisons were initially made by NatureServe ecologists and reviewed by BOR. Each point was reviewed for accuracy and for errors made by the AA ecologist. In this manner, "false" errors or mismatches between a polygon and an accuracy assessment were separated from true errors. False errors were generally recognized as resulting from one of three problems:

- **GPS errors:** The point was located incorrectly (wrong polygon) due to projection issues, GPS limitations (+/- error), or the target was placed too close to a polygon boundary.
- **Ecotone errors:** A point occurred in a zone of transition between two types.
- **Intuitive errors:** A point was classified differently than the polygon label but was overruled by NatureServe and/or BOR staff. These errors were due to discrepancies between the actual cover values and what the stand was called by the field crews. Also sometimes the stand that was assessed was too small of an area (*i.e.* inclusion). Points that made no sense were removed from the assessment entirely.

Final assessments for each point were recorded in an error matrix (*i.e.*, contingency table) (**Table 6**).

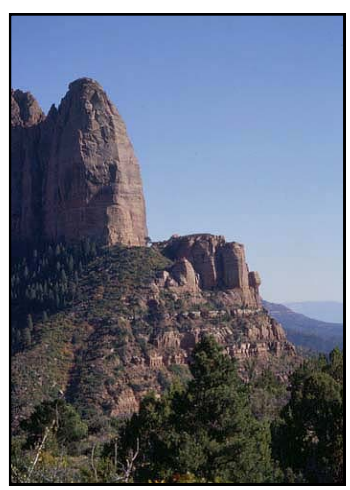


Table 2. Polygon attribute items and descriptions used in the ZION spatial database (GIS coverage).

ATTRIBUTE	DESCRIPTION
AREA*	Surface area of the polygon in meters squared
PERIMETER*	Perimeter of the polygon in meters
ZION_VEG#*	Unique internal polygon coding
ZION_VEG-ID*	Unique internal polygon coding
OLD_CODE	Initial Map Unit Codes (non-sequential), - BOR derived, project specific.
VEG_CODE	Final Map Unit Codes (sequential) - BOR derived, project specific.
VEG_NAME	Map Unit Scientific Description Name - BOR derived, project specific.
VEG_CNAME	Map Unit Common Description Name - BOR derived, project specific.
ECOLOGY	Ecological Groups - vegetation types sharing ecological processes.
PHYSIO	Physiognomic Groups – vegetation types sharing physiognomic features.
ECO_CODE	Ecological Systems Classification Code – NatureServe Ecological Classification
ECO_NAME	Ecological Systems Classification Name – NatureServe Ecological Classification
PHOTO	Corresponding Zion Orthophoto basemap (1-27 panels/sheets).
LOCATION	Location of polygon (Park or Environs).
CC_GRASS	Percent canopy cover of the grass/herbaceous layer.
CC_SHRUB	Percent canopy cover of the shrub layer.
CC_ TREE	Percent canopy cover of the tree layer. **(Percent canopy cover classes: < 5%, 5 - 25%, 25 - 50%, 50 - 75%, 75 - 100%)**
HGT_CLASS	Height range of the dominant vegetation layer **(Height classes: 0-2, 2-5, 5-10, 10-20, >20 meters)**
VEG_PAT	Vegetation pattern within the polygon or line **(Vegetation pattern classes: Clumped/patchy, Homogenous, Linear)**
BURN	Evidence of recent burning (Yes/No)
ASPEN	Presence of aspen in the polygon (Yes/No)
ASN_NAME	Project Community Name - NVC Association(s)
ASN_NAME2	Project Community Name - NVC Association(s) (continued)
ASN_CNAME	Project Common Community Name - synonym name of Association(s)
ASN_CNAME2	Project Common Community Name - synonym name of Association(s) (cont.)
ASN_CEGL	Community Element Global Code - Elcode link to NVC Association
ALL_KEY	NVC Code – to NVC Alliance Level
ALL_NAME	Project Alliance Name – NVC Alliance(s)
ALL_CNAME	Project Common Alliance Name – NVC Alliance(s)
NVCS_CODE	NVC Code - to NVC Formation level
CLASS NVCS	Formation Class - Class name (code)
SUBCLASS	NVC Formation Subclass - Subclass name (code)
GROUP	NVC Formation Group - Group name (code)
SUBGROUP	SUBGROUP NVC Formation Subgroup - Subgroup name (code)
FORMATION	NVC Formation - Formation name (code)
LUC_II	Land Use and Land Cover Classification System (USGS, Anderson et al. 1976)
NWI_SYS	National Wetlands Inventory Cowardian Wetland Classification System Label
NWI_SUB-S	National Wetlands Inventory Sub-system Label
NWI_CLASS	National Wetlands Inventory Class Label
NWI_SPEC-M	National Wetlands Inventory Special Modifiers
COMMENT1	General Description about the map unit and its distribution
COMMENT2	General Comment of how the map unit relates to other map units

(*ArcInfo© default items)

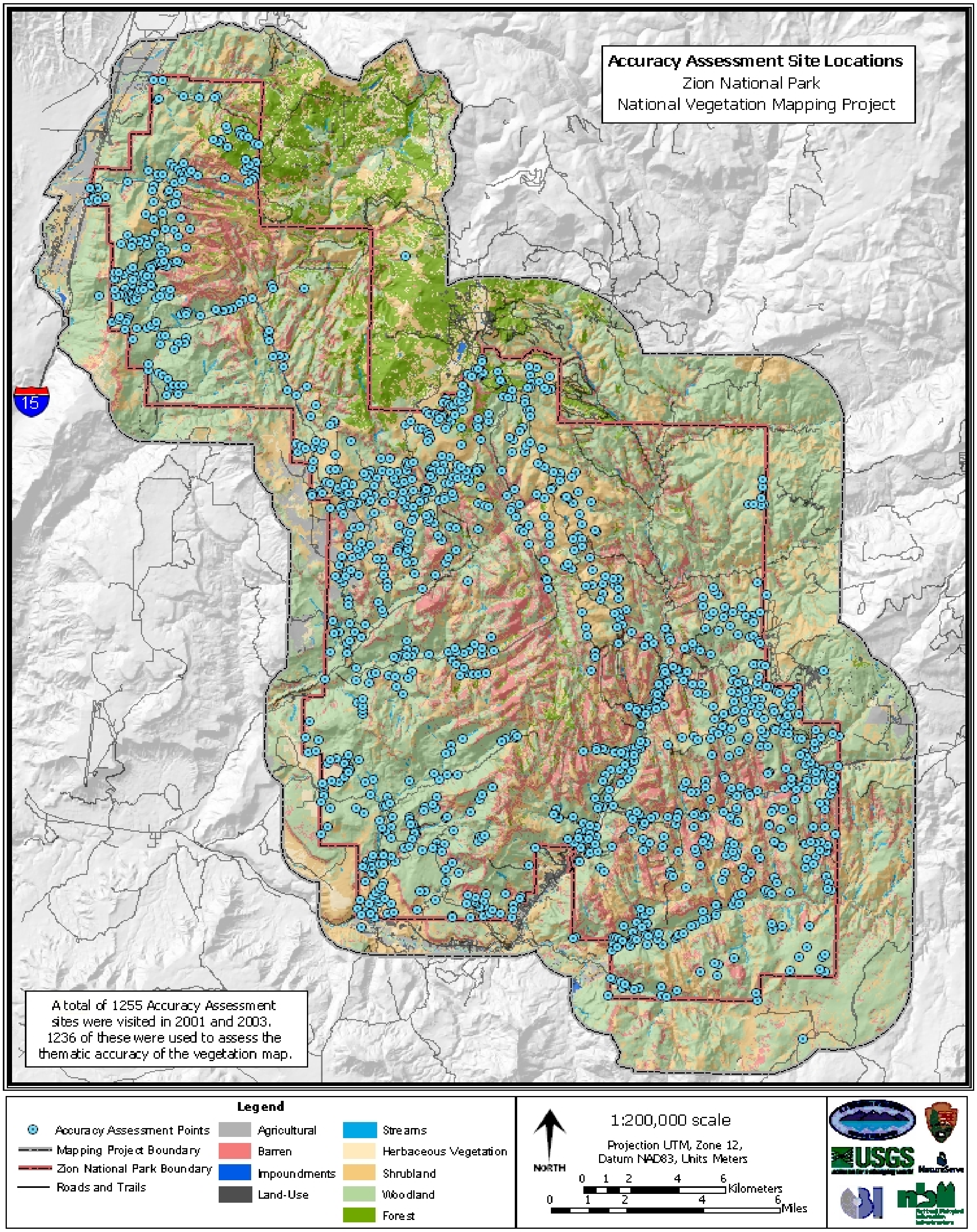


Figure 12. Locations of Accuracy Assessment Points collected at ZION.

3. RESULTS

3.1 NVC at ZION

General characteristics of the vegetation

During the course of the field work and data analyses several observations about the vegetation at ZION were made by NatureServe ecologists. These include the following:

1. During the course of the plot data collection **366** different plant species were identified by the field researchers (**Appendix H**).

2. Species common to the major bio-geographical regions around ZION contribute and intermingle in specific areas of the Park. Specifically: the Mojave Desert in the southwest, Great Basin in the west, and the Colorado Plateau in the east and northern portions.

3. The huge elevation gradient of nearly a mile (1128-2660 m, 3666-8726 ft) from Coalpits Wash to Horse Ranch Mountain and the complex landscape contribute to the high vegetation diversity. Dividing the Park into low, middle, and high elevation zones is useful to describe the vegetation of Zion National Park.

4. In hot, arid regions such as ZION, solar isolation and therefore aspect, plays a large role in determining where different vegetation types will occur. Therefore, generalized elevation zones overlap and are only approximations that vary with aspect and other local conditions.

5. The area of low elevation vegetation in the Park ranges from just below 1130 m (3700 ft) to approximately 1280m (4200 ft) depending on aspect, and is largely restricted to the South and Southwestern portions of Zion. Vegetation at these sites includes desert and semi-desert shrublands dominated by *Coleogyne ramosissima* (blackbrush), *Artemisia tridentata* (big sagebrush), *Atriplex canescens* (fourwing saltbush), *Ericameria nauseosa* (rabbitbrush), *Sarcobatus vermiculatus* (greasewood), *Gutierrezia sarothrae* (snakeweed), and *Ephedra nevadensis* (Mormon tea). There are smaller areas of desert grasslands, e.g., *Pleuraphis jamesi* (galleta) and *Aristida* spp. (threeawn). This desert vegetation may grade into sparse *Juniperus osteosperma* (Utah juniper) or *Pinus monophylla* (single-leaf pinyon) woodlands. There are also sparse badland types in eroded areas of Chinle and Moenkopi formation that are dominated by *Eriogonum corymbosum* (buckwheat), *Atriplex canescens* or *Ephedra nevadensis*.

6. Lowland riparian forests and woodlands are dominated by *Populus fremontii* (Fremont cottonwood), *Fraxinus velutina* (velvet ash), *Acer negundo* (box elder), or the introduced *Elaeagnus angustifolia* (Russian olive). Riparian and wetland areas may be dominated by herbaceous or shrub species such as *Juncus balticus* (baltic rush), *Baccharis emoryi* (seepwillow), or *Salix exigua* (sandbar willow). Some of these riparian forests and woodlands lack understories or are dominated by non-native species. This configuration is common in areas of high use such as along trails, roads, and campgrounds.

7. Middle elevation vegetation ranges from approximately 1220-2080 m (4000-6800 ft) and is often dominated by woodlands of *Juniperus osteosperma, J. scopulorum* (Rocky Mountain juniper), *Pinus edulis* (two-needle pinyon) and/or *P. monophylla*. The woodland understories are dominated by *Amelanchier utahensis* (Utah serviceberry), *Arctostyphylos patula* (greenleaf manzanita), *Artemisia tridentata, Cercocarpus montanus* (mountain mahogany), *C. ledifolius* (curl-leaf mountain-mahogany), *Purshia stansburiana* (Stansbury cliff-rose), *Quercus turbinella* (turbinella live oak), or *Q. gambelii* (gambel oak). *Juniperus osteosperma* and *Pinus monophylla* woodlands typically occur at lower elevations and on southern exposures, and *Pinus edulis* woodlands at higher elevations. *Juniperus scopulorum* and *Pinus ponderosa* (ponderosa pine) woodlands become important in this zone depending on aspect. Pure stands of oak will also occur depending on fire history. Middle-elevation riparian types are similar to low elevation types where streams are

perennial except that *Populus angustifolia* (narrow-leaf cottonwood) may be present.

8. Higher elevation vegetation is approximately 1830-2600 m (6000-8600 ft) and is characterized by montane vegetation types such as *Pinus ponderosa* woodland and forest, *Populus tremuloides* (quaking aspen) forest, *Pseudotsuga menziesii* (Douglas-fir) forests, *Abies concolor* (white fir) forests, and mixed montane shrublands and grasslands. *Quercus gambelii* is also an important shrub in this zone. Vegetation typical of this zone can extend to middle elevations in canyons where cold air drains and in more mesic environments, such as north-facing slopes. *Populus tremuloides* stands occur on more mesic sites and *Artemisia nova* (black sagebrush) shrublands on dry, rocky exposed sites.

9. There are also several "edaphic controlled" vegetation types such as *Artemisia filifolia* on sand deposits below sandstone cliffs of Navajo and perhaps other geologic formations. Sparse vegetation types such as *Pinus ponderosa* and *Cercocarpus intricatus* (littleleaf mountain-mahogany) slickrock, *Shepherdia rotundifolia* (round-leaf buffaloberry) on slumps, talus slopes, and shale/clay barrens are also present.

10. A result of the Great Basin and Colorado Plateaus floras mixing at ZION is a zone of introgression between two pinyon pines, *Pinus monophylla* and *Pinus edulis*. Individual trees may have hybrid characteristics of both species, namely the number of needles per fascicle; single-needled for *P. monophylla* and two per fascicle for *P. edulis*. We initially thought that *P. monophylla* would dominate woodlands in the western part of the Park switching to *P. edulis* in the eastern part, with Zion Canyon as the breaking point. However by looking at the plot data the actual trend was a little more complicated. Plotting the distribution of species as recorded in the plot data (**Figure 12**) you can see that *Pinus monophylla* is more common at lower elevations in the southern and western portions of ZION, with *Pinus edulis* more typical in the eastern and northern higher elevations. Based on this analysis, the zone of introgression appears very broad and not well defined. The contact zone for the two species seems to run northwest to southeast in ZION with elevation likely playing a large role.

    It should be noted that plots containing putative hybrids of *Pinus edulis* and *P. monophylla* were not included in this analysis, but could be added as a third category. Studies of other plant taxa distributions within the Park could also be done using this database.

11. Several vegetation types were very problematic to classify. The most difficult were the mixes of montane shrubs. In some areas of ZION, there are complicated, repeating mixes of montane shrubland associations dominated or co-dominated by several different shrubs such as *Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii,* or *Q. turbinella* with varying amounts of *Arctostyphylos patula, Artemisia tridentata, Purshia stansburiana, Juniperus osteosperma, Pinus edulis* or *P. monophylla.*

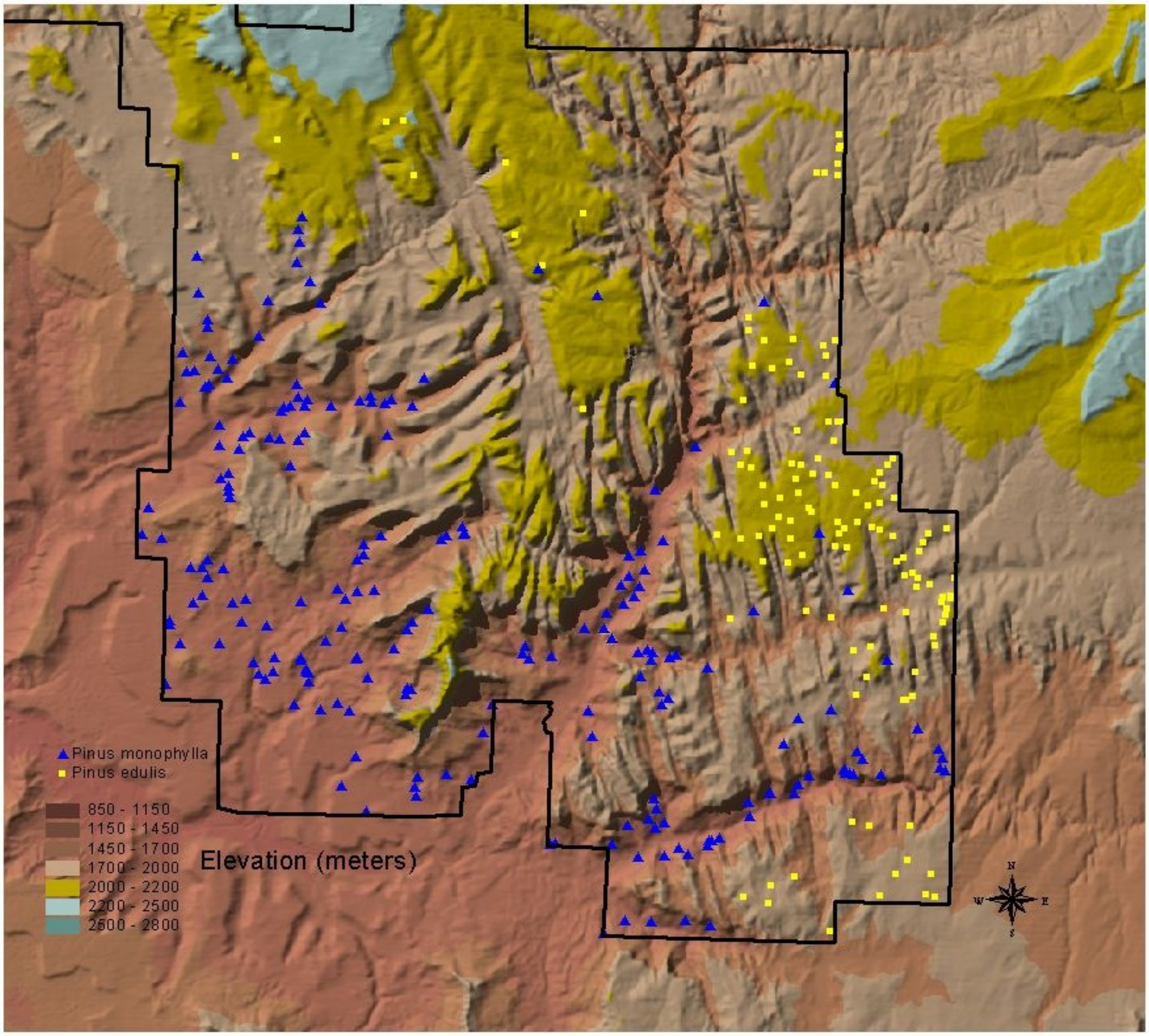


Figure 13. Location and elevation of ZION plots with Pinus edulis and Pinus monophylla.
(Figure created by Michael Schindel, TNC 2001)

We speculate that various environmental factors including fire history play important roles in controlling the distribution of these species at ZION. Although common as individual associations elsewhere in the Park, when the montane shrubs/trees intermix they form a repeatable pattern. This can be evidenced on the cobbly slopes in the Kolob Canyon region of ZION. In these instances it is difficult to determine whether the species form an unique association, a complex or mosaic of many associations, or a broad ecotone

Another group we found difficult to classify was the sparse vegetation. The distribution of sparse vegetation at ZION seemed to vary environmentally. For example it occurred on sandstone slickrock, colluvial slopes and badlands shale substrates. It also varied physiognomically, such as being tree, shrub, or forb dominated. Sparse vegetation at ZION also exhibited a wide difference in species diversity between sites. This may have been due to anthropogenic disturbance (such as past

12. agricultural activity) that effected both species composition (i.e. native vs. non-native) and abundance. Combined, these variables all compounded the classification efforts.

13. Some of the most unique vegetation types at ZION occur on "hanging gardens". These gardens are found in hydrophytic habitats associated with infrequent seeps and springs along xeric canyon walls throughout the Colorado Plateau region. The hanging gardens of ZION were not included in this study, and no plot data were collected for them, due to their small size, infrequent occurrence, often remote locations. However, they are important to recognize in any discussion of the vegetation of Zion National Park because they support endemic plants that are confined to these wet locations in the midst of an arid region. Fowler (1995) conducted a biogeographic study of the hanging gardens of the Colorado Plateau, including some of those found in ZION. He grouped the 84 gardens he sampled into five vegetation types: fern, fern-columbine, columbine, reedgrass, and fern-thistle.

    Welsh (1989) found that hanging garden vegetation varies from canyon to canyon as well as between separate alcoves within a canyon. The vegetation of hanging gardens generally has some common species that are found at most of the hanging gardens, for example *Maianthemum stellatum*, *Adiantum capillusveneris*, *Adiantum pedatum*, and *Mimulus* spp. Numerous endemics occur in these habitats and some only occur in one or two sites. These include: *Aquilegia micrantha, Carex curatorum, Cirsium rydbergii, Erigeron kachensis* (one occurrence outside of the hanging gardens in the Abajo Mts.), *Erigeron sionis*, *E. zothecinus, Platanthera zothecina, Mimulus eastwoodiae, Perityle specuicola,* and *Primula specuicola.*

NVC Associations

The final classification for ZION resulted in **95** associations. Of that total, 53 are existing NVC associations and 42 are new local associations that were defined by this project. The classification results reflect both the high diversity of vegetation in the Park and the lack of comprehensive vegetation classification work in this region. This is especially true with the montane shrublands, and pinyon and juniper woodlands. **Table 3** has a complete list of Zion plant associations that were described by this study, and **Appendix F** provides complete descriptions for each of them.

3.2 Photo-interpretation and Map Units

We recognized and delineated 76 map units on the true color aerial photographs for ZION. This included 17 barren or unvegetated units, 48 vegetation units and 11 Anderson Level II (1976) land-use units (**Table 4**). All map units were developed from a combination of an initial NVC vegetation classification provided by NatureServe with input from Park biologists and BOR ecologists, fieldwork, and preliminary photo-interpretation.

Please reference **Appendix I**. for detailed descriptions and representative photos for all vegetation map units.

An example of the Intermittent Stream Map Unit #72 and Tinaja (natural water holes / tanks) Map Unit #17 at ZION

Table 3. List of NVC Plant Associations found at Zion National Park.

Plant Association Name	Common Name	Elcode*
Mesic Herbaceous Vegetation		
Carex nebrascensis Herbaceous Vegetation	Nebraska Sedge Herbaceous Vegetation	CEGL001813
Carex utriculata Herbaceous Vegetation	Beaked Sedge Herbaceous Vegetation	CEGL001562
Equisetum (arvense, variegatum) Herbaceous Vegetation	(Field Horsetail, Variegated Scouringrush) Herbaceous Vegetation	CEGL005148
Juncus balticus Herbaceous Vegetation	Baltic Rush Herbaceous Vegetation	CEGL001838
Upland Grasslands		
Bouteloua gracilis - Hesperostipa comata Dwarf-shrub Herbaceous Vegetation	Blue Grama - Needle-and-Thread Dwarf-shrub Herbaceous Vegetation	NEW CEGL002932
Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation	Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation	CEGL005264
Bromus tectorum Semi-natural Herbaceous Vegetation	Cheatgrass Herbaceous Semi-natural Herbaceous Vegetation	CEGL003019
Hesperostipa comata Great Basin Herbaceous Vegetation	Needle-and-Thread Great Basin Herbaceous Vegetation	CEGL001705
Muhlenbergia (pungens, montana) - Heterotheca villosa Herbaceous Vegetation	(Sandhill Muhly, Mountain Muhly) - Hairy Goldenaster Herbaceous Vegetation	NEW CEGL002938
Pleuraphis jamesii Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	CEGL001777
Poa pratensis Semi-natural Seasonally Flooded Herbaceous Vegetation	Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Vegetation	CEGL003081
Sporobolus cryptandrus Great Basin Herbaceous Vegetation	Sand Dropseed Great Basin Herbaceous Vegetation	CEGL002691
Thinopyrum intermedium Semi-natural Herbaceous Vegetation	Intermediate Wheatgrass Semi-natural Herbaceous Vegetation	NEW CEGL002935

Xeric Shrublands		
Coleogyne ramosissima Shrubland	Blackbrush Shrubland	CEGL001332
Coleogyne ramosissima / Pleuraphis jamesii Shrubland	Blackbrush / James' Galleta Shrubland	CEGL001334
Ephedra nevadensis – Lichen Sparse Vegetation	Nevada Jointfir – Lichen Sparse Vegetation	NEW CEGLOO2976
Ephedra nevadensis Basalt Shrubland	Nevada Jointfir Basalt Shrubland	NEW CEGL002936
Eriogonum corymbosum Badlands Sparse Vegetation	Crispleaf buckwheat Badlands Sparse Vegetation	NEW CEGL002979
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland	Broom Snakeweed – (Prickly Pear) / James' Galleta Dwarf-shrubland	CEGL002690
Upland Shrublands		
Amelanchier utahensis Shrubland	Utah Serviceberry Shrubland	CEGL001067
Arctostaphylos patula Shrubland	Greenleaf Manzanita Shrubland	NEW CEGL002696
Arctostaphylos patula - Artemisia tridentata ssp. vaseyana Shrubland	Greenleaf Manzanita - Mountain Big Sagebrush Shrubland	NEW CEGL002694
Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis) Shrubland	Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland	NEW CEGL002695
Arctostaphylos pungens Shrubland	Mexican Manzanita Shrubland	CEGL000958
Artemisia filifolia Colorado Plateau Shrubland	Sand Sagebrush Colorado Plateau Shrubland	CEGL002697
Artemisia nova / Elymus elymoides Dwarf-shrubland	Black Sagebrush / Bottlebrush Dwarf-shrubland	CEGL001418
Artemisia nova / Hesperostipa comata Dwarf-shrubland	Black Sagebrush / Needle-and-Thread Dwarf-shrubland	CEGL001425
Artemisia nova / Poa fendleriana Dwarf-shrubland	Black Sagebrush / Muttongrass Dwarf-shrubland	NEW CEGL002698
Artemisia tridentata / Bouteloua gracilis Shrubland	Big Sagebrush / Blue Grama Shrubland	CEGL000995

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Shrubland	Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Shrubland	NEW CEGL002699
Artemisia tridentata ssp. tridentata / Pascopyrum smithii - (Elymus lanceolatus) Shrubland	Basin Big Sagebrush / Western Wheatgrass - (Streamside Wild Rye) Shrubland	CEGL001017
Artemisia tridentata ssp. vaseyana / Hesperostipa comata Shrubland	Mountain Big Sagebrush / Needle-and-Thread Shrubland	NEW CEGL002931
Atriplex canescens Shrubland	Fourwing Saltbush Shrubland	CEGL001281
Atriplex canescens - Artemisia tridentata Shrubland	Fourwing Saltbush - Big Sagebrush Shrubland	CEGL001282
Cercocarpus intricatus Slickrock Sparse Vegetation	Littleleaf Mountain-mahogany Slickrock Sparse Vegetation	NEW CEGL002977
Cercocarpus montanus Rock Pavement Sparse Vegetation	Mountain-mahogany Rock Pavement Sparse Vegetation	NEW CEGL002978
Chrysothamnus viscidiflorus / Poa pratensis Shrub Herbaceous Vegetation	Green Rabbitbrush / Kentucky Bluegrass Shrub Herbaceous Vegetation	NEW CEGL002933
Ericameria nauseosa / Bromus tectorum Shrubland	Rubber Rabbitbrush / Cheatgrass Shrubland	CEGL002937
Ericameria nauseosa Sand Deposit Sparse Vegetation	Rubber Rabbitbrush Sand Deposit Sparse Vegetation	NEW CEGL002980
Purshia stansburiana - Arctostaphylos patula Shrubland	Stansbury Cliff-rose - Greenleaf Manzanita Shrubland	NEW CEGL002948
Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland	Gambel Oak - Mountain-mahogany / (Geyer's Sedge) Shrubland	CEGL001113
Quercus gambelii / Amelanchier utahensis Shrubland	Gambel Oak / Utah Serviceberry Shrubland	CEGL001110
Quercus gambelii / Artemisia tridentata Shrubland	Gambel Oak / Big Sagebrush Shrubland	CEGL001111
Quercus gambelii / Poa fendleriana Shrubland	Gambel Oak / Muttongrass Shrubland	NEW CEGL002949
Quercus gambelii / Symphoricarpos oreophilus Shrubland	Gambel Oak / Mountain Snowberry Shrubland	CEGL001117
Quercus turbinella - (Amelanchier utahensis) Colluvial Shrubland	Turbinella Live Oak - (Utah Serviceberry) Colluvial Shrubland	NEW CEGL002950
Symphoricarpos oreophilus / Poa pratensis Semi-natural Shrubland	Mountain Snowberry / Kentucky Bluegrass Semi-natural Shrubland	NEW CEGL002951
Tetradymia canescens - Ephedra viridis Shrubland	Gray Horsebrush - Mormon-tea Shrubland	NEW CEGL002973

Riparian Shrublands		
Baccharis emoryi Shrubland	Emory Seepwillow Shrubland	NEW CEGL002974
Salix exigua / Barren Shrubland	Coyote Willow / Barren Shrubland	CEGL001200
Salix exigua / Mesic Graminoids Shrubland	Coyote Willow / Mesic Graminoids Shrubland	CEGL001203
Salix ligulifolia / Carex utriculata Shrubland	Strapleaf Willow / Beaked Sedge Shrubland	NEW CEGL002975
Pluchea sericea Seasonally Flooded Shrubland	Arrow-weed Seasonally Flooded Shrubland	CEGL003080
Riparian Woodlands		
Acer negundo / Brickellia grandiflora Woodland	Box-elder / Tasselflower Brickelbush Woodland	NEW CEGL002692
Acer negundo / Disturbed Understory Woodland	Box-elder / Disturbed Understory Woodland	NEW CEGL002693
Fraxinus anomala Woodland	Single-leaf Ash Woodland	NEW CEGL002752
Populus fremontii / Baccharis emoryi Woodland	Fremont Cottonwood / Emory Seepwillow Woodland	NEW CEGL002946
Populus fremontii / Betula occidentalis Wooded Shrubland	Fremont Cottonwood / Water Birch Wooded Shrubland	NEW CEGL002981
Populus fremontii / Salix exigua Forest	Fremont Cottonwood / Coyote Willow Forest	CEGL000666
Populus fremontii - Fraxinus velutina Woodland	Fremont Cottonwood - Velvet Ash Woodland	CEGL000942
Deciduous Forests		
Acer grandidentatum / Quercus gambelii Forest	Bigtooth Maple / Gambel Oak Forest	CEGL000559
Populus tremuloides - Abies concolor / Poa pratensis Forest	Quaking Aspen - White Fir / Kentucky Bluegrass Forest	NEW CEGL002947
Populus tremuloides - Abies concolor / Symphoricarpos oreophilus Forest	Quaking Aspen - White Fir / Mountain Snowberry Forest	CEGL000523
Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus Forest	Quaking Aspen / Gambel Oak / Mountain Snowberry Forest	CEGL000598
Populus tremuloides / Symphoricarpos oreophilus / Tall Forbs Forest	Quaking Aspen / Mountain Snowberry / Tall Forbs Forest	CEGL000615

Coniferous Woodlands		
Juniperus osteosperma / Artemisia tridentata Woodland	Utah Juniper / Big Sagebrush Woodland	CEGL000730
Juniperus scopulorum - Quercus gambelii Woodland	Rocky Mountain Juniper - Gambel Oak Woodland	NEW CEGL002967
Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland	Two-needle Pinyon - Utah Juniper / Greenleaf Manzanita Woodland	NEW CEGL002939
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland	Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland	CEGL000779
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland	Two-needle Pinyon - Utah Juniper / Stansbury Cliff-rose Woodland	CEGL000782
Pinus edulis - Juniperus spp. / Artemisia tridentata Woodland	Two-needle Pinyon - Juniper species / Big Sagebrush Woodland	CEGL000776
Pinus edulis - Juniperus spp. / Cercocarpus montanus Woodland	Two-needle Pinyon - Juniper species / Mountain-mahogany Woodland	CEGL000780
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland	Two-needle Pinyon - Juniper species / Gambel Oak Woodland	CEGL000791
Pinus edulis / Cercocarpus ledifolius Woodland	Two-needle Pinyon / Curl-leaf Mountain-mahogany Woodland	NEW CEGL002940
Pinus monophylla - Juniperus osteosperma Woodland	Singleleaf Pinyon - Utah Juniper Woodland	CEGL000829
Pinus monophylla - Juniperus osteosperma / Artemisia tridentata Woodland	Singleleaf Pinyon - Utah Juniper / Big Sagebrush Woodland	CEGL000832
Pinus monophylla - Juniperus osteosperma / Artemisia nova Woodland	Singleleaf Pinyon - Utah Juniper / Black Sagebrush Woodland	CEGL000831
Pinus monophylla - Juniperus osteosperma / Cercocarpus montanus - Quercus gambelii Woodland	Singleleaf Pinyon - Utah Juniper / Mountain-mahogany - Gambel Oak Woodland	NEW CEGL002968
Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima Woodland	Singleleaf Pinyon - Utah Juniper / Blackbrush Woodland	NEW CEGL002971
Pinus monophylla - Juniperus osteosperma / Gutierrezia sarothrae / Pleuraphis jamesii Woodland	Singleleaf Pinyon - Utah Juniper / Snakeweed / James' Galleta Woodland	NEW CEGL002970
Pinus monophylla - Juniperus osteosperma / Hesperostipa comata Woodland	Singleleaf Pinyon - Utah Juniper / Needle-and-Thread Woodland	NEW CEGL002969
Pinus monophylla - Juniperus osteosperma / Quercus turbinella Woodland	Singleleaf Pinyon - Utah Juniper / Turbinella Live Oak Woodland	NEW CEGL002941

Pinus monophylla - Juniperus osteosperma / (Shepherdia rotundifolia, Amelanchier utahensis) Woodland	Singleleaf Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Woodland	NEW CEGL002942
Pinus ponderosa / Arctostaphylos patula Woodland	Ponderosa Pine / Greenleaf Manzanita Woodland	CEGL000842
Pinus ponderosa / Artemisia nova Woodland	Ponderosa Pine / Black Sagebrush Woodland	CEGL000846
Pinus ponderosa / Bromus inermis Semi-natural Woodland	Ponderosa Pine / Smooth Brome Semi-natural Woodland	NEW CEGL002943
Pinus ponderosa / Pteridium aquilinum Woodland	Ponderosa Pine / Northern Bracken Woodland	NEW CEGL002944
Pinus ponderosa / Quercus gambelii Woodland	Ponderosa Pine / Gambel Oak Woodland	CEGL000870
Pinus ponderosa Slickrock Sparse Vegetation	Ponderosa Pine Slickrock Sparse Vegetation	NEW CEGL002972
Coniferous Forests		
Abies concolor / Acer grandidentatum Forest	White Fir / Bigtooth Maple Forest	CEGL000241
Abies concolor / Arctostaphylos patula Forest	White Fir / Greenleaf Manzanita Forest	CEGL000242
Abies concolor / Quercus gambelii Forest	White Fir / Gambel Oak Forest	CEGL000261
Abies concolor / Symphoricarpos oreophilus Forest	White Fir / Mountain Snowberry Forest	CEGL000263
Pseudotsuga menziesii / Quercus gambelii Forest	Douglas-fir / Gambel Oak Forest	CEGL000452
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest	Douglas-fir / Mountain Snowberry Forest	CEGL000462
Pseudotsuga menziesii / Acer granditentatum Forest	Douglas-fir / Bigtooth Maple Forest	CEGL000419

***ELCODE** represents NatureServe's internal database tracking code for each recognized plant association.
- NVC associations first defined at Zion during this project are indicated in the ELCODE column (**NEW**).

Table 4. Map units used for Zion National Park.
The units are organized into ecological groups. "Level" refers to whether the map unit represents a NVC plant association or alliance (NVC unless otherwise noted), local plant community/plant population, or a land use class. Anderson Land Use Classes are identified by Roman numerals.

Map Code	Map Unit Name	Map Unit Common Name	Level
Unvegetated Surfaces			
1	Carmel Formation (Limestone)	Carmel Formation (Limestone)	N/A
2	Temple Cap (Sandstone)	Temple Cap (Sandstone)	N/A
3	Navajo Formation (Sandstone)	Navajo Formation (Sandstone)	N/A
4	Kayenta Formation (Sandstone)	Kayenta Formation (Sandstone)	N/A
5	Moenave Formation (Sandstone)	Moenave Formation (Sandstone)	N/A
6	Chinle Formation – Petrified Forest (Shale)	Chinle Formation – Petrified Forest (Shale)	N/A
7	Chinle Formation – Shinarump (Shale)	Chinle Formation – Shinarump (Shale)	N/A
8	Moenkopi Formation (Conglomerate)	Moenkopi Formation (Conglomerate)	N/A
9	Kaibab Formation (Limestone)	Kaibab Formation (Limestone)	N/A
10	Basalt Talus	Basalt Talus	N/A
11	Unvegetated Volcanic Cinders and Cinder Cones	Unvegetated Volcanic Cinders and Cinder Cones	N/A
12	Slides (Fans and Slumps)	Slides (Fans and Slumps)	N/A
13	Gullies and Eroded Lands	Gullies and Eroded Lands	N/A
14	Sand Bars and Beaches	Sand Bars and Beaches	N/A

15	Volcanic and Basalt Cliffs	Volcanic and Basalt Cliffs	N/A
16	Snags	Snags	N/A
17	Tinajas (natural water holes / tanks)	Tinajas (natural water holes / tanks)	N/A
	Upland Grasslands		
18	*Poa pratensis - Bromus inermis* Semi-natural Grassland Complex	Perennial Disturbed Grassland Complex	Complex
19	*Bromus tectorum* Semi-natural Herbaceous Vegetation	Cheatgrass Annual Disturbed Grassland	Association
20	*Pleuraphis jamesii* Herbaceous Vegetation	James' Galleta Herbaceous Vegetation	Association
21	*Sporobolus cryptandrus* Great Basin Herbaceous Vegetation	Sand Dropseed Great Basin Herbaceous Vegetation	Association
22	Dry Meadow Mixed Herbaceous Vegetation Mosaic	Dry Meadow Mixed Herbaceous Vegetation Mosaic	Mosaic
	Mesic Herbaceous Vegetation		
23	*Carex spp.- Juncus spp.* Wet Meadow Herbaceous Vegetation Mosaic	Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic	Mosaic
	Wetland Herbaceous Vegetation		
24	*Typha spp., Scirpus spp.* Emergent Wetland Complex	Cattail, Bulrush, Emergent Wetland Complex	Complex
	Xeric Shrublands		
25	*Coleogyne ramosissima* Shrubland Complex	Blackbrush Shrubland Complex	Complex
26	*Ephedra nevadensis - Eriogonum corymbosum* Badlands Sparse Vegetation	Painted Desert Sparsely Vegetated Alliance	Alliance
27	*Ephedra nevadensis* Basalt Shrubland	Nevada Joint-fir Basalt Shrubland	Association
28	*Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii* Dwarf-shrubland	Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland	Association
29	*Prosopis glanulosa* Shrub Stands	Honey Mesquite Shrub Stands	Local Plant Community[3]

Upland Shrublands			
30	*Artemisia filifolia* Colorado Plateau Shrubland	Sand Sagebrush Colorado Plateau Shrubland	Association
31	*Artemisia tridentata* Shrubland Complex	Big Sagebrush Shrubland Complex	Complex
32	*Ericameria (Chrysothamnus) spp.* Shrubland Complex	Rabbitbrush Shrubland Complex	Complex
33	*Cercocarpus intricatus Slickrock* Sparse Vegetation	Littleleaf Mountain-mahogany Slickrock Sparse Vegetation	Association
34	*Quercus turbinella - (Amelanchier utahensis)* Colluvial Shrubland	Talus Mixed Shrubland	Association
35	*Symphoricarpos oreophilus / Poa pratensis* Semi-natural Shrubland	Mountain Snowberry / Kentucky Bluegrass Semi-natural Shrubland	Association
36	*Artemisia nova Dwarf-shrubland* Complex	Black Sagebrush Dwarf-shrubland Complex	Complex
37	*Arctostaphylos patula* Shrubland Complex	Greenleaf Manzanita Shrubland Complex	Complex
38	*Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis)* Shrubland	Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland	Association
39	*Quercus gambelii* Shrubland Alliance	Gambel Oak Shrubland Alliance	Alliance
40	*Mixed Mountain* Shrubland Complex	Mixed Mountain Shrubland Complex	Complex
41	*Amelanchier utahensis* Shrubland	Utah Serviceberry Shrubland	Association
42	*Cercocarpus montanus* Rock Pavement Sparse Vegetation	Mountain-mahogany Rock Pavement Sparse Vegetation	Association
Riparian Shrublands			
43	*Baccharis emoryi* Shrubland	Emory Seepwillow Shrubland	Association
44	*Salix exigua* Shrubland Alliance	Sandbar Willow Shrubland Alliance	Alliance
45	*Tamarix spp.* Temporarily Flooded Shrubland	Tamarisk spp. Temporarily Flooded Shrubland	Association

46	*Pluchea sericea* Seasonally Flooded Shrubland	Arrow-weed Seasonally Flooded Shrubland	Association
47	*Salix ligulifolia / Carex utriculata* Shrubland	Strapleaf Willow / Beaked Sedge Shrubland	Association
Riparian Woodlands			
48	*Fraxinus anomala* Woodland	Single-leaf Ash Woodland	Association
49	*Acer negundo* Woodland Alliance	Boxelder Woodland Alliance	Alliance
50	*Populus fremontii* Woodland Complex	Fremont Cottonwood Woodland Complex	Complex
51	*Populus fremontii - Fraxinus velutina* Woodland	Fremont Cottonwood – Velvet Ash Woodland	Association
52	*Elaeagnus angustifolia* Semi-natural Woodland	Russian Olive Semi-natural Woodland	Association
Deciduous Forests			
53	*Quercus gambelii* Woodland	Gambel Oak Woodland	Association
54	*Acer grandidentatum / Quercus gambelii* Forest	Bigtooth Maple / Gambel Oak Forest	Association
55	*Populus tremuloides* Forest Complex	Quaking Aspen Forest Complex	Complex
Coniferous Woodlands			
56	*Juniperus spp. / Artemisia tridentata* Woodland Complex	Juniper / Big Sagebrush Woodland Complex	Complex
57	*Pinus spp. - Juniperus spp.* Woodland Complex	Pinyon - Juniper Woodland Complex	Complex
58	*Pinus spp. - Juniperus spp. / Quercus gambelii* Woodland Complex	Pinyon - Juniper / Gambel Oak Woodland Complex	Complex
59	*Pinus ponderosa* Slickrock Sparse Vegetation	Ponderosa Pine Slickrock Sparse Vegetation	Association
60	*Pinus ponderosa / Arctostaphylos patula* Woodland	Ponderosa Pine / Greenleaf Manzanita Woodland	Complex
61	*Pinus ponderosa / Quercus gambelii* Woodland Complex	Ponderosa Pine / Gambel Oak Woodland Complex	Complex
62	*Pinus ponderosa* / Mixed Herbaceous Woodland Complex	Ponderosa Pine / Mixed Herbaceous Woodland Complex	Complex

Coniferous Forests			
63	*Pinus ponderosa* Forest (Closed Canopy)	Ponderosa Pine Forest (Closed Canopy)	Association
64	*Pseudotsuga menziesii* Forest Alliance	Douglas-fir Forest Alliance	Alliance
65	*Abies concolor* Forest Alliance	White Fir Forest Alliance	Alliance
Land-use			
66	Transportation, Communications, and Utilities	Transportation, Communications, and Utilities	Level II
67	Mixed Urban or Built-up Land	Mixed Urban or Built-up Land	Level II
68	Croplands and Pastures	Croplands and Pastures	Level II
69	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	Level II
70	Other Agricultural Lands	Other Agricultural Lands	Level II
71	Perennial Streams	Perennial Streams	Level II
72	Intermittent Streams	Intermittent Streams	Level II
73	Reservoirs	Reservoirs	Level II
74	Canals	Canals	Level II
75	Stock Ponds	Stock Ponds	Level II
76	Strip Mines, Quarries, and Gravel Pits	Strip Mines, Quarries, and Gravel Pits	Level II

[1] **Complex:** a group of plant associations that cannot be mapped individually on the aerial photographs but occur together predictably on the landscape**.** Complexes typically are composed of associations with similar physiognomies, thus are more difficult to tell apart on the photos.

[2] **Mosaic:** individual associations are recognizable on the aerial photography but are too intermixed to map as separate polygons.

[3] **Local Plant Community:** represents discrete stands of vegetation that are too small and/or occur too infrequently to classify.

3.3 Relationship between Map Units and Plant Associations

The ZION map units represent a compromise among the detail of the NVC, the needs of the Park and the limitations of the photography. As a result, the ZION mapping scheme does not exactly match the NVC. Rather, the vegetation map units are linked (i.e. "crosswalked") to the NVC plant associations.

Here are the possible scenarios: 1) When a plant association or alliance has an unique photo signature and can be readily delineated on the photos, the map unit adopts the plant association/alliance name. This is considered a one-to-one relationship. 2) When plant associations occur in stands too small to map or when related plant associations share the same signature and *are not* recognizable on the photos, several plant associations are lumped into a single map unit called a complex.
3) Similarly, when associations *are* recognizable on the aerial photography but are too intermixed to map as separate polygons a mosaic designation is used; these are many-to-one situations. 4) Next, when more than one phase of a single plant association can be recognized on the photos, a plant association is split into several map classes. This is a one-to-many situation. 5) Finally, non-vegetated areas and vegetation types not recognized by the NVC receive special map unit designations.

Below is a comprehensive breakdown of the crosswalking of the NVC associations to the map units for ZION:

(One Association-to-One Map Class)

-Map Units Representing Single NVC Units (either existing or new)

The following map units were created from the NVC and represent established or provisional plant associations or alliances that could be discerned and delineated on the aerial photography.

Map Code | Map Unit
NVC Plant Association / ALLIANCE

19 *Bromus tectorum* Semi-natural Herbaceous Vegetation
Bromus tectorum Semi-natural Herbaceous Vegetation

20 *Pleuraphis jamesii* Herbaceous Vegetation
Pleuraphis jamesii Herbaceous Vegetation

21 *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation
Sporobolus cryptandrus Great Basin Herbaceous Vegetation

26 *Ephedra nevadensis - Eriogonum corymbosum* Badlands Sparse Vegetation (Alliance)
PAINTED DESERT SPARSELY VEGETATED ALLIANCE
Ephedra nevadensis / Lichen Sparse Vegetation*
Eriogonum corymbosum Badlands Sparse Vegetation*

27 *Ephedra nevadensis* Basalt Shrubland
Ephedra nevadensis Basalt Shrubland

28 *Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii* Dwarf-shrubland
Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland

30 *Artemisia filifolia* Colorado Plateau Shrubland
Artemisia filifolia Colorado Plateau Shrubland

33 *Cercocarpus intricatus* Slickrock Sparse Vegetation
Cercocarpus intricatus Slickrock Sparse Vegetation

34 *Quercus turbinella - (Amelanchier utahensis)* Colluvial Shrubland
Quercus turbinella - (Amelanchier utahensis) Colluvial Shrubland

35 *Symphoricarpos oreophilus / Poa pratensis* Semi-natural Shrubland
Symphoricarpos oreophilus / Poa pratensis Semi-natural Shrubland

38 *Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis)* Shrubland
Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis) Shrubland

41 *Amelanchier utahensis* Shrubland
Amelanchier utahensis Shrubland

42 *Cercocarpus montanus* Rock Pavement Sparse Vegetation
Cercocarpus montanus Rock Pavement Sparse Vegetation

43 *Baccharis emoryi* Shrubland
Baccharis emoryi Shrubland

44 *Salix exigua* Shrubland Alliance
SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE
Salix exigua / Barren Shrubland*
Salix exigua / Mesic Graminoids Shrubland*

45 *Tamarix* spp. Temporarily Flooded Shrubland
Tamarix spp. Temporarily Flooded Shrubland

46 *Pluchea sericea* Seasonally Flooded Shrubland
Pluchea sericea Seasonally Flooded Shrubland

47 *Salix ligulifolia / Carex utriculata* Shrubland
Salix ligulifolia / Carex utriculata Shrubland

48 *Fraxinus anomala* Woodland
Fraxinus anomala Woodland

49 *Acer negundo* Woodland Alliance
ACER NEGUNDO TEMPORARILY FLOODED WOODLAND ALLIANCE
Acer negundo / Brickellia grandiflora Woodland*
Acer negundo / Disturbed Understory Woodland*

51 *Populus fremontii - Fraxinus velutina* Woodland
Populus fremontii - Fraxinus velutina Woodland

52 *Elaeagnus angustifolia* Semi-natural Woodland
Elaeagnus angustifolia Semi-natural Woodland

54 *Acer grandidentatum / Quercus gambelii* Forest
Acer grandidentatum / Quercus gambelii Forest

59 *Pinus ponderosa* Slickrock Sparse Vegetation
Pinus ponderosa Slickrock Sparse Vegetation

60 *Pinus ponderosa / Arctostaphylos patula* Woodland
Pinus ponderosa / Arctostaphylos patula Woodland

64 *Pseudotsuga menziesii* Forest Alliance
PSEUDOTSUGA MENZIESII FOREST ALLIANCE
Pseudotsuga menziesii / Quercus gambelii Forest*
Pseudotsuga menziesii / Symphoricarpos oreophilus Forest*
Pseudotsuga menziesii / Acer granditentatum Forest*

65 *Abies concolor* Forest Alliance
ABIES CONCOLOR FOREST ALLIANCE
Abies concolor / Acer grandidentatum Forest*
Abies concolor / Arctostaphylos patula Forest*
Abies concolor / Quercus gambelii Forest*
Abies concolor / Symphoricarpos oreophilus Forest*

*Represents documented associations that could not be mapped separately from other associations within the Alliance.

(Many Associations-to-One Map Class)

-Map Units Representing Aggregations of Plant Associations (Mosaic)
Associations are recognizable on the aerial photography but are too intermixed to map as separate polygons.

Map Code | Map Unit
NVC Plant Associations

22 Dry Meadow Mixed Herbaceous Vegetation Mosaic
Bouteloua gracilis - Hesperostipa comata Herbaceous Vegetation
Hesperostipa comata Great Basin Herbaceous Vegetation
Muhlenbergia (pungens, montana) - Heterotheca villosa Herbaceous Vegetation
Thinopyrum intermedium Herbaceous Vegetation Herbaceous Vegetation

23 Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic
Carex utriculata Herbaceous Vegetation
Carex nebrascensis Herbaceous Vegetation
Equisetum (arvense, variegatum) Herbaceous Vegetation
Juncus balticus Herbaceous Vegetation


Geologic Formations at ZION

(Many Associations-to-One Map Class)

-Map Units Representing Aggregations of Plant Associations (Complex)
In cases where closely related plant associations could not be distinguished on the photos, they were combined into a single map unit.

Map Code	Map Unit / *NVC Plant Associations*
18	Perennial Disturbed Grassland Complex
	Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation
	Poa pratensis Semi-natural Seasonally Flooded Herbaceous Alliance
25	*Coleogyne ramosissima* Shrubland Complex
	Atriplex canescens Shrubland
	Coleogyne ramosissima Shrubland
	Coleogyne ramosissima / Pleuraphis jamesii Shrubland
31	*Artemisia tridentata* Shrubland Complex
	Artemisia tridentata / Bouteloua gracilis Shrubland
	A. tridentata - (Ericameria nauseosa) / Bromus tectorum Shrubland
	A. tridentata ssp. tridentata / Pascopyrum smithii - (Elymus lanceolatus) Shrubland
	Artemisia tridentata ssp. vaseyana / Hesperostipa comata Shrubland
	Atriplex canescens - Artemisia tridentata Shrubland
	Tetradymia canescens - Ephedra viridis Shrubland
32	*Ericameria (Chrysothamnus)* spp. Shrubland Complex
	Chrysothamnus viscidiflorus / Poa pratensis Shrub Herbaceous Vegetation [Provisional]
	Ericameria nauseosa / Bromus tectorum Shrubland
	Ericameria nauseosa Sand Deposit Sparse Vegetation
36	*Artemisia nova* Dwarf-shrubland Complex
	Artemisia nova / Elymus elymoides Dwarf-shrubland
	Artemisia nova / Hesperostipa comata Dwarf-shrubland
	Artemisia nova / Poa fendleriana Dwarf-shrubland
37	*Arctostaphylos patula* Shrubland Complex
	Arctostaphylos patula - Artemisia tridentata ssp. vaseyana Shrubland
	Arctostaphylos patula Shrubland
	Purshia stansburiana - Arctostaphylos patula Shrubland
40	Mixed Mountain Shrubland Complex*
	Arctostaphylos pungens Shrubland
	Arctostaphylos patula - Artemisia tridentata ssp. vaseyana Shrubland *
	Arctostaphylos patula Shrubland *
	Purshia stansburiana - Arctostaphylos patula Shrubland*
	Quercus turbinella - (Amelanchier utahensis) Colluvial Shrubland *
	Cercocarpus montanus Rock Pavement Sparse Vegetation*

50 *Populus fremontii* Woodland Complex
Populus fremontii / Betula occidentalis Wooded Shrubland
Populus fremontii / Salix exigua Forest
Populus fremontii / Baccharis emoryi Woodland

55 *Populus tremuloide*s Forest Complex
Populus tremuloides - Abies concolor / Symphoricarpos oreophilus Forest
Populus tremuloides - Abies concolor / Poa pratensis Forest
Populus tremuloides / Symphoricarpos oreophilus / Tall Forbs Forest
Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus Forest

56 *Juniperus spp. / Artemisia tridentata* Woodland Complex
Juniperus osteosperma / Artemisia tridentata Woodland
Pinus edulis - Juniperus spp. / Artemisia tridentata Woodland
Pinus monophylla - Juniperus osteosperma / Artemisia tridentata Woodland

57 *Pinus spp. - Juniperus spp.* Woodland Complex,
Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus Woodland
Pinus edulis - Juniperus osteosperma / Purshia stansburiana Woodland
Pinus edulis - Juniperus osteosperma / Arctostaphylos patula Woodland
Pinus edulis - Juniperus osteosperma / Cercocarpus montanus Woodland
Pinus edulis - Juniperus osteosperma / Cercocarpus ledifolius Woodland
Pinus monophylla - Juniperus osteosperma / Artemisia nova Woodland
Pinus monophylla - Juniperus osteosperma / Quercus turbinella Woodland
Pinus monophylla - Juniperus osteosperma / (Shepherdia rotundifolia Amelanchier Utahensis) Woodland
Pinus monophylla - Juniperus osteosperma / Cercocarpus montanus - Quercus gambelii Woodland
Pinus monophylla - Juniperus osteosperma / Gutierrezia sarothrae Woodland
Pinus monophylla - Juniperus osteosperma / Pleuraphis jamesii Woodland
Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima Woodland

58 *Pinus spp. - Juniperus spp. / Quercus gambelii* Woodland Complex
Juniperus scopulorum - Quercus gambelii Woodland
Pinus edulis - Juniperus spp. / Quercus gambelii Woodland

61 *Pinus ponderosa / Quercus gambelii* Woodland Complex
Pinus ponderosa / Quercus gambelii Woodland
Pinus ponderosa / Pteridium aquilinum Woodland [Provisional]

62 *Pinus ponderosa* / Mixed Herbaceous Woodland Complex
Pinus ponderosa / Bromus inermis Semi-natural Woodland
Pinus ponderosa / Artemisia nova Woodland

***** The Mixed Mountain Shrubland Complex represents an unique map unit that occurs on a specific habitat in ZION. This map unit contains an intricate mix of both an uncommon shrub association (*Arctostaphylos pungens* Shrubland) and other more common shrub associations at ZION (denoted by *). This map unit likely represents a broad ecotone containing many common species.

(One Association-to-Many Map Classes)

-Map Units Representing Multiple Phases of a Plant Association
The following map units represent plant associations that are divided into multiple map units because of structural differences easily discerned on the aerial photographs. Map units used to delineate these types can be considered local variations of the plant communities or plant populations.

Map Code	Map Unit / *NVC Plant Associations / ALLIANCE*
39	*Quercus gambelii* Shrubland Alliance
	QUERCUS GAMBELII SHRUBLAND ALLIANCE
	Quercus gambelii / Amelanchier utahensis Shrubland
	Quercus gambelii / Artemisia tridentata Shrubland
	Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland
	Quercus gambelii / Symphoricarpos oreophilus Shrubland
	Quercus gambelii / Poa fendleriana Shrubland
53	*Quercus gambelii* Woodland (Alliance)
	QUERCUS GAMBELII SHRUBLAND ALLIANCE
	Quercus gambelii / Amelanchier utahensis Shrubland
	Quercus gambelii / Artemisia tridentata Shrubland
	Quercus gambelii / Symphoricarpos oreophilus Shrubland
	Quercus gambelii / Poa fendleriana Shrubland
	(Note: This map unit represents Gambel Oak shrubs that have grown into large trees under favorable conditions. The NVC still considers this type as part of the shrubland Alliance.)

-Map Units Representing No Association
These three map units were created for ZION to describe vegetation that had no corresponding NVC association for the following reasons, respectively:

- (24) Represents infrequent or rare types that can not be classified to an association since no plots or points were collected;
- (29) Represents types occurring in patches smaller than the minimum mapping unit of 0.5 ha;
- (63) Represents situations were the associated species can not be seen on the aerial photography (i.e. closed canopy).

Map Code	Map Unit
24	*Typha spp., Scirpus spp*. Emergent Wetland Complex
29	*Prosopis glandulosa* Shrub Stands
63	*Pinus ponderosa* Forest (Closed Canopy)

3.4 Vegetation Map

A total of 246,696 acres (99,838 ha) comprising Zion National Park and its environs was mapped. Of this total, NVC-related vegetation map units covered 210,169 acres (85,055 ha). The remaining acreage was mapped using land cover and unvegetated map units. Of all the map units, the most frequent was #3 Navajo Formation (Sandstone) with 4050 polygons ranging from barren slickrock to steep cliffs and slopes. The most frequent vegetation map unit was #39 Gambel Oak Shrubland Alliance with 3638 polygons. The most abundant map unit in terms of area was #57, Pinyon - Juniper Woodland Complex type covering 56,026 acres or about 23% of the project area. Frequencies of map units (*i.e.*, number of polygons) along with acreage per map unit are listed in **Table 5**.

Table 5. Total acreage and frequency of map units for Zion National Park.

Map Code	Map Unit Common Name	Polygons			Acres		
		Park	Environs	Total	Park	Environs	Total
1	Carmel Formation (Limestone)	39	181	220	89.3	473.0	562.3
2	Temple Cap (Sandstone)	38	17	55	38.4	24.6	62.9
3	Navajo Formation (Sandstone)	2,660	636	3,296	22,037.1	2,396.8	24,434.0
4	Kayenta Formation (Sandstone)	90	3	93	196.5	36.0	232.5
5	Moenave Formation (Sandstone)	46	1	47	98.8	4.7	103.4
6	Chinle Formation – Petrified Forest (Shale)	117	73	190	387.2	167.6	554.9
7	Chinle Formation – Shinarump (Shale)	44	66	110	69.4	170.3	239.7
8	Moenkopi Formation (Conglomerate)	73	50	123	227.5	177.5	404.9
9	Kaibab Formation (Limestone)	1	16	17	0.6	47.8	48.4
10	Basalt Talus	116	116	232	230.6	263.2	493.8
11	Unvegetated Volcanic Cinders and Cinder Cones	1	0	1	0.8	0.0	0.8
12	Slides (Fans and Slumps)	336	60	396	526.4	137.3	663.7
13	Gullies and Eroded Lands	184	92	276	234.3	139.3	373.6
14	Sand Bars and Beaches	119	81	200	92.1	54.5	146.7
15	Volcanic and Basalt Cliffs	17	22	39	32.0	38.3	70.2
16	Snags	44	0	44	21.2	0.0	21.2
17	Tinajas (natural water holes / tanks)	8	4	12	0.8	1.4	2.2
18	Perennial Disturbed Grassland Complex	86	217	303	272.0	716.9	988.9
19	Cheatgrass Annual Disturbed Grassland	70	137	207	138.4	485.0	623.3
20	James' Galleta Herbaceous Vegetation	31	24	55	257.4	778.1	1,035.5
21	Sand Dropseed Great Basin Herbaceous Vegetation	103	8	111	143.6	33.6	177.3
22	Dry Meadow Mixed Herbaceous Vegetation Mosaic	300	687	987	554.2	1,678.7	2,232.9
23	Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic	68	316	384	101.5	764.0	865.5
24	Cattail, Bulrush, Emergent Wetland Complex	2	71	73	2.6	118.6	121.2
25	Blackbrush Shrubland Complex	69	104	173	681.3	1,109.7	1,791.0
26	Painted Desert Sparsely Vegetated Alliance	24	39	63	409.7	254.4	664.1
27	Nevada Joint-fir Basalt Shrubland	12	24	36	200.9	251.9	452.8

Map Code	Map Unit Common Name	Polygons			Acres		
		Park	Environs	Total	Park	Environs	Total
28	Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland	232	180	412	641.8	1,204.5	1,846.3
29	Honey Mesquite Shrub Stands	0	6	6	0.0	2.0	2.0
30	Sand Sagebrush Colorado Plateau Shrubland	41	2	43	123.8	3.2	127.0
31	Big Sagebrush Shrubland Complex	628	780	1,408	2,200.5	4,544.4	6,744.9
32	Rabbitbrush Shrubland Complex	197	241	438	357.2	730.0	1,087.2
33	Littleleaf Mountain-mahogany Slickrock Sparse Vegetation	1,049	199	1,248	3,723.0	907.7	4,630.7
34	Talus Mixed Shrubland	784	87	871	2,795.7	317.9	3,113.6
35	Mountain Snowberry / Kentucky Bluegrass Semi-natural Shrubland	43	25	68	186.0	94.6	280.6
36	Black Sagebrush Dwarf-shrubland Complex	147	67	214	463.8	445.7	909.4
37	Greenleaf Manzanita Shrubland Complex	1,702	543	2,245	7,860.1	3,161.6	11,021.6
38	Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland	144	41	185	1,000.1	427.3	1,427.3
39	Gambel Oak Shrubland Alliance	2,164	1,035	3,199	10,990.4	6,588.7	17,579.1
40	Mixed Mountain Shrubland Complex	720	414	1,134	3,985.9	2,531.7	6,517.6
41	Utah Serviceberry Shrubland	75	11	86	461.5	131.8	593.3
42	Mountain-mahogany Rock Pavement Sparse Vegetation	60	68	128	294.8	448.8	743.6
43	Emory Seepwillow Shrubland	96	25	121	53.4	12.9	66.3
44	Sandbar Willow Shrubland Alliance	52	8	60	34.9	5.5	40.4
45	Tamarisk spp. Temporarily Flooded Shrubland	10	118	128	3.4	195.6	199.0
46	Arrow-weed Seasonally Flooded Shrubland	0	3	3	0.0	7.8	7.8
47	Strapleaf Willow / Beaked Sedge Shrubland	5	19	24	4.9	33.8	38.7
48	Single-leaf Ash Woodland	0	1	1	0.0	0.9	0.9
49	Boxelder Woodland Alliance	42	2	44	67.4	1.2	68.6
50	Fremont Cottonwood Woodland Complex	264	126	390	424.9	243.6	668.5
51	Fremont Cottonwood – Velvet Ash Woodland	548	252	800	1,136.0	490.6	1,626.6
52	Russian Olive Semi-natural Woodland	1	42	43	0.7	72.3	72.9
53	Gambel Oak Woodland	780	788	1,568	2,046.4	2,432.6	4,479.0
54	Bigtooth Maple / Gambel Oak Forest	98	233	331	1,362.2	7,767.6	9,129.9
55	Quaking Aspen Forest Complex	99	383	482	297.1	2,395.8	2,692.8
56	Juniper / Big Sagebrush Woodland Complex	203	421	624	2,298.0	3,917.6	6,215.6

Map Code	Map Unit Common Name	Polygons			Acres		
		Park	Environs	Total	Park	Environs	Total
57	Pinyon - Juniper Woodland Complex	1,594	785	2,379	34,323.0	21,672.3	55,995.3
58	Pinyon - Juniper / Gambel Oak Woodland Complex	1,084	791	1,875	7,111.5	7,674.0	14,785.5
59	Ponderosa Pine Slickrock Sparse Vegetation	746	70	816	4,922.4	803.8	5,726.2
60	Ponderosa Pine / Greenleaf Manzanita Woodland	1979	455	2,434	15,743.7	5,787.0	21,530.7
61	Ponderosa Pine / Gambel Oak Woodland Complex	1,730	455	2,185	8,763.1	3,675.1	12,438.2
62	Ponderosa Pine / Mixed Herbaceous Woodland Complex	113	64	177	608.1	317.4	925.6
63	Ponderosa Pine Forest (Closed Canopy)	26	17	43	241.6	385.9	627.5
64	Douglas-fir Forest Alliance	552	48	600	1,717.7	131.0	1,848.7
65	White Fir Forest Alliance	290	161	451	2,861.1	2,333.0	5,194.1
66	Transportation, Communications, and Utilities	31	56	87	2,94.6	1,195.0	1,489.6
67	Mixed Urban or Built-up Land	67	439	506	71.9	574.1	646.0
68	Croplands and Pastures	30	183	213	478.6	3,873.2	4,351.8
69	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	0	14	14	0.0	100.2	100.2
70	Other Agricultural Lands	1	25	26	0.5	35.9	36.4
71	Perennial Streams	41	20	61	474.6	213.7	688.3
72	Intermittent Streams	208	91	299	488.8	242.9	731.7
73	Reservoirs	5	16	21	2.3	142.1	144.5
74	Canals	0	3	3	0.0	3.9	3.9
75	Stock Ponds	23	165	188	4.6	47.7	52.2
76	Strip Mines, Quarries, and Gravel Pits	2	49	51	1.8	79.1	80.8
Totals							
Barren/Unvegetated Lands (1-17)		3,933	1418	5,351	24,283	4,132	28,415
Natural/Semi-natural Vegetation Map Units (18-66)		19,094	10,649	29,743	12,2162	89,283	211,445
Planted/Cultivated, Land-use/Land Cover (66-76)		377	1,005	1,382	1,523	5,313	6,836
All Map Units		23,404	13,72	36,476	147,968	98,728	246,696

3.5 Accuracy Assessment

2001 Accuracy Assessment

The 2001 accuracy assessment effort yielded 817 points. However, upon comparing them to the vegetation map we calculated a very low accuracy of 15%. During subsequent analysis we determined the cause of the low accuracy to be a result of a difference between the projection datum of the vegetation map, North America Datum 1983, (NAD83) and the datum used by the AA field teams (North America Datum 1927 or NAD27). This difference resulted in an offset that placed the field crews about 200 meters north of their targets.

By re-projecting the vegetation map into NAD27 we corrected for the offset giving us the correct location of the AA points and improving our accuracy. However, the offset effectively removed the stratification in the pre-selection procedure and placed the target points in a more random distribution. Specifically, 521 or 64% of the points fell into only 5 map classes. Further, we found that the largest portion of the points (285, 35%) occured in the Pinyon-Juniper Woodland Complex (Map code 57), which also happened to cover the largest area in ZION (34,323 acres or 23% of the Park). The result was a lop-sided distribution with the majority of the map units under-represented.

Another issue caused by the offset was the positional accuracy of the field teams in relation to the lines on the map. Since the original target locations were not sampled, the 10 meter buffer used to avoid sampling in ecotones or in the wrong polygon due to GPS error was rendered ineffective. This resulted in points occurring directly on lines between polygons with no clear way of determining which polyon was assessed. To help solve this problem, we created a halo or buffer around each point of 20 meters to represent a conservative estimate of combined map and GPS errors. We then overlaid these on the vegetation map and scored them by how many polygons they fell into. Points clearly contained in one polygon were given a high score, or a high probability that this vegetation polygon was the actual one assessed. Buffered points that were associated with 2 or more vegetation polygons were listed in order of the area of their intersection. This resulted in a list with each of the possible vegetation types in descending order of their area of intersection with the buffered point.

2003 Accuracy Assessment

Based on the 2001 lop-sided distribution another round of accuracy assessment data collection was conducted in 2003. For this session, we specifically targeted the under-represeted and unsampled map units. The projection discrepancy was addressed and using only one, 2-person crew we collected an additional 438 AA sample points in the correct locations. The 2003 data was combined with the 2001 data yielding a total of 1255 data points.

Accuracy Assessment Analysis

Analysis of the AA points involved a point by point review in two stages. During stage one, an initial assessment of the AA field call versus the vegetation polygon was conducted by NatureServe. At this time, the actual field form data were evaluated for consistency between the assigned map unit name and the actual recorded foliar cover values of the dominant species. As a result some of the AA points were changed to reflect the species cover values. For example, an AA point assessed as “Ponderosa Pine Slickrock Sparse Vegetation” with only a 5% cover of Ponderosa pine and 15% cover of Littleleaf Mountain-mahogany would be changed to “Littleleaf Mountain-mahogany Slickrock Sparse Vegetation”. Fewer than 45 points were renamed following this review.

During the second stage, we compared each point to the vegetation map by creating a GIS layer of the AA points and spatially joining this to the vegetation layer. In a stepwise fashion, AA points that clearly mathced a polygon were scored as correct, points that justifiably matched any of the polygons in a 20-m buffer were scored correct (i.e. the second call matched a neighboring polygon), and finally polygons that did not match at all were misses.

In the course of analysis 19 points were removed due to extreme differences in location caused by questionable GPS reception (i.e. +- >50 meter error) or obvious GPS recording errors as compared to the indended targets. This left 1236 points that were compared to the vegetation map. By comparing these points we were able to calculate an overall thematic accuracy of **82%**. **Table 6** presents the accuracy assessment scores and confidence intervals for each map unit assessed along with the values for the entire map.

Table 6. Contingency table (error matrix) for vegetation mapping at Zion National Park.

Reference Data (Accuracy Assessment Field Data)

Sample Data (Polygon Map Data)

Map Code	18	19	20	21	22	23	24	25	26	27	28	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	47	49	50	51	53	54	55	56	57	58	59	60	61	62	63	64	65	Samples	Commission Error % Correct	90% Confidence Interval -	90% Confidence Interval +
18	5				2	1								1					1	2																								12	42%	18	71
19		13												1																														14	93%	74%	99%
20			4								1		2					1																										8	50%	24%	76%
21		7		0												1																												8	0	0	26%
22	3	2			13													4																										22	59%	39%	76%
23	8					3							1																															12	25%	10%	50%
24																																												0	N/A	N/A	N/A
25								16				1																																17	94%	78%	99%
26									13																																			13	100%	83%	100%
27										5			1																															6	83%	46%	98%
28		1						1	1		11																								1									15	73%	50%	88%
30		1										9																																10	90%	65%	99%
31	1		1						1				36								2													3	2									46	78%	68%	88%
32								4					2	13																														19	68%	44%	85%
33															23				1																2									26	88%	75%	96%
34									1			1	1			20																			2									25	80%	64%	90%
35																	2				1																							3	67%	20%	97%
36													2					13			1																							16	81%	62%	93%
37															1	2			26	2	1	1													4	1		3						41	63%	51%	75%
38																			1	8																		1						10	80%	50%	95%
39					1											3				1	101							1			1	1		3	2	3			1					118	86%	81%	91%
40																1			3		3	11						1				1			2	1								23	48%	27%	67%
41																					1		10																					11	91%	69%	99%
42																								3																				3	100%	46%	100%
43																									15				1															16	94%	77%	99%
44	1																									2			3	1				1										8	25%	7%	58%
47																											1																	1	100%	10%	100%
49																												8				1												9	89%	61%	99%
50																													18	4														22	82%	66%	92%
51																					1									20		2			2									25	80%	64%	90%
53																							1								30	2		3										36	83%	73%	93%
54																					2											11												13	85%	62%	96%
55																																	13											13	100%	93%	100%
56								1					1																					7	9									18	39%	22%	58%
57					1							1	1	1		1			2											1					302	12			1					323	93%	91%	95%
58																2			1		1											2			1	50						1		58	86%	69%	100%
59																			1																2		29	4						36	81%	70%	92%
60																2			1	2	1														1		1	54	2					64	84%	77%	91%
61																					1								1			1			1	2		1	54	4			1	66	82%	74%	90%
62																					1																			11			1	13	85%	62%	96%
63																				1																					1			2	50%	5%	95%
64																																										10	1	11	91%	69%	99%
65																																										1	23	24	96%	84%	100%
Samples	18	24	5	0	17	4	0	22	16	5	12	12	47	16	24	32	2	18	37	16	117	12	11	3	15	2	1	10	23	26	31	21	13	17	333	69	30	63	58	15	1	12	26				
Correct	5	13	4	0	13	3	0	16	13	5	11	9	36	13	23	20	2	13	26	8	101	11	10	3	15	2	1	8	18	20	30	11	13	7	302	50	29	54	54	11	1	10	23				
Omission Error	28%	54%	80%	N/A	76%	75%	N/A	73%	81%	100%	92%	75%	77%	81%	96%	63%	100%	72%	70%	50%	86%	92%	91%	100%	100%	100%	100%	80%	78%	77%	97%	52%	100%	41%	91%	72%	97%	86%	93%	73%	100%	83%	88%				
90% Confidence -	14%	37%	38%	N/A	57%	32%	N/A	56%	62%	62%	70%	50%	67%	62%	84%	47%	32%	52%	58%	30%	81%	71%	69%	46%	85%	32%	10%	50%	62%	62%	92%	31%	83%	23%	88%	63%	92%	70%	87%	50%	10%	60%	75%				
90% Confidence +	48%	74%	98%	N/A	89%	97%	N/A	88%	93%	1%	99%	90%	87%	93%	100%	79%	100%	87%	82%	70%	91%	99%	99%	100%	100%	100%	100%	95%	89%	90%	100%	69%	100%	64%	94%	81%	100%	100%	99%	88%	100%	96%	96%				

Total Correct = 1017
Total Samples = 1236

OVERALL TOTAL ACCURACY = 82% **OVERALL KAPPA INDEX = 80%** [Pchance = 0.10] **OVERALL 90% UPPER AND LOWER CONFIDENCE INTERVAL: 80% and 84%**

Using the Accuracy Assessment Contingency Table: The contingency table or error matrix is an array of numbers set out in rows and columns corresponding to a particular vegetation map unit relative to the actual vegetation type as verified on the ground. The column headings represent the vegetation classification as determined in the field and the row headings represent the vegetation classification taken from the vegetation map. The highlighted diagonal indicates the number of points assessed in the field that agree with the map label. Conversely, the inaccuracies of each map unit are described as both errors of inclusion (user's or commission errors) and errors of exclusion (producer's or omission errors). By reading across this table (*i.e.*, rows) one can calculate the percent error of commission, or how many polygons for each map unit were incorrectly labeled according to the field ecologist. By reading down the table (*i.e.*, columns) one can calculate the percent error of omission, or how many polygons for that type were left off the map. Numbers "on the diagonal" tell the user how well the map unit was interpreted and how confident they can be in using it. Numbers "off the diagonal" yield important information about the deficiencies of the map including which types were under- or over-represented.

Common Map Errors

Of the assessed map units, some had lower than expected levels of accuracy. By carefully examining these discrepancies we found some common issues that seem to explain most of the errors, these include:

1. Perspective: Many of the errors occurred when a polygon was classified with a very similar, but different map unit than the one identified by the field ecologist. This can happen because the photo interpreter and the field ecologist see the vegetation differently. For example, the photo interpreter sees the cover of shrubs and herbaceous vegetation over a large area, while the field ecologist assesses the cover in a much smaller area. Also the field ecologist can thoroughly assess the understory whereas the interpreter may have his view partially or completely blocked by overstory canopy. Different perspectives can lead to different estimates of cover and differing conclusions as to the correct plant association or map unit.

- *Example:* Ten errors of omission were recorded for the Talus Mixed Shrubland where the map showed them to be various other shrublands and woodlands. This likely happened in part due to the field ecologists being able to see a talus substrate for only a small subsection of the entire polygon. Whereas, the photo-interpreter either could not see the talus substrate or viewed the mixed talus shrubland as a small inclusion within a larger vegetation type.

2. Cover cut-offs: Discrepancies with some map units arose from the NVC, which depends on an arbitrary cutoff of shrub cover to separate herbaceous communities from shrublands. At ZION, the cutoff between grasslands and shrublands was 25% shrub cover, which was very difficult for the photo interpreters to see.

- *Example:* In some instances we mapped sites as Sand Dropseed Great Basin Herbaceous Vegetation but they were assessed as Big Sagebrush Shrubland Complex. The resulting commission errors likely resulted from big sagebrush occurring in the stands but not at a high level. The low cover of sagebrush allowed the understory grasses to appear more abundant on the aerial photos causing these areas to be mapped as grasslands.

3. Shrubland vs. Woodland: A majority of the omission and commission errors at ZION appeared to occur between woodlands/forests and their understory shrub component. In some cases stands were mapped as shrublands but assessed as a woodland/forest with the same shrub in the understory. Conversely, mapped woodlands/forests were assessed as the understory shrubland. These discrepancies likely arose again because of the different perspectives of the photo interpreter and the field ecologists, where the field team either saw enough trees in a small area to call it woodland or didn't see enough.

- *Example:* Sites mapped as Greenleaf Manzanita Shrubland Complex were assessed as Ponderosa Pine / Greenleaf Manzanita Woodland. Similarly, sites mapped as either Ponderosa Pine / Gambel Oak Woodland Complex or Pinyon - Juniper / Gambel Oak Woodland Complex were assessed as Gambel Oak Shrubland Alliance. Finally some errors of commission occurred between the mapping of Gambel Oak Shrubland Alliance and the AA field teams' assessment of Pinyon - Juniper / Gambel Oak Woodland Complex. These likely represent situations where the pinyon pine and juniper trees were either locally abundant but not consistent throughout the polygon or were not abundant enough to appear on the aerial photos.

4. Transition areas: Finally the high variability in the terrain at ZION created many transition areas were species of different map units overlapped (i.e. broad ecotones). This was especially true of the shrub species. Both mapping and assessing these areas proved to be challenging. The landscape perspective of the aerial photos allowed these areas to be mapped separately as complexes/mosaics if they proved to repeat consistently across ZION. Unfortunately the field ecologists did not have this ability.

- *Example:* The Mixed Mountain Shrubland Complex gave a very distinct photo signature and occurred repeatedly on slopes in the northwestern corner of ZION. However, this type contained many shrub and tree species characteristic of other associations. In the field, small pockets of a dominant species such as gambel oak would appear to the field ecologist as a different association. However, on the aerial photos this pocket would occur in the transition area and be mapped as part of the complex. The low commission error of this type is likely a result of this confusion.


Navajo rock formations and riparian vegetation at ZION.

4. DISCUSSION

Zion National Park is an unique place with many spectacular landforms caused by massive geological uplift and erosion. This has led to a complex topography of benches, slopes, slot canyons, sheer cliffs, and isolated mesas that create new habitats and fragment many other habitats typical of the Colorado Plateau. During this project we found it very challenging to both classify and map the vegetation into meaningful context for all levels of interest (local, regional and national). However, with patience and persistence we feel that we were fairly successful as evidenced by the **42** new plant associations documented for ZION, the high level of detail (over 41,000 polygons), and the initial accuracy of more than 81%. Now that it is done, we are proud of our efforts and hope that they will be used and improved upon in the future.

–A few thoughts and suggestions:

4.1 Field Survey

In our opinion, the single most valuable asset in mapping vegetation is the field ecologist. Without a thorough detailed documentation of the vegetation on the ground no classification or map could be produced. Collecting plot data across rugged terrain is not easy and every effort should be made to find competent and energetic field crews with botanical and ecological backgrounds that can accomplish this task. Second, once hired, field crews should be adequately trained in both the project's methods and the local flora. Third, field crews should be supported logistically with housing, transportation, supplies, technical training, supplies, and equipment

In retrospect, smooth field survey work can be insured in part by following these recommendations:

- Job posting and hiring of competent field ecologists should begin as early in the project as possible.
- Field crews should be hired and retained across multiple field seasons to maintain consistency and avoid re-training.

- Help with housing and transportation for field crews should be reviewed and addressed before the start of work especially for expensive or remote areas.

- Training should be thorough and include both Park specific issues such as access limitations, GPS specifications and program specific parameters such as plot set-up and data recording.

- Follow-up, oversight, and communication with the field crews should be maintained at all times. This includes regular updates/progress reports and meetings with all participants (photo interpreters, Park staff, and ecologists)

- Parks should be encouraged to take on as much of an active role as they can. This can include anything from the actual hiring of the crews as NPS seasonals, to providing housing, or just tagging along on a data collection trip.

Helicopter

One of the most daunting tasks was collecting plot data away from established roads and trails. Even after two full field seasons we did not get adequate distribution of sample plots. This was a direct result of the inaccessible nature of the Park. Literally some areas of ZION, such as isolated towers and slot canyons, proved impossible to traverse without technical climbing capabilities. This, coupled with other common hazards such as dehydration, heat exhaustion, and flash floods, caused the field crews to avoid large areas of the Park. Examining our options we felt that a short helicopter-assisted field session would be the safest and most economical solution. Although concerns were raised about impact to remote sites, in the end the helicopter proved to be a safe alternative for getting ecologists into the backcountry. Please see **Appendix G** for more details on the use of the helicopter at ZION.

4.2 NVC Classification

Once the data was collected it took a tremendous amount of time to classify the NVC plant associations. This was due in part to two contributing factors: lack of previous plant classification work in the area and a complex mix of vegetation. Future projects with a similar lack of information and a high level of diversity may want to increase the time to collect more data and postpone the mapping stage.

Global rarity

ZION is a very special and unique place with over 20 endemic plant taxa (Welsh 1995). Most of these endemic taxa are restricted to hanging gardens, which are an unusual but distinctive feature of the Park. Hanging gardens occur on sheer rock cliffs and are fed by water seeping out of more porous Navajo Sandstone where it overlays impervious rock layers. They were not addressed by this project due to their small and concealed nature and also because they have been well studied in the past (Malanson and Kay 1980, Malanson 1980, 1982, Welsh 1989).

Other than hanging gardens, relatively few vegetation types at Zion are considered globally rare or threatened. However not enough is known about many of these associations to evaluate their global rarity. Thirty-one of the 52 existing NVC associations found at ZION have not been assessed for their global rarity or endangerment, and none of the 42 new associations have been assessed. Thus global rarity or endangerment is not known for 73 of the 95 total plant associations documented by this study. It is likely some of the new plant associations are rare or threatened, but more vegetation survey is needed across the Colorado Plateau, Utah Mountains and Great Basin to develop a regional perspective.

Currently, we feel that the most threatened vegetation types at ZION are the riparian forests and the native dry grasslands. Multiple impacts from hydrological modification, historic overgrazing, recreation, interruption of ecological processes (such as fire suppression), and/or invasion of introduced species (especially the annual grasses such as *Bromus rigidus, B. rubens* and *B. tectorum)* all threaten these types. Based on these criteria, 3 plant associations to watch at ZION include:

Association Name Element Code Global Rank

Populus fremontii - Fraxinus velutina Woodland
(CEGL000942) G2G3

Hesperostipa comata Great Basin Herbaceous Vegetation
(CEGL001705) G2G4

Pleuraphis jamesii Herbaceous Vegetation
(CEGL001777) G2G4

Additional survey work is needed to further define some of the remaining sparse vegetation types. Anthropogenic disturbance of many of the lowland riparian vegetation types created challenges in classifying them.

4.3 Aerial photos and Orthophotos

The acquisition of new orthophotos in addition to the aerial photography was critical to our mapping efforts at ZION. We found that these not only saved time in the digitizing and transfer stage but also aided tremendously with map verification. The true color orthophotos provided the utility of a map with the functionality of an aerial photo. In other words, we could easily prepare and plot draft maps that contained both our polygon outlines and a true color representation of the vegetation. In the past we would have had to either plot polygons on less-clear black-and-white orthophotos or use a clumsy combination of non-rectified aerial photos and simple color plots. Further, as a digital product they afforded us the capability of easily reproducing them for multiple users.

We would suggest that future projects strongly consider purchasing new orthophotos in addition to the aerial photography for the following reasons: 1.) Reduces the amount of time needed for digital transfer or digitizing of the line work; 2.) helps minimize shadows and scale distortion in areas with large changes in elevation; 3.) increases the accuracy and thoroughness of the mapping by having *recent,* true-color basemap imagery; 4.) allows for more useful and easier dissemination of draft products to field crews, mappers, ecologists, etc., and 5.) is a great stand alone product that can be used in many other applications.

4.4 Photo-interpretation and Map Units

Inherent to vegetation mapping projects is the need to produce both a consistent vegetation classification and a set of map units. Typically the systems are very similar if not identical, but when using a national classification such as the NVC there is typically not a strict one-to-one correspondence. This is due to the remote sensing nature of photographic interpretation and its ability to only delineate map units based on complex photo signatures. Subtle vegetation characteristics that can be seen on the ground are not necessarily the same as those apparent on the photos. Canopy closure, shadows, and timing of the photography can also distort or obscure photo signatures.

For a highly diverse park such as Zion we suggest that a completed (or nearly completed) classification be in place before the actual interpretation begins. This will avoid having to revisit or, worst case, redo the interpretation based on classification changes. Ideally, plot sampling should begin early in the project, followed by analysis of the vegetation data to the NVCS before the ground-truthing and interpretation of the aerial photographs. It is important to have a high level of confidence in the plant associations during photo interpretation so that vegetation types can be accurately related to the photo signatures. Also critical is deciding how to characterize and describe common types that are widely distributed but highly variable in species composition

To ensure effective mapping, more map verification or ground-truthing needs to occur at ZION. We feel that this project in many ways should be viewed as a cursory remote sensing effort that needs to be refined and periodically updated. To do this, GPS points, mapping, surveying, or new photo interpretation of the vegetation on the ground can greatly help improve the quality and accuracy of this project. Also since the photos represent just a snapshot in time, verification efforts should occur across the entire growing season to better describe seasonal variability.

4.5 Future Recommendations

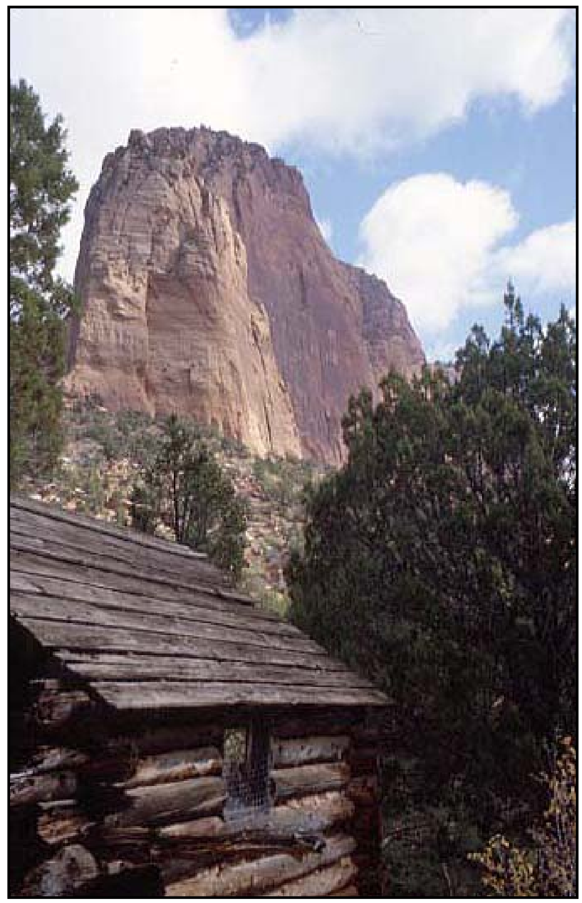
In summary, this project represents the best efforts put forth by one group of people over one relatively short period in time. In order to create the best possible "long-term" vegetation classification for ZION and the most accurate and detailed GIS layer, this project should be viewed as a place to start rather than an ending. In other words, present and future ZION staff should be encouraged to scruitinize this project, building from its strengths and fixing its limitations. By keeping in mind that this project was only a snapshot in time, future efforts can help complete our understanding of the vegetation at ZION and how it may change. We hope that the products presented here will help focus and tailor future efforts such as the following:

1. The high diversity of plant species and inaccessibility of the Park warrants periodic **field surveys** by experienced ecologists. In this way new plant associations could be discovered and existing types could be updated.

2. Remote sensing does not replace on-the-ground knowledge or hard GPS or survey-linked data. Time limitations curtailed the amount of **ground-truthing** done with the map. As opportunities arise, maps should be sent into the field to be verified by competent crews. Also GPS data and other GIS layers should be used to improve and update the spatial data. We feel strongly that this product should not be static but change with new and better information.

3. To better understand the limitations of the map, the **accuracy assessment** data presented in **Table 6** should be thoroughly reviewed by the Park. Map classes with low accuracy should be examined to see if they could be improved with future studies using ground-truthing or other remote-sensing formats (i.e. color infrared, hyperspectral, etc). Also, landscape modeling my help to tease out the location of specific types based on specific habitat information. Finally for some applications it may make sense to combine map classes into higher units, such as alliances or ecological systems to improve their accuracy**.**

4. For monitoring purposes, **change over time** could be addressed by similar remote sensing projects. New aerial photos or compatible digital imagery taken 5, 10, 20+ years from now would capture this change. This new imagery could then be used to create up-to-date vegetation layers and compare changes in both specific vegetation stands and across the entire Park.



5. BIBLIOGRAPHY

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

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

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Science. **23**: 69-82.

Federal Geographic Data Committee. 1997. *FGDC Vegetation Classification and Information Standards*. Reston, VA.

Fowler, James Floyd. 1995. Biogeography of hanging gardens on the Colorado Plateau (diversity, species richness). Ph.D. dissertation, University of Wyoming. Laramie, WY. 209 p.

Gillison, A.N. and K.R.W. Brewer. 1985. The use of gradient directed transects of gradsects in natural resource survey. Journal of Environmental management. **20**:103-127.

Grossman, D.H., D. Faber-Langendoen, A.W. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K.D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. *International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume I: The National Vegetation Classification Standard.* (Draft June 1997.) The Nature Conservancy, Arlington, VA.

Grossman, D.H., K.L. Goodin, Xiaojun Li, D. Faber-Langendoen, M. Anderson, P. Bourgeron, and R. Vaughn. 1994. Field methods for Vegetation Mapping. NBS/NPS Vegetation Mapping Program. The Nature Conservancy, Arlington, VA, and Environmental Systems Research Institute, Redlands, CA.

Hamilton, Wayne. 1995. *The Sculpturing of Zion.* Zion Natural History Association. Springdale, UT 132 pages.

Hill, M. O. 1979. Twinspan, a Fortran program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Cornell Univ., Ithaca, NY. 90 p.

Hill, M. O., and H. G. Gauch, Jr. 1980. Detrended correspondence analysis: An improved ordination technique. Vegetatio. 42:47-58.

Kartesz, J. T. 1999. *A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland, First Edition,* In: J. T. Kartesz and C. A. Meacham. Synthesis of the North America Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, N.C.

Malanson, G. P., and J. Kay. 1980. Flood frequency and the assemblage of dispersal types in hanging gardens of the Narrows, Zion National Park, Utah. Great Basin Naturalist 40(2):365-371.

Malanson, G. P. 1980. Habitat and plant distributions in hanging gardens of the Narrows, Zion National Park, Utah. Great Basin Naturalist 40(2):178-182.

Malanson, G. P. 1982. The assembly of hanging gardens: Effects of age, area, and location. American Naturalist 119:145-150.

McCune, B. and M.J. Mefford. 1997. PC-ORD*. Multivariate Analysis of Ecological Data, Version 3.0*. Gleneden Beach, OR: MjM Software Design

Moravec, J. 1993. Syntaxonomic and nomenclatural treatment of Scandinavian-type associations and associations. Journal of Vegetation Science 4:833-838.

Ter Braak, C. J. F. (1987-1992) CANOCO – a FORTRAN program for Canonical Community Ordination. CANOCO is an extension of Cornell Ecology program DECORANA (Hill,1979). Microcomputer Power. Ithaca, NY. P95

The Nature Conservancy. 1997. PLOTS Database System, Version 1.1. The Nature Conservancy, Arlington, VA.

The Nature Conservancy and Environmental Research Systems Institute. 1994a. *NBS/NPS Vegetation Mapping Program: Accuracy Assessment Procedures.* Arlington, VA.

_____. 1994b. *NBS/NPS Vegetation Mapping Program: Field Methods for Vegetation Mapping*. Arlington, VA.

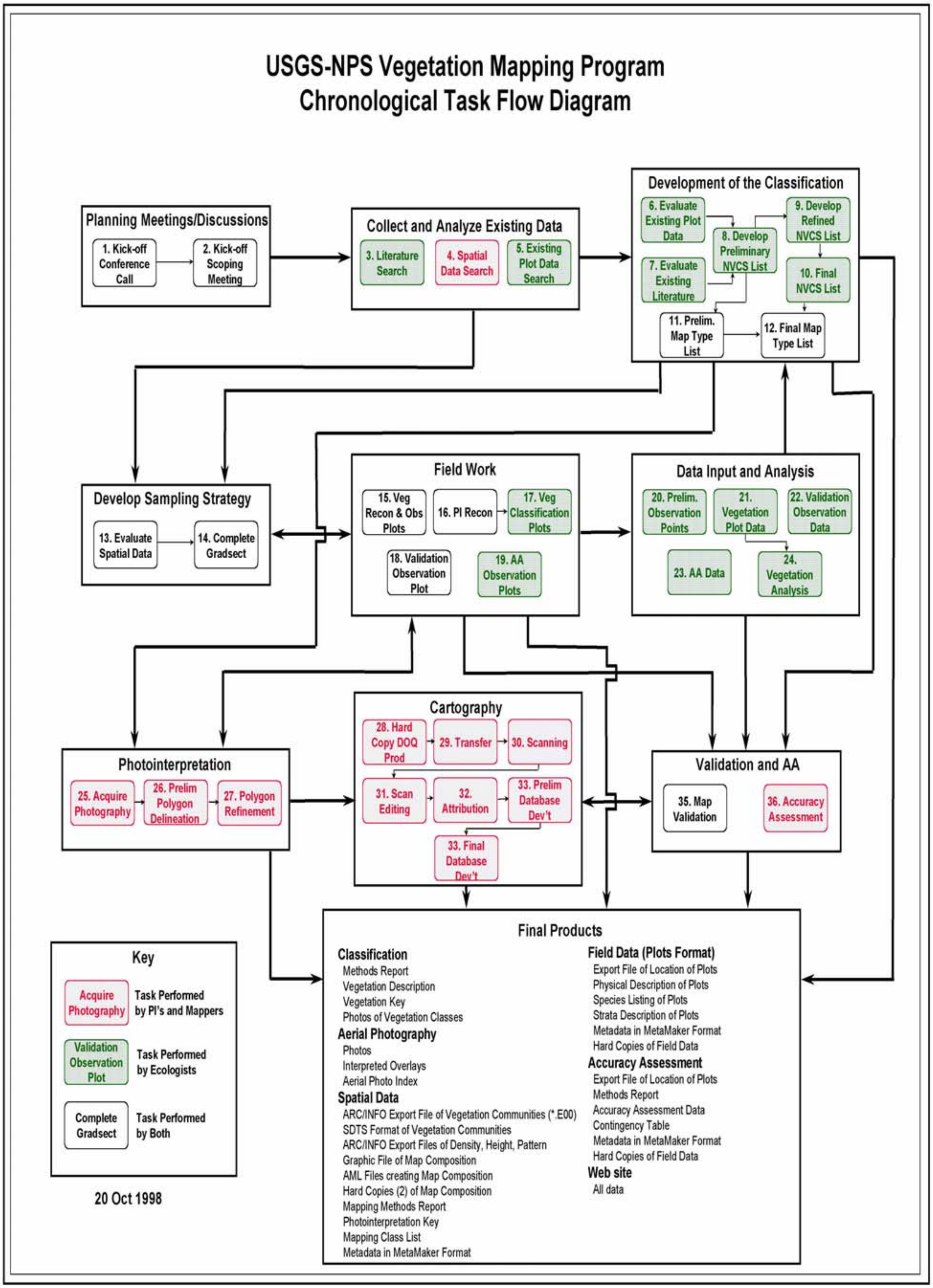
_____. 1994c. *NBS/NPS Vegetation Mapping Program: Standardized National Vegetation Classification System*. Arlington, VA.

Welsh, S.L. 1995. Rare plant survey of shuttle system and vascular plant scientific and common name list. Zion National Park annual report 1994-95. Unpublished report. Zion National Park. Utah. p28.

Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins. 1993. *A Utah Flora, 2nd ed*. Brigham Young University Print Services, Provo, UT.

Welsh, S.L. 1989. On the distribution of Utah's hanging gardens. Great Basin Naturalist **49**(1):1-30.

APPENDIX A. Flowchart for the USGSNPS Vegetation Mapping Program


USGS-NPS Vegetation Mapping Program
Chronological Task Flow Diagram
Planning Meetings/Discussions
1. Kick-off Conference Call
2. Kick-off Scoping Meeting
Collect and Analyze Existing Data
3. Literature Search
4. Spatial Data Search
5. Existing Plot Data Search
Development of the Classification
6. Evaluate Existing Plot Data
7. Evaluate Existing Literature
8. Develop Preliminary NVCS List
9. Develop Refined NVCS List
10. Final NVCS List
11. Prelim. Map Type List
12. Final Map Type List
Develop Sampling Strategy
13. Evaluate Spatial Data
14. Complete Gradsect
Field Work
15. Veg Recon & Obs Plots
16. PI Recon
17. Veg Classification Plots
18. Validation Observation Plot
19. AA Observation Plots
Data Input and Analysis
20. Prelim. Observation Points
21. Vegetation Plot Data
22. Validation Observation Data
23. AA Data
24. Vegetation Analysis
Cartography
28. Hard Copy DOQ Prod
29. Transfer
30. Scanning
31. Scan Editing
32. Attribution
33. Prelim Database Dev't
33. Final Database Dev't
Photointerpretation
25. Acquire Photography
26. Prelim Polygon Delineation
27. Polygon Refinement
Validation and AA
35. Map Validation
36. Accuracy Assessment
Final Products
Classification
Methods Report
Vegetation Description
Vegetation Key
Photos of Vegetation Classes
Aerial Photography
Photos
Interpreted Overlays
Aerial Photo Index
Spatial Data
ARC/INFO Export File of Vegetation Communities (*.E00)
SDTS Format of Vegetation Communities
ARC/INFO Export Files of Density, Height, Pattern
Graphic File of Map Composition
AML Files creating Map Composition
Hard Copies (2) of Map Composition
Mapping Methods Report
Photointerpretation Key
Mapping Class List
Metadata in MetaMaker Format
Field Data (Plots Format)
Export File of Location of Plots
Physical Description of Plots
Species Listing of Plots
Strata Description of Plots
Metadata in MetaMaker Format
Hard Copies of Field Data
Accuracy Assessment
Export File of Location of Plots
Methods Report
Accuracy Assessment Data
Contingency Table
Metadata in MetaMaker Format
Hard Copies of Field Data
Web site
All data
Key
Acquire Photography
Task Performed by PI's and Mappers
Validation Observation Plot
Task Performed by Ecologists
Complete Gradsect
Task Performed by Both
20 Oct 1998

APPENDIX B: Sampling Design: Modified Stratified Random

Zion National Park Sample Site Selection Methodology
Written By Michael Schindel

BACKGROUND

A modified Gradsect analysis procedure was developed for the Yosemite National Park vegetation mapping project as a tool to aid field crews in visiting as many of the different environments as possible to sample the diversity of vegetation in the park (Schindel 1999 unpublished report). The theory behind the Gradsect methodology is that if field crews visit the full spectrum of physical environments, then most of the vegetation types will be sampled. To do this ecologists select a set of key abiotic factors that influence vegetation diversity. A practical constraint for this project (Zion NP) was that neither time nor money was available to develop new digital data so we were limited to existing data layers or those that could be developed relatively quickly.

METHODS

The Zion National Park fieldwork site selection was largely based on concepts of gradsect (Gradient- Directed Transects) analysis. Gradsect analysis focuses on the key abiotic factors that influence a region's vegetative diversity. The four physical factors used for the Zion modified gradsect model were geology, solar insolation, hydrology, and fire history. Each of these 4 variables was broken into logical classes. We used perennial streams and divided the region into hydric and upland classes. A 40 year fire history map provided by the Park was used to identify recently burned areas. The solar values were based upon an annual solar budget model derived from the 30 m DEM and solar ephemeris values calculated by the Jet Propulsion Laboratory's Ephemeris Generator. The geologic layers were classified on the basis of similar chemistry and vegetation response. Volcanic rocks were broken into 3 elevation classes because they are the only non-sedimentary rocks and aren't confined to any particular stratum. Elevation was otherwise not modeled because the sedimentary geology divides the park into nearly perfect horizontal classes.

The 4 resulting maps were then combined to generate a grid of all the possible combinations of these factors. Each unique combination represented a Biophysical Unit (BPU). There were 70 BPU types within the Park boundary forming a mosaic of 18000 polygons.

BPU Key

1000-Hydric	100-Burned	10-Full Shade	1-Alluvium
2000-Uplands	200-Unburned	20-Partial Sun	2-Carmel
		30-Partial Shade	3-Chinle/Moenkopi/Kaibab
		40-Full Sun	4-Slide/Kayenta/Moemave
			5-Dakota
			6-Navajo/Temple Cap
			7-Volcanics 3600-5300 ft.
			8-Volcanics 5301-7000 ft.
			9-Volcanics 7001-Summit

Field Survey Site Selection

A subset of BPU polygons was selected for field visits using cost surface analysis. The Zion cost surface model was based upon the slope calculation (in degrees) of the 30 meter DEM. Cells containing perennial streams and steep slopes (> 45 degrees) were reclassified as "No Data". These cells were considered barriers in subsequent cost-path analysis. The remaining cells were valued according to their slope, except roads, trails and routes, which were reclassified as 1, 2 and 3 respectively. A Cost Distance function was performed to calculate the cumulative cost of travelling to any 30 meter cell in the park from the nearest road. The centroid of each BPU was then joined to its associated cost value. The cost, acreage and *x, y* coordinates of each BPU were then used to select 2-3 polygons of every type that were accessible, of reasonable size, and stratified geographically. Polygons ranged in size from .18-110 hectares, with most between 1-10 hectares. The smallest polygons in this group represented BPU types that only occurred as small patches. Riparian BPUs, for example, tend to be small because they are often confined to narrow, meandering settings. BPUs with only one or two occurrences also were selected regardless of size or cost.

Six, 1:24000 scale maps were produced for the field crews showing the selected BPU polygons with USGS Digital Raster Graphes (DRG) as backdrops. These maps covered the entire park. A table was included on each map containing the *x y* coordinates for each selected BPU to assist with navigation. These maps and supporting documentation were sent to the field leader prior to the field season.

Results

The field crew sampled 91 plots during the 1999 field season. 46 of those plots were on or within 100 meters of the selected BPU polygons. Most of the remaining samples were taken en route to a BPU polygon. A diverse assemblage of vegetation types was captured during the 1999 sampling effort. The modified gradsect analysis selected a good approximation of the range of physical habitats present within the park. It will be interesting to compare this initial selection of BPUs to the final vegetation map to see exactly how many types would be captured if each of the 170 BPU polygons in this set had been visited and inventoried.

Analysis for the 2000 Field Season

For the 2000 field season this approach was modified. Photo Interpretation had begun after the 1999 sampling season and the interpreters needed information on specific sites they couldn't identify. The narrow selection of potential samples was abandoned in order to allow the field crews to work anywhere in the park in response to the interpreters questions. Two analyses were used to select the season's samples. The first was a neighborhood analysis on the full BPU set. This analysis measured the diversity of BPU types within a 1 kilometer radius. Three areas were identified with exceptional BPU diversity. Previous studies have shown that steep environmental gradients correlate with a high diversity of vegetation types. All the polygons from these 3 regions were included in the final data set.

The second analysis began with the full BPU set merged by type. In other words, all polygons of type "1261" throughout the entire park were considered part of the same super polygon. This data set was intersected with the 1999 field work. All types that had received a sample that year were removed from the set. Polygons less than 0.18 ha. were also removed. The remaining polygons were left as potential sample sites.

The union of these two analyses yielded a mosaic of 2,121 polygons scattered across the park; heavily weighted towards types that hadn't yet been sampled. As the sampling and photo interpretation proceeded, the field crews were able to accommodate requests from the photo interpreters while sampling other types in the vicinity. Field crews were responsible for keeping track of the polygons to insure that too many samples were not collected from any one BPU or vegetation type. At least one of the 3 high diversity areas was also thoroughly investigated regardless of the BPU types.

APPENDIX C: Field Methods Manual

SAMPLING AT ZION NATIONAL PARK

A Basic Guide for Field Work

Modified for the 2000 Field Season, USGS/NPS Vegetation Mapping Program

This document is intended to give you general instructions and guidelines for conducting your field work at Zion National Park. 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' (**Appendix D**).

Overview

The data that you collect in Zion this year will be combined with data collected in 1999 and used to create a relatively fine-scale delineation of vegetation pattern in Zion National Park and its environs. The range of habitats, and the corresponding diversity of vegetation types, found here is 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.

Establishing a field sampling strategy that captures—in only two field seasons—sufficient data on all the distinct vegetation types in an area as large, diverse, and rugged as Zion is an ongoing challenge. To make the sampling as efficient as possible, the key environmental variables thought to be driving vegetation pattern were identified. These included factors such as geology, solar insolation, hydrology, and fire history (see TNC 1998). The geographic locations of various classes of these environmental factors were then overlaid and areas with unique combinations (called biophysical units or BPUs) were mapped. The basic idea being that by identifying and placing samples in the range of BPUs we would be likely to sample the range of vegetation types. During the first sampling season, wherever possible, areas with clusters of these different BPUs in close proximity to each other *and* in close proximity to roads and trails were located, so that getting to these places could be as easy as possible. In 2000, we will be putting more emphasis on sampling the diversity of environmental conditions and access will be a secondary factor in sampling selection.

As much as possible, photo interpreters will be examining aerial photos of the areas identified by the BPUs and will make an educated guess about what types of vegetation will be found in the unsampled BPUs using plot information from the sampled ones. The photo interpreters will supply Mylar overlays with polygons delineated and labeled with vegetation types. The vegetation "types" they are using to tag their polygons are those included in the preliminary classification of Park vegetation created using the U.S. National Vegetation Classification system (Grossman et al. 1998).

During the second field season, some interpreted overlays attached to the photo prints will be available to help find the vegetation types to sample. The delineated polygons provide a perspective of accessibility to selected points and also indicate the size of homogenous stands so that sampling can be placed to best advantage within the types. The photo interpreters will give the selected, delineated polygons labeled with U.S. National Vegetation Classification types to the field crew, who will be keeping a running tally of the number of plots that still need to be established and sampled for each type.

The field crew will evaluate the field data, assign a preliminary vegetation type, 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 over-sampling of some types and under-sampling of others. Deciding where to sample to capture the full range of diversity over the Park is going to be very much an iterative process as the field season goes along!

Getting There
You will have a Digital Ortho Quarter Quad (DOQQ) with the BPUs you are to sample indicated. You and your partner will navigate towards each selected BPU using your road and trail maps, the DOQQ, and/or GPS. The DOQQ's will have roads and trails highlighted on them to help you as well.

Before you leave... check that you have all the materials needed to complete your fieldwork (Please see the checklist and "considerations for mission planning" in **Appendix D** to help you).

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

Along the way...look around. Digital data layers are great, but they do ***not*** replace human perception. The goal of this field work is to sample all the different vegetation types that occur at Zion. If, on the way to one vegetation type, you see an assemblage of plants that seems unique and that is not included on the list of vegetation types, please sample if time allows. At Zion these undescribed vegetation types are more likely herbaceous or shrublands. You will be better able to recognize these undescribed vegetation types as the season progresses and you become more familiar with the vegetation types and how they can look on the ground.

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 polygon as a whole. In other words, avoid areas where the vegetation appears to be transitioning from one type to another and areas with anomalous or heterogeneous structure or species composition. Take some time to do this carefully, because some of the plots you set up may be *permanent*; relocated and resampled over time in order to determine responses to management and other useful things. 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 if time and topography allows.

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

The first plot in each type will be permanent. Drive rebar or some other steel marker flush with ground with a rock or hammer in the approximate center of the plot. If you are unable to place a marker in the center (e.g., slickrock), clearly describe on the form where it is in relation to the plot center e.g., 3.5 m @200 degrees from plot center. Details of marking need to be arranged with the Park.

3) Using your GPS receiver, record the UTM in the center of the plot under the **Field UTM X** and **Field UTM Y** on the field form. Remember that this is about to become a permanent plot, so being able to *find* it again will be key: use the GPS, rather than estimating. Also mark and label the location of the plot on a USGS 7.5 min. topographic map. If you cannot get a GPS reading, estimate UTMs from the USGS topographic map and note on the form that you had to resort to this method. Plot may be circular, rectangle or square. Note shape and dimensions on the field form. If the plot is rectangle 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 (i.e., trees have their crowns overlapping, usually forming 60-100% cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Woodland (i.e., open stands of trees with crowns usually not touching. Canopy tree cover is 25-60% Or exceeds shrub, dwarf-shrub, herb, and nonvascular cover).	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Shrubland (i.e., shrubs greater than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, dwarf-shrub, herb, and nonvascular cover)	11.3 m radius OR 20 m x 20 m	400 m^2 400 m^2
Dwarf-shrubland (heath) (i.e., Shrubs less than 0.5 m tall are dominant, usually forming more than 25% cover OR exceeding tree, shrub, herb, and nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Herbaceous (i.e., Herbs dominant, usually forming more than 25 percent cover OR exceeding tree, shrub, dwarf-shrub, and nonvascular cover).	5.65 m radius OR 10 m x 10 m	100 m^2 100 m^2
Nonvascular (i.e., nonvascular cover dominant, usually forming more than 25% 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 (100 m^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.

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

Taking photographs
Two color slide photos will be taken of each plot. The purpose is to get 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 made, 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 may save time in the field by not having to write plot numbers.

Take the photograph looking across the contour if plot is steep. Work out a standard direction for gentle and flat plots with Park personnel. Flag or mark plot marker for photo if plot is permanent to aid relocation. Record roll #, frame # and azimuth on plot form. Crew Leader is responsible for labeling and organizing slides. One entire set of 35-mm slides will be provided to both the Park and to the USGS. Digital scanned copies will also be available on the final report CD-Rom.

<u>Data Collection</u>
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, 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 and different species to record. Remember that these plot data are to be used to classify the overall vegetation of the Park, not to make a complete species list for it. And 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. 1," 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, 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.

Please store your plant specimens in a cool, dry place. Bagged specimens will keep fresh longer in the refrigerator or ice chest until pressed or identified. You can, of course, 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. If pressed specimens begin to build up, let TNC folks know. They can take steps to have some of them identified.

Observation Point Form

Occasionally, you will need to collect some plot-free data. This will happen when:
1) The photo interpreters can't tell what kind of vegetation is in a particular polygon [as noted on the Mylar] or
2) The photo interpreters were wrong about what kind of vegetation is in a polygon and sufficient plot data has already been collected for the kind of vegetation that is actually there.

In these two cases, there is no need to establish a plot. However, you will help the photo interpreters identify this type in the future if you collect some data. You will navigate to the polygon as usual, 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 an abbreviated version of the Plot Survey form, and the same cheat sheet can be used to help with filling it out. GPS points may be taken at any part of the polygon as long as it is >30 m from its edge, to verify its location.

We hope you find your field season at Zion enjoyable and rewarding. Best of luck!

LITERATURE CITED

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

The Nature Conservancy [TNC]. 1998. An environmentally-driven approach to vegetation sampling and mapping at Yosemite National Park. Report prepared for the U.S. Department of the Interior, National Biological Survey and National Park Service. The Nature Conservancy, Arlington, Virginia.

APPENDIX D: Observation, Plot, and AA Field Forms and Instructions

NATIONAL PARK VEGETATION MAPPING PROGRAM: OBSERVATION POINT FORM (1997)

IDENTIFIERS/LOCATORS

Plot Code____ Polygon Code_________________________

Provisional Community Name____

State ___ Park Name ___________________________________ Park Site Name _____________________

Quad Name____ Quad Code______________________

GPS file name_____________ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

please do not complete the following information when in the field
Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone__________

Survey Date___________ Surveyors____

ENVIRONMENTAL DESCRIPTION

Elevation ________________ Slope ________________ Aspect____________________

Topographic Position

Landform

Cowardian System	Hydrologic Regime		Salinity Modifiers
___Upland	Non-Tidal		___Saltwater
___Riverine	___Permanently Flooded	___Saturated	___Brackish
___Palustrine	___Semipermanetly Flooded	___Temporarily Flooded/Saturated	___Freshwater
___Lacustrine	___Seasonally Flooded	___Intermittently Flooded	

Environmental Comments:

Unvegetated Surface: (please use the cover scale below)
___ Bedrock ___ Litter, duff ___ Wood (> 1 cm)
___ Large rocks (cobbles, boulders > 10 cm)
___ Small rocks (gravel, 0.2-10 cm)
___ Sand (0.1-2 mm) ___ Bare soil
___ Other:________________________________

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata & Unvegetated Surface	Height Scale for Strata
Trees and Shrubs	___Broad-leaved	___Forest	01 5%	01 <0.5 m
___Evergreen	___Needle-leaved	___Woodland	02 10%	02 0.5-1m
___Cold-deciduous	___Mixed broad-leaved/Needle leaved	___Shrubland	03 20%	03 1-2 m
___Drought-deciduous	___Microphyllous	___Dwarf Shrubland	04 30%	04 2-5 m
___Mixed evergreen - cold-deciduous	___Graminoid	___Herbaceous	05 40%	05 5-10 m
___Mixed evergreen - drought-deciduous	___Forb	___Nonvascular	06 50%	06 10-15 m
Herbs	___Pteridophyte	___Sparsely Vegetated	07 60%	07 15-20 m
___Annual			08 70%	08 20-35 m
___Perennial			09 80%	09 35 - 50 m
			10 90%	10 >50 m
			11 100%	

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

please see the table on the previous page for height and cover scales for strata

Other Comments

Cover Scale for Species
01 <1%
02 1-5%
03 5-25%
04 25-50%
05 50-75%
06 75-100%

NATIONAL PARK VEGETATION MAPPING PROGRAM: PLOT SURVEY FORM

IDENTIFIERS/LOCATORS

Plot Code__________________________________ Habitat/BPU Code____

Provisional Community Name____

State _____ Park Name______________________ Park Site Name____

Quad Name____ Quad Code____

GPS file name________________ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N
Comments: ____ Error +/- ___ ____ m
Please do not complete the following information when in the field
Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone ____________

Survey Date_____________________ Surveyors____

Directions to Plot

Plot length(m)______ Azimuth ______ Plot width(m)_____ If circle (diam)_____ Plot Photos (y/n) __ Roll # _____ Frame # ____________

Plot Permanent (y/n) ____ Comments on photos or marker

Plot representativeness (discuss decisions for placement and/or reasons for non-representativeness)
a. Representativeness of association (if known):

b. Representativeness of plot in stand:

ENVIRONMENTAL DESCRIPTION

Elevation ____________________ Slope _____________________ Aspect_________________________

Topographic Position (see cheat sheet)

Landform (see cheat sheet)

Surficial Geology (see cheat sheet)

Cowardian	System
___ Upland	____ Palustrine
___ Riverine	____ Lacustrine

Hydrology
___Permanently Flooded ___Seasonally Flooded ___Temporarily Flooded
___Semipermanetly Flooded ___Saturated ___Intermittently Flooded
___Unknown

Environmental Comments (dynamic stage, fire history, insect damage, etc):

Ground Cover: *(please estimate to the nearest percentage. Sum = 100%)*
___ Bare soil ___ Litter / duff ___ Wood (> 1 cm)
___ Bedrock ___Large rocks (cobbles, boulders > 10 cm)
___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) dune /alluvium
___ Moss ___ Lichen ___ Cryptogam ___ Water ___ Other (name):

Soil Texture:
___ sand ___ loamy sand ___ sandy loam ___ loam
___ silt loam ___ silt ___ clay loam ___ silty clay
___ sandy clay ___ clay ___ peat ___ muck

Soil Drainage
___ Rapidly drained ___ Well drained
___ Moderately well drained ___ Somewhat poorly drained
___ Poorly drained ___ Very poorly drained

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	Cover Scale for Strata	Height Scale for Strata
Trees and Shrubs __Evergreen __Cold-deciduous __Mixed evergreen-cold-deciduous Herbs ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf Shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	T 0-1% P >1-5% 1 >5-15% 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%	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

	Height/Strata Class	Cover Class	Dominant Species (mark Diagnostics with *)
T1 Emergent	_______	_______	______________________________
T2 Canopy	_______	_______	______________________________
T3 Sub-canopy	_______	_______	______________________________
S1 Tall shrub	_______	_______	______________________________
S2 Short Shrub	_______	_______	______________________________
S3 Dwarf-shrub	_______	_______	______________________________
Ht Herbaceous	_______	_______	______________________________
H1 Graminoids	_______	_______	______________________________
H2 Forbs	_______	_______	______________________________
H3 Ferns	_______	_______	______________________________
H4 Tree seedlings	_______	_______	______________________________
N Non-vascular	_______	_______	______________________________
V Vine/liana	_______	_______	______________________________
E Epiphyt	_______	_______	______________________________

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

Natural and Anthropogenic Disturbance Comments (please see cheat sheet for impact codes, list intensity as High, Med, or Low)

Other Comments (locations of photos and permanent plot marker)

Plot Code____

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

Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class	Stratum	Species Name	Cover Class

Cover Class Scale

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

Tree D.B.H Form

Plot Code:______________________________Units in cm or inches (circle one)

Record tree diameter over 5 cm at 4.5 feet (1.37 m) height for species that contribute to tree canopy.

Separate measurements of multi-stemmed trees with commas. Can estimate by 5 cm dia. classes

Species	D.B.H.(s) for multi-stems trees

Species	D.B.H.(s) for multi-stems trees

Instructions for filling out Fields in the PLOT SURVEY FORM

Plot Survey Form

Plot Code
Code indicating the specific plot within the vegetation polygon. For the 2000 field season, the codes will be “ZION.XXX”. Begin with ZION.101 and go from there. If another team is working, decide with them which plot numbers each team will use to identify the data they gather. For example, if a second team is working one week and approximately 100 plots have already been collected, they may get plots ZION.200 through ZION.215.

BPU Code
The biophysical unit identified—will be taken from the map. This is a less important field this year and can be filled in based on a post processing of GIS data from the GIS analysts.

Provisional Community Name
Using the provisional classification of the Park with which you’ve been provided, assign the name of the vegetation type which 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 ZION NP

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

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 if at all possible. If you can’t get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

Field UTM Y
Use GPS if at all possible. If you can’t get a GPS reading, estimate coordinates from a topo map and note on the form that this method was used.

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

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 topo map, a major highway, using park naming conventions for roads) readily locatable on a 7.5 minute topo 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 10 m	**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 have been taken at the time of sampling, and the roll and frame numbers of any photos. Also record azimuth of photo if not taken in standard direction.

Plot Permanent
Check off that the plot has been permanently marked.

Plot Representativeness
Does this plot represent the full variability of the polygon? If not, were additional plots taken? Note 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 if you have no opinion at this time.

ENVIRONMENTAL DESCRIPTION

Elevation

Elevation of the plot. **Specify whether in feet or meters** (this will depend on the units used on the GPS or on the topographic map being used). In general, we have determined that the reading you get from a topo 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 topo 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 (drainages) that sheds water to the drainage channels.

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

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

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

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

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). You can develop your own list for Zion. Just be consistent so we can analyze by landform.

arroyo	lowland
alluvial fan	mid slope
alluvial flat	mountain
alluvial terrace	mud flat
bajada	noseslope
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	sinkhole (undifferentiated)
drainage channel (undifferentiated)	slide
dune (undifferentiated)	slope
escarpment	slough
flood plain	soil creep slope
foothills	stream terrace (undifferentiated)
gap	streambed
gorge	swale
hills	talus
hogback	toe slope
interfluve	valley floor
lake	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 Zion NP Geology Map.

Zion NP Geology Map Units
Alluvium
Alluvium Remnants
Carmel Formation
Chinle Formation
Dakota Formation
Kaibab Formation
Kayenta Formation
Lake and Pond Deposits
Lake Deposits
Moenave Formation
Moenkopi Formation
Navajo Sandstone
Slide Deposits
Slide Deposits – Calcite
Temple Cap Formation
Volcanic Rocks
Volcanic Rocks - Tephra

Gradsect lumped types (use these if you cannot determine the Zion Geology Map type)
Alluvium (except slide deposits)
Sandstones (Navajo and Temple Cap)
Limestone (Carmel formation)
Sandstone/shale (Kayenta, Moenave, and slide formations)
Shale and gypsum (Chinle and Moenkopi Formations)

The Sedimentary Geology of Zion from http://www.aqd.nps.gov/grd/parks/zion/#relsites

Rock Layer	Appearance	Where To See	Deposition	Rock Type
Dakota Formation	cliffs	top of Horse Ranch Mountain	streams	conglomerate and sandstone
Carmel Formation	cliffs	Mt. Carmel Junction	shallow sea and coastal desert	limestone, sandstone and gypsum
Temple Cap Formation	cliffs	top of West Temple	desert	sandstone
Navajo Sandstone	steep cliffs 1,600-2,200' thick red lower layers are colored by iron oxides tall cliffs of Zion Canyon;	Highest exposure is West Temple and Checkerboard Mesa	desert sand dunes covered150,000 square miles shifting winds during deposition created cross-bedding	sandstone
Kayenta Formation	rocky slopes	throughout canyon	streams	siltstone and sandstone
Moenave Formation	slopes and ledges	lower red cliffs seen from Zion Canyon Visitor Center	streams and ponds	siltstone and sandstone
Chinle Formation	purpleish slopes	above Rockville	streams	shale, loose clay and conglomerate
Moenkopi Formation	chocolate cliffs with white bands	rocky slopes from Virgin to Rockville	shallow sea	shale, siltstone, sandstone, mudstone, and limestone
Kaibab Formation	cliffs	escarpment of Hurricane Fault along I-15 near Kolob Canyons	shallow sea	limestone

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 (adapted from Cowardin et al. 1979).
SEMIPERMANENTLY FLOODED **-** Surface water persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's Intermittently Exposed and Semipermanently Flooded modifiers.

SEASONALLY FLOODED - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases 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 not known. The unit is simply 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.

Soil Taxon/Description ***This does not apply for the Zion Project***

Ground Cover
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.

Simplified Key to Soil Texture (Brewer and McCann 1982)

A1 Soil does not remain in a ball when squeezed..sand

A2 Soil remains in a ball when squeezed..B

B1 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

F1 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 (1) actual moisture content (in excess of field moisture capacity) and (2) the extent of the period during which excess water is present in the plant-root zone. It is recognized that permeability, level of groundwater, and seepage are factors affecting moisture status. However, because these are not easily observed or measured in the field, they cannot generally be used as criteria of moisture status. It is further recognized that soil profile morphology, for example mottling, normally, but not always, reflects soil moisture status. Although soil morphology may be a valuable field indication of moisture status, it should not be the overriding criterion. Soil drainage classes cannot be based solely on the presence or absence of mottling. Topographic position and vegetation as well as soil morphology are useful field criteria for assessing soil moisture status.

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 Ae horizon, if present, may be mottled. The matrix generally has a lower chroma than in the well-drained soil on similar parent material.

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

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

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

MIXED EVERGREEN - COLD DECIDUOUS - Evergreen and deciduous species generally contribute 25-75% of the total woody cover. Evergreen and cold-deciduous species 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 which best describes the leaf form of the dominant stratum. The dominant stratum is the uppermost stratum that contains at least 10% cover.

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

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

MICROPHYLLOUS - Woody cover primarily microphyllous.

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

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

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

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 25% cover, trees generally less than 25% cover). Shrub cover may be less than 25% where it exceeds tree, dwarf-shrub, herb, and nonvascular cover, 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 25% cover, trees and tall shrubs generally less than 25% cover). Dwarf-shrub cover may be less than 25% where it exceeds tree, shrub, herb, and nonvascular cover, respectively

Herbaceous: Herbs (graminoids, forbs, and ferns) dominant (generally forming at least 25% cover; trees, shrubs, and dwarf-shrubs generally with less than 25% cover). Herb cover may be less than 25% where it exceeds tree, shrub, dwarf-shrub, and nonvascular cover, 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 25% 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- or few-stemmed woody plants, generally greater than 5 m in height and 10 cm DBH at maturity and under optimal growing conditions. Individuals can be determined relatively easily. Shrubs are defined as multiple-stemmed woody plants generally less than 5 m in height at maturity and under optimal growing conditions, and determining individuals can sometimes be difficult. At Zion, Quercus gambelii can occur in either shrub or tree form.

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 species known to be diagnostic of a particular vegetation type are present, 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	0.5-1m
1	5-15%	03	1-2 m
2	15-25%	04	2-5 m
3	25-35%	05	5-10 m
4	35-45%	06	10-15 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	95-100%		

Animal Use Evidence
Comment on any evidence of use of the plot/polygon by non-domestic animals (i.e., tracks, scat, gopher or prairie dog mounds, etc.). Notes on domestic animals should be made in the field below.

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

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 T1 (emergent tree), T2 (tree canopy), or T3 (tree sub-canopy). If in the shrub layer, note in the "S" 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 E (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 10 cm diameter. For multi-stemmed individuals, separate the measurements with a comma. Also tally tree stems with DBH between 5-10 cm (See Tree DBH Form). 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 10 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.

CONSIDERATIONS FOR MISSION PLANNING:
PHASE II FIELD SAMPLING FOR ZION VEGETATION MAPPING PROJECT Draft 2000

Planning for the day: (ecologist/team leader)

- Safety and sustenance issues (plenty of food, water, first-aid kit bring water filter if long steep hike where water can be obtained)
- Field communications: Develop plan with other team(s)(if necessary) for radio check-in time re: plot types and contingencies for duplication problems
- Do you have radio and are batteries charged?
- check on GPS (batteries, memory available, waypoints for priority samples logged using spreadsheet?)
- check list for all other field equipment
- clipboard
- pens, pencils
- compass-clinometer
- two tape measures
- plastic bags for plants
- masking tape and sharpies for labeling specimens
- If longer mission, small plant press with adequate blotters and newspaper
- Bring sufficient field forms for all possible samples
- Bring all ancillary information. (cheat sheet, species list, key, sampling priority list for zone, fuels protocol, main sampling protocol)
- Plan day's mission before departure for day using one copy per team of a) USGS quad, b) hardcopy DOQQ with flagged points, and c) aerial photo with coded overlay
- considerations for mission planning:
- considerations based on topography, existing access routes, density and complexity of vegetation (more time for forest and woodland plots, less for herbaceous and scrub),
- considerations based on priority needs, and
- considerations based on possible redundancy of other team (adequate alternative samples)

Planning for the Week:

With which 7.5' quads will you be working?
Do you have all appropriate maps, photos and DOQQ's?
Develop an estimate of reasonable expectations of plots to choose from for each team broken up by day and based on an estimate of individual team's travel logistics for the week.
Develop plan of attack for the week to capture all essential associations in work area.
Balance points two and three above with the expected work schedule of the teams and ensure adequate time-off and reduce over-time concerns.
Do you have all necessary information for weekly planning? a) DOQQ's for the zone, b) adequate field copies of air photos (1 per team if both will be working same photo) , c) blank field forms.

Communication with management team (Jim, Marion, Keith, Dan Cohan, or some appropriate subset) and field crews.

- update matrix of sampled plots by type, (enter plot number and provisional community name in plots database.
- all uncertainties dealt with (new types seen should we sample?, problems with interpreting PI information, personnel issues, problems in interpreting classification/key, park-related logistics.).
- Organization of field crews:
- gather Quality control (Q.C.'ed) field forms (allow time for your Q.C. and resolving your questions about the forms)
- obtain all plants not identified (allow time for plant I.D.)
- what were your questions about the polygons visited during the week?
- What was accomplished, what was not accomplished?
- Pass on the developments and questions to the management team on a regular basis. Don't let them build up too long.

<u>Materials checklist</u>

road / trail maps
DBH tape
2 tape measure(s)
DBH tape or plastic DBH measurement device
compass
plot markers – large nails or cut rebar (1 per plot, plus extra)
small sledgehammer (for driving plot markers into ground)
PLGR
GPS receiver (checked daily to ensure that it is set to NAD 83)
radio
clinometer
camera & film (allow at least 3 exposures per plot)
baggies – for unidentified plant samples
plant press & paper
pens / permanent markers
Plot Survey forms
Forest Fuel forms
Accuracy Assessment Point forms
white board
dry-erase markers (for white board)
most recent version of provisional classification of the Park x number of plots needed per type (updated approx. every 2 weeks)

ZION CODE LIST – Draft cheatsheet

LANDFORM
Arroyo
Alluvial fan
Alluvial flat
Alluvial terrace
Badland
Bajada
Basin
Bench
Bottomland
Butte
Canyon
Channel
Cinder cone
Cliff
Colluvial slope
Cuesta
Drainage channel (undifferentiated)
Dune
Earth flow
Eroded bench
Eroding stream channel system
Erosional stream terrace
Escarpment
Flood plain
Fluvial
Gorge
Hill
Hillslope bedrock outcrop
Hogback
Knob
Knoll
Lake/pond
Lake bed
Lake plain
Lake terrace
Lava flow (undifferentiated)
Ledge
Mesa
Mound
Mountain
Mud flat
Pinnacle
Plateau
Playa
Ravine
Ridge
Ridge & valley
Ridgetop bedrock outcrop
Rock fall avalanche
Rim
Riverbed
Saddle
Scour
Seep
Upper 1/3 of slope
Middle 1/3 of slope
Lower 1/3 of slope
Soil creep slope
Stream terrace (undifferentiated)
Streambed
Swale
Talus
Toe slope
Valley floor
Wash

TOPOGRAPHIC POSITION

Designation	Synonym(s)
Interfluve	crest, summit, ridge
High slope	shoulder slope, upper slope, convex creep slope
High level	mesa
Midslope	transportational midslope, middle slope
Backslope	dipslope
Step in slope	ledge, terracette
Lowslope	lower slope, foot slope, colluvial footslope
Toeslope	alluvial toeslope
Low level	terrace
Channel wall	bank
Channel bed	narrow valley bottom, gully, arroyo/wash
Basin floor	depression

SURFICIAL GEOLOGY
Alluvium
Alluvium Remnants
Carmel Formation
Chinle Formation
Dakota Formation
Kaibab Formation
Kayenta Formation
Lake and Pond Deposits
Lake Deposits
Moenave Formation
Moenkopi Formation
Navajo Sandstone
Slide Deposits
Slide Deposits – Calcite
Temple Cap Formation
Volcanic Rocks
Volcanic Rocks – Tephra

ASPECT
Flat (n/a)
Variable

N	338-22
NE	23-67
E	68-112
SE	113-157
S	158-202
SW	203-247
W	248-292
NW	293-337

SOIL TEXTURE
Sand
Loamy sand
Sandy loam
Loam
Silt loam
Clay loam
Silt
Clay
Sandy Clay
Silty Clay
Peat
Muck

DRAINAGE
Rapidly drained
Well drained
Moderately well drained
Somewhat poorly drained
Poorly drained
Very poorly drained

IMPACTS
Recent Fire Suppression Activity (e.g. fire lines)
Mountain Pine Beetle Damage
Blister Rust (specify tree species and mortality)
Mistletoe (specify tree species)
Trespass Grazing Evidence
Development
Recreation (campsites, etc.)
Significant Weed Invasion

ACCURACY ASSESSMENT POINT FORM

IDENTIFIERS/LOCATORS

Field Point Code ____ Database Point Code ________________________

State __ Park Name _____________________________________ Park Site Name ___________________________

Quad Name ____ QuadCode _____________________________

Primary Name Veg Assoc: ____

Secondary Name Veg Assoc: ____

Other Veg Assoc within 50 m ____

Classification Comments:

GPS file name________________ Field UTM X___ ___ ___ ___ ___ ___ m E Field UTM Y___ ___ ___ ___ ___ ___ ___ m N

GPS Error ________________ m

please do not complete the following information when in the field

Corrected UTM X___ ___ ___ ___ ___ ___ m E Corrected UTM Y___ ___ ___ ___ ___ ___ ___ m N UTM Zone_____

Survey Date______________
Surveyors____

ENVIRONMENTAL DESCRIPTION

Elevation _______________________ Slope ______________________ Aspect __________________________

Topographic Position

Landform

Environmental Comments (including hydrology):	Unvegetated Surface: *(please use the cover scale below)* ___ Bedrock ___ Litter, duff ___ Wood (> 1 cm) ___ Large rocks (cobbles, boulders > 10 cm) ___ Small rocks (gravel, 0.2-10 cm) ___ Sand (0.1-2 mm) ___ Bare soil ___ Other:__________________________

VEGETATION DESCRIPTION

Leaf phenology (of dominant stratum)	Leaf Type (of dominant stratum)	Physiognomic class	HEIGHT (M) SCALE	COVER
<u>Trees and Shrubs</u> ___Evergreen ___Cold-deciduous ___Drought-deciduous ___Mixed evergreen - cold-deciduous ___Mixed everg. - drought-deciduous <u>Herbs</u> ___Annual ___Perennial	___Broad-leaved ___Needle-leaved ___Mixed broad-lvd/Needle-lvd ___Microphyllous ___Graminoid ___Forb ___Pteridophyte	___Forest ___Woodland ___Shrubland ___Dwarf-shrubland ___Herbaceous ___Nonvascular ___Sparsely Vegetated	01 -<0.5 02 - 0.5-1 03 - 1-2 04 - 2-5 05 - 5-10 06 - 10-15 07 - 15-20 08 - 20-35 09 - 35-50 10 ->50	T - <1% 01 - 1-5% 02 - 6-15% 03 - 16-25% 04 - 26-35% 05 - 36-45% 06 - 46-55% 07 - 56-65% 08 - 65-75% 09 - 76-85% 10 - 86-95% 11- 96-100%

Strata	Height Class	Cover Class	Dominant species (mark any known diagnostic species with a *)	Cover Class
T1 Emergent	______	______		
T2 Canopy	______	______		
T3 Sub-canopy	______	______		
S1 Tall shrub	______	______		
S2 Short Shrub	______	______		
S3 Dwarf-shrub	______	______		
H Herbaceous	______	______		
N Non-vascular	______	______		
V Vine/liana	______	______		
E Epiphyte	______	______		

APPENDIX E: Dichotomous Key to the Plant Associations of ZION

(Produced by NatureServe 2001 Western Regional Office (Marion Reid and Keith Schulz)

DICHOTOMOUS KEY TO THE PLANT ASSOCIATIONS OF ZION NATIONAL PARK

Plant names in Latin and follow the nomenclature of Kartesz (1999).

1a. Non-forested Plant Associations. Shrub or herbaceous plant species have greater cover than trees. Tree canopy cover is typically less than 25%. However, canopy cover for *Pinus edulis, Pinus monophylla, Pinus ponderosa*, and *Juniperus osteosperma* may be less, as low as 20%, and the stand still be considered a forest or woodland plant association occurring in particularly dry climate conditions. (See **Forest and Woodland Vegetation).**

2a. Sparsely Vegetated Plant Associations: Cover of vascular plant species is minimal, usually less than 10%, but may exceed 20% in some stands with characteristic substrates. The substrate is the dominant feature. Examples of substrates nearly barren of vegetation are sandstone (slickrock), Chinle badlands, lichen crusts, and shale rock fragments .... **Key A**
2b. Shrublands and Grasslands: Cover of vascular plant species is greater than 10%. Vegetation is dominated by either shrubs or herbaceous forbs and grass-like plants .... **3a -3b**

3a. Shrub layer dominates over other stratums with heights to 3 meters **(Shrublands)**....... **4a -4b**
3b. Herbaceous species dominate .... **7a -7b**

4a. Shrub heights are less than ½ meter (**Dwarf-shrublands**) .... **Key B**
4b. Shrub heights are ½ meter to 3 meters .... **5a – 5b**

5a. Palustrine environments, seasonally, temporarily, or permanently saturated soils .... **Key C**
5b. Upland environments .... **6a – 6b**

6a. Upland environments occurring below 4500 feet in elevation, southern and southwestern region of Zion National Park .... **Key D**
6b. Upland environments, occurring above 4500 feet in elevation .... **Key E**

7a. Graminoids (grasses and grass-like plants) dominate woodland or forest openings and rocky outcrops; upland environments........ **Key F**
7b. Graminoids dominate in non-upland (palustrine) environments .... **Key G**

1b. Forest and Woodland Plant Associations. Greater than 25% tree canopy cover for *Abies concolor, Acer grandidentatum, Acer negundo, Fraxinus anomala, Populus fremontii, Populus tremuloides*, and *Pseudotsuga menziesii.* Canopy cover for *Pinus edulis, Pinus monophylla, Pinus ponderosa*, and *Juniperus osteosperma* may be less, as low as 20% and still be considered a forest or woodland plant association occurring in particularly dry climate conditions .... **2a -2b**

2a. Pines or Junipers dominate the tree canopy layer, dominant tree species include *Pinus edulis, Pinus monophylla, Pinus ponderosa,* and *Juniperus osteosperma* .... **Key H**
2b. Other conifers or deciduous trees dominate the tree canopy .... **3a – 3b**

3a. Douglas-fir or white fir dominate the tree canopy layer, *Pseudotsuga menziesii* and *Abies concolor* .... **Key I**
3b. Deciduous trees dominate the tree canopy; riparian ecosystems or cool and relatively mesic environmental conditions, such as higher elevations, north-facing ravines and canyons. Dominant species include *Populus fremontii, Populus angustifolia, Fraxinus velutina, F. anomala, Acer negundo, Acer grandidentatum*, or *Populus tremuloides* .... **Key J**

Key A: Sparse Vegetation

1 Substrate is Navaho sandstone Formation, "slickrock".

2 *Pinus ponderosa* is present, with only 5-20% cover and usually stunted growth, heights average less than 10 meters. *Arctostaphylos patula, Cercocarpus intricatus, Quercus turbinella and Amelanchier utahensis* are usually present in some combination in the shrub layer distributed sparsely across Navaho sandstone "slickrock" slopes. .... ***Pinus ponderosa* Slickrock Sparse Vegetation**

2 *Pinus ponderosa* is absent or has less than 5% cover and heights less than 5 meters. *Cercocarpus intricatus* dominates the shrub layer. Other shrubs commonly present are *Arctostaphylos patula, Amelanchier utahensis,* and *Quercus turbinella.* Total shrub cover is less than 20%. Sandstone slopes are generally steep........................... ***Cercocarpus intricatus* Slickrock Sparse Vegetation**

1 Substrate is not Navajo sandstone.

3 Substrate is shale rock fragments. *Cercocarpus montanus* dominates the shrub layer with few other shrubs present. Only known to occur in the northern region of the Park on mesa rims or mountain ridges.. ***Cercocarpus montanus* Rock Pavement Sparse Vegetation**

3 Substrate is not shale rock fragments.

4 Substrate is Chinle Formation. *Gutierrezia sarothrae* and *Eriogonum corymbosum* codominate the dwarf-shrub layer with less than 20% cover. Other species commonly present contributing minimal cover are *Atriplex canescens, Ericameria nauseosa, Psorothamnus fremontii, Purshia stansburiana* and/or *Coleogyne ramosissima.* Graminoid *Pleuraphis jamesii* is commonly present. .... ***Eriogonum corymbosum* Badlands Sparse Vegetation**

4 *Ephedra nevadensis* dominates the shrub layer, but may have less than 5% cover. Cryptogamic crust contributes up to nearly 90% ground cover and usually occurs on Chinle Formation. .... ***Ephedra nevadensis* / Lichen Sparse Vegetation [Provisional]**

Key B: Dwarf-shrublands

1 *Gutierrezia sarothrae* dominates the dwarf-shrub layer, but may only have 10% cover. *Opuntia* spp. is frequently present. Graminoid *Pleuraphis jamesii* is present and may exceed the cover of *Gutierrezia sarothrae.* .... ***Gutierrezia sarothrae – (Opuntia spp.) / Pleuraphis jamesii* Dwarf-shrubland**

1 *Artemisia nova* is the dominant shrub with greater than 10% cover. (Always occurring above 6000 feet.)

2 *Hesperostipa comata* dominates the herbaceous layer. Other graminoids may be present with less cover. .... ***Artemisia nova / Hesperostipa comata* Dwarf-shrubland.**

2 *Hesperostipa comata* does not dominate the herbaceous layer.

3 *Poa fendleriana* dominates the herbaceous layer. Other graminoids may be present with less cover. ....***Artemisia nova / Poa fendleriana*** **Dwarf-shrubland [Provisional]**

3 *Poa fendleriana* does not dominate the herbaceous layer.

4 *Elymus elymoides* dominates the herbaceous layer and may codominate with *Poa secunda*, *Bouteloua gracilis, Koeleria macrantha,* or other graminoid species. ....***Artemisia nova / Elymus elymoides*** **Dwarf-shrubland**

Key C: Palustrine Shrublands

1 Shrub dominated riparian, intermittent stream (washes) or wet meadow vegetation occupying all elevations in the Park. *Salix* species dominate the shrub layer.

2 *Salix exigua* dominates the shrub layer.

3 *Salix exigua* cover is 10 to 30%. Herbaceous layer cover is less than 10%. ....***Salix exigua /*** **Barren Shrubland**

3 *Salix exigua* cover is over 20% with a lush, mesic graminoid understory ....***Salix exigua /*** **Mesic Graminoids Shrubland**

2 *Salix ligulifolia* dominates the shrub layer. This association occurs in high-elevation (above 7000 feet) willow carrs with diverse and lush herbaceous understory that typically includes *Carex utriculata, Carex rostrata, Poa pratensis, Agrostis stolonifera, Phleum pratensis, Carex microptera, Maianthemum stellatum,* and other mesic herbaceous species. ....***Salix ligulifolia / Carex utriculata*** **Shrubland [Provisional]**

1 *Salix* species do not dominate the riparian shrub layer.

4 *Pluchea sericea* dominates the shrub layer. Herbaceous cover is minimal. ....***Pluchea sericea*** **Shrubland [Placeholder]**

4 *Pluchea sericea* is not present.

5 *Baccharis emoryi* dominates shrubland. ....***Baccharis emoryi*** **Shrubland [Provisional]**

5 *Betula occidentalis* is present in the understory. Canopy species include *Populus fremontii, Populus angustifolia, Fraxinus velutina, Acer negundo*, *Pinus ponderosa* and *Juniperus scopulorum*. Tree canopy typically minimal, trees are young and included in tall shrub layer. *Acer grandidentatum* and *Quercus gambelii* are often present in the shrub layer. .... ***Populus fremontii / Betula occidentalis*** **Wooded Shrubland**

Key D: Shrublands below 4500 feet elevation

1 *Coleogyne ramosissima* dominates the shrub layer.

2 Shrubs, *Atriplex canescens, Ephedra* spp., and *Gutierrezia* spp. are commonly present, but contribute less cover than *Coleogyne ramosissima*. Graminoid, *Pleuraphis jamesii,* is absent or has less than 10% cover. .... ***Coleogyne ramosissima* Shrubland**.

2 Herbaceous layer is well represented by graminoid *Pleuraphis jamesii*, at least 10% cover. .... ***Coleogyne ramosissima / Pleuraphis jamesii* Shrubland**

1 *Coleogyne ramosissima* is not the dominant shrub.

3 *Artemisia filifolia* dominates the shrub layer and is often associated with graminoid *Sporobolus cryptandrus*.. ***Artemisia filifolia* Colorado Plateau Shrubland**

3 *Artemisia filifolia* is not the dominant shrub.

4 *Ephedra nevadensis* dominates the shrub layer on volcanic rock substrate. .... ***Ephedra nevadensis* Basalt Shrubland [Provisional]**

4 *Ephedra nevadensis* does not dominate.

5 *Ericameria nauseosa* dominates shrub layer on alluvial flats. *Rhus trilobata* is absent to well represented. *Artemisia tridentata* may be present. *Bromus tectorum* and other exotic herbaceous species are a major component of the herbaceous layer. May also occur above 4500 feet.....................***Ericameria nauseosa / Bromus tectorum* Semi-natural Shrubland**

5 *Ericameria nauseosa* does not dominate shrub layer.

6 *Atriplex canescens* and *Artemisia tridentata* ssp. *tridentata* codominate, each with only 5-10% cover. Other shrubs commonly present are *Ephedra nevadensis, Ericameria nauseosa, Chrysothamnus viscidiflorus,* and *Gutierrezia microcephala.* .... ***Atriplex canescens – Artemisia tridentata* Shrubland**

6 *Atriplex canescens* dominates shrubland with 10 to 30% cover. *Artemisia tridentata* is not present. Other shrubs commonly present are *Lycium pallidum, Psorothamnus fremontii, Ephedra nevadensis,* and *Gutierrezia sarothrae.* Herbaceous layer has dense cover of exotic species.....................................***Atriplex canescens* Shrubland**

Key E: Shrublands above 4500 feet elevation

1 *Quercus gambelii* dominates or is codominant in the shrub layer. Cover ranges from 10 to 100%. Physiognomic form may be tree (over 10 cm DBH), tall shrub or short shrub.

2 *Artemisia tridentata* is codominant with cover of 10% to 40%. Other shrubs commonly present are *Tetradymia canescens, Ericameria nauseosa, Purshia tridentata,* and *Chrysothamnus viscidiflorus.* The co-dominants are distributed as a relatively uniform, fine-scaled mosaic of *Quercus gambelii* clumps in extensive stands of *Artemisia tridentata.*.. .... ***Quercus gambelii / Artemisia tridentata* Shrubland**

2 *Artemisia tridentata* does not codominate with *Quercus gambelii*.

3 *Cercocarpus montanus* is present with 10 to 50% cover. Other shrubs commonly present, with substantial cover, are *Amelanchier utahensis, Quercus turbinella, Arctostaphylos patula,* and *Peraphyllum ramosissima* .... ***Quercus gambelii – Cercocarpus montanus* / (*Carex geyeri*) Shrubland**

3 *Cercocarpus montanus* is absent or has less than 10% cover.

4 *Amelanchier utahensis* is codominant in the stand with cover ranging 10 to 50% and occasionally exceeding cover of *Quercus gambelii.* *Cercocarpus montanus* is either absent or has minimal cover. ....***Quercus gambelii / Amelanchier utahensis* Shrubland**

4 *Amelanchier utahensis* does not codominate.

5 *Quercus gambelii* dominates the stand as a tall shrub, 1 to 3 meters high, and can be tree size in some cases. *Symphoricarpos oreophilus* dominates the shrub layer under *Quercus gambelii.* Cover must be over 5%. The herbaceous layer may be significant. *Poa fendleriana* cover is less than 5%. .... ***Quercus gambelii / Symphoricarpos oreophilus* Shrubland**

5 *Symphoricarpos oreophilus* has less than 5% cover in the understory or less cover than *Poa fendleriana*............ ***Quercus gambelii / Poa fendleriana* Shrubland [Provisional]**

1 *Quercus gambelii* does not dominate the shrub layer.

6 *Arctostaphylos patula* dominates or is codominant in the shrub layer.

7 *Quercus gambelii* is codominant in the shrub layer in a mosaic pattern with *Arctostaphylos patula*. This association usually occurs on high mesas or plateaus. Other shrubs may be present, but have minimal cover.. ***Arctostaphylos patula – Quercus gambelii – (Amelanchier utahensis)* Shrubland**

7 *Quercus gambelii* does not codominate.

8 *Arctostaphylos patula* has cover of 10 to 100%. *Pinus ponderosa, Juniperus osteosperma, Pinus monophylla,* or *Pinus edulis* may be present but have less than 10% cover. This association mostly occurs on sandy slickrock basins, benches, and mesas. *Arctostaphylos patula* occurs alone or in a shrub mix. *Cercocarpus intricatus, Amelanchier utahensis, Quercus turbinella* may be well represented in the mix. *Quercus gambelii,* if present, is poorly represented. ....***Arctostaphylos patula* Shrubland**

8 *Artemisia tridentata* ssp. *vaseyana* codominates the shrub layer. Other shrubs that may be present and even with significant cover are *Quercus gambelii* and *Tetradymia canescens.* Presence of *A. tridentata ssp. vaseyana* with *Arctostaphylos patula* identifies this association. ....***Arctostaphylos patula – Artemisia tridentata ssp. vaseyana* Shrubland**

6 *Arctostaphylos patula* does not dominate.

9 *Artemisia tridentata* dominates the shrub layer.

10 *Tetradymia canescens* is usually co-dominant with *Artemisia tridentata* or at least present. *Bouteloua gracilis* dominates the herbaceous layer with 10% cover or more. ....***Artemisia tridentata / Bouteloua gracilis* Shrubland**

10 *Bouteloua gracilis* is not dominant in the herbaceous understory.

11 *Hesperostipa comata* is present to abundant in the herbaceous layer and occurs with *Artemisia tridentata* ssp. *vaseyana* at elevations above 6000 feet. This association occurs amongst *Quercus gambelii* and *Pinus edulis – Juniperus osteosperma* woodlands. Other graminoid species commonly present are *Bouteloua gracilis, Poa fendleriana,* and *Muhlenbergia* spp. ....***Artemisia tridentata* ssp. *vaseyana / Hesperostipa comata* Shrubland**

11 *Hesperostipa comata* does not dominate the herbaceous layer.

12 *Pascopyrum smithii* or *Elymus lanceolatus* dominates the herbaceous layer. This association has only been documented on the western side of the Park in Lee Valley. …***Artemisia tridentata* ssp. *tridentata / Pascopyrum smithii - (Elymus lanceolatus)* Shrubland**

12 *Bromus tectorum* dominates the herbaceous understory of this *Artemisia tridentata* shrubland. *Ericameria nauseosa* has 0 to 30% cover. This association is likely to be found in highly disturbed areas...***Artemisia tridentata – (Ericameria nauseosa) / Bromus tectorum* Semi-natural Shrubland**

9 *Artemisia tridentata* does not dominate.

13 *Arctostaphylos pungens* dominates the shrub layer or has at least 10% cover. Other species present may be *Arctostaphylos patula, Amelanchier utahensis, Quercus gambelii*, and *Ceanothus fendleri*. This association is uncommon in Zion NP and is most commonly found in the Kolob Canyons region..***Arctostaphylos pungens* Shrubland**

13 *Arctostaphylos pungens* is not dominant.

14 *Quercus turbinella* dominates the shrub layer with 10 to 70% cover. Other shrubs that may be present are *Amelanchier utahensis, Arctostaphylos patula, Arctostaphylos pungens, Shepherdia rotundifolia, Fraxinus anomala, Rhus trilobata,* and *Quercus gambelii.* This shrubland is composed of various combinations of these species. Environmental conditions are significant in that this association occurs on 20^{o} to 40^{o} colluvial slopes below sandstone walls or on gentle slopes at the base of colluvial slopes throughout the Park...***Quercus turbinella – (Amelanchier utahensis)* Colluvial Shrubland**

14 *Quercus turbinella* does not dominate.

15 *Amelanchier utahensis* clearly dominates this association with 10 to 50% cover. *Artemisia tridentata* has been documented to occur and sometimes codominate with *Amelanchier utahensis* in Cave Valley. In most cases other shrubs are absent or insignificant. ....***Amelanchier utahensis* Shrubland**

15 *Amelanchier utahensis* does not dominate

16 *Symphoricarpos oreophilus* dominates the shrub layer with an understory dominated by *Poa pratensis*. ....***Symphoricarpos oreophilus / Poa pratensis* Semi-natural Shrubland [Provisional]**

16 *Symphoricarpos oreophilus* does not dominate.

17 *Chrysothamnus viscidiflorus* dominates the shrub layer with an understory dominated by *Poa pratensis*... ....***Chrysothamnus viscidiflorus / Poa pratensis* Semi-natural Shrub Herbaceous Vegetation [Provisional]**

17 *Chrysothamnus viscidiflorus* does not dominate.

18 *Ericameria nauseosa* dominates the shrub layer.

19 Other shrubs may present may include *Rhus trilobata* and *Artemisia tridentata*. *Bromus tectorum* is a major component of the herbaceous understory of this vegetation association.. ....***Ericameria nauseosa / Bromus tectorum* Semi-natural Shrubland**

19 Other vegetation is sparse but usually includes *Eriogonum corymbosum, Gilia congesta, Yucca utahensis,* and *Gutierrezia sarothrae* on steep slopes where rock avalanches and severe erosion has occurred. ....***Ericameria nauseosa* Sand Deposit Sparse Vegetation**

18 *Ericameria nauseosa* does not dominate.

20 *Tetradymia canescens* dominates mixed shrub layer. Characteristic shrub species in mix are *Ephedra viridis, Quercus gambelii, Amelanchier utahensis, Artemisia tridentata* and *Ericameria nauseosa***.** .... ***Tetradymia canescens – Ephedra viridis* Shrubland [Provisional]**

20 *Purshia stansburiana* and *Arctostaphylos patula* codominate shrub layer. Mostly found on high mesa tops.. ***Purshia stansburiana – Arctostaphylos patula* Shrubland [Provisional]**

Key F: Herbaceous Vegetation - Graminoids

1 *Poa pratensis* dominates meadow with cover of 10 to 80%. Other graminoids that may be present are *Bromus inermis, Elymus elymoides, Achnatherum lettermanii,* and *Elymus lanceolatus*. ....***Poa pratensis* Semi-natural Seasonally Flooded Herbaceous Alliance**

1 *Poa pratensis* may be present but is not dominant.

2 *Thinopyrum intermedium* is dominant in high-elevation dry meadows with cover of 60 to 80%. Other species commonly present are *Bromus inermis, Achnatherum lettermanii, Artemisia ludoviciana, Vicia americana,* and *Mertensia arizonica.* ....***Thinopyrum intermedium*** **Semi-natural Herbaceous Vegetation**

2 *Thinopyrum intermedium* is not present.

3 *Bromus inermis* is the dominant graminoid in intermittently flooded meadows with 50 to 90% cover. *Pascopyrum smithii* is commonly present. .... ***Bromus inermis – (Pascopyrum smithii)*** **Semi-natural Herbaceous Vegetation**

3 *Bromus inermis* is not present.

4 *Hesperostipa comata* dominates small grasslands of plateaus in woodland or shrubland openings with cover of 10 to 50%... ....***Hesperostipa comata*** **Great Basin Herbaceous Vegetation**

4 *Hesperostipa comata* does not dominate but may be present or co-dominant.

5 *Hesperostipa comata* and *Bouteloua gracilis* codominate grasses of grassland/shrubland mosaic. Shrubs are present, but with less than 10% total cover, and can include *Ericameria nauseosa, Arctostaphylos patula, Artemisia tridentata, Quercus gambelii* and *Yucca elata* var. *utahensis* .... ***Bouteloua gracilis – Hesperostipa comata*** **Herbaceous Vegetation [Provisional]**

5 *Hesperostipa comata* is not present.

6 *Muhlenbergia pungens* or *Muhlenbergia montana* is present in sparsely vegetated sands and is co-dominant with *Heterotheca villosa*. .... ***Muhlenbergia (pungens, montana) – Heterotheca villosa*** **Herbaceous Vegetation [Provisional]**

6 *Muhlenbergia pungens,*or *M. montana* and *Heterotheca villosa* do not dominate vegetation association.

7 *Bromus tectorum* dominates floodplains and mesas with nearly 100% cover. ....***Bromus tectorum*** **Semi-natural Herbaceous Alliance**

7 *Bromus tectorum* is usually present, but does not dominate.

8 *Pleuraphis jamesii* dominates, greater than 10% cover, in low-elevation Pinyon-Juniper Woodland openings. *Gutierrezia* spp., *Opuntia* spp., and *Bromus tectorum* are commonly present. ....***Pleuraphis jamesii*** **Herbaceous Vegetation**

8 *Sporobolus cryptandrus* dominates the grassland of alluvial terraces with 10 to 20% cover. *Bromus tectorum, Bromus rigidus,* and *Pleuraphis jamesii* are commonly present. ....***Sporobolus cryptandrus*** **Great Basin Herbaceous Vegetation**

Key G: Herbaceous Vegetation – Palustrine

1 *Equisetum* spp. dominates streambank or stream channel vegetation ....
***Equisetum (arvense, variegatum)* Herbaceous Vegetation**

1 *Equisetum* spp. does not dominate wetland vegetation

2 *Carex utriculata* dominates wetland vegetation with 80% cover. ....
.... ***Carex utriculata* Herbaceous Vegetation**

2 *Carex utriculata* does not dominate wetland vegetation.

3 *Carex nebrascensis* forms homogeneous stands of 80% cover or dominates heterogeneous wetlands with at least 10% cover. ....***Carex nebrascensis* Herbaceous Vegetation**

3 *Juncus* balticus dominates, with cover of 70 to 90% and few other species are present or it has at least 10% cover in heterogeneous mesic graminoid stand. ....
....***Juncus balticus* Herbaceous Vegetation**

Key H: Forest and Woodland Plant Associations – Pines and Junipers

H1 – *Pinus ponderosa* dominates canopy layer; other species can be present but do not attain as much cover as Ponderosa pine.

H2 – *Pinus edulis* and *Juniperus osteosperma* dominate canopy layer, together having higher cover than other pine or juniper species.

H3 - *Pinus monophylla* and *Juniperus osteosperma* dominate canopy layer, together having higher cover than other pine or juniper species.

H4 – *Juniperus osteosperma* or *Juniperus scopulorum* dominate canopy layer; species of pine have little to no cover.

H1 – *Pinus ponderosa*

1 *Pinus ponderosa* is the dominant tree species with 20% to 60% cover.

2 In this open canopy woodland, *Arctostaphylos patula* dominates the shrub layer with at least 10% cover. A combination of shrubs present or even co-dominant in the association are *Arctostaphylos pungens, Amelanchier utahensis, Quercus gambelii, Quercus turbinella, Cercocarpus montanus, Cercocarpus intricatus*, and *Purshia tridentata*. This association occurs mostly in slickrock basins where sandy soils collect at elevations above 5800 feet. Occasionally, it will be found in gentle drainages on plateaus with low shrub cover and high herbaceous cover. ....***Pinus ponderosa / Arctostaphylos patula* Woodland**

2 *Arctostaphylos patula* may be present, but is not dominant in the shrub layer.

3 *Quercus gambelii* is dominant in the shrub layer and has at least 10% cover and heights of 1 to 3 meters. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Purshia tridentata, Symphoricarpos oreophilus, Artemisia tridentata* and dwarf-shrubs*, Mahonia repens* and *Artemisia nova*. In some cases, *Pinus edulis* is present with tall

shrub *Quercus gambelii* in the subcanopy. *Juniperus scopulorum* is present in ravine environments. (If *Acer grandidentatum* has significant cover in sub-canopy, see Deciduous Vegetation Key) .... ***Pinus ponderosa / Quercus gambelii*** **Woodland**

3 *Quercus gambelii* may be present, but is not dominant.

4 *Pinus ponderosa* is sparse with 10 to 30% cover and the dwarf-shrub, *Artemisia nova*, is dominant in the shrub layer with 10% to 20% cover. Islands of *Quercus gambelii* may be scattered amongst the dwarf-shrubs with equal or less cover. Herbaceous species typically present are *Carex rossii*, *Elymus elymoides*, *Poa secunda*. ....***Pinus ponderosa / Artemisia nova*** **Woodland**

4 *Artemisia nova* is not present or dominant.

5 *Pinus ponderosa* has a closed canopy, 60 to 100% cover in this mesic environment with somewhat organic soils. The understory is dominated by *Pteridium aquilinum*. .... ***Pinus ponderosa / Pteridium aquilinum*** **Woodland [Provisional]**

5 *Pinus ponderosa* has an open canopy, 25 to 60% cover, in a mesic environment. The understory is dominated by *Bromus inermis,* not *Pteridium aquilinum. Poa pratensis* may be present to well represented.. ....***Pinus ponderosa / Bromus inermis*** **Semi-natural Woodland**

<u>H2 – *Pinus edulis – Juniperus osteosperma*</u>

1 *Pinus edulis* and *Juniperus osteosperma* make up the dominant strata with 20 to 60% combined cover *Pinus edulis* is most common on the eastern side of the Park.

2 Shrub layer is dominated by *Arctostaphylos patula*, 5 to 30% cover. *Amelanchier utahensis* and *Quercus gambelii* are present, but do not dominate. .... ***Pinus edulis – Juniperus osteosperma / Arctostaphylos patula*** **Woodland**

2 *Arctostaphylos patula* may be present, but is not the dominant shrub.

3 *Cercocarpus montanus* characterizes this association. It must have at least 10% cover. *Amelanchier utahensis* is typically present and may codominate. *Quercus gambelii* may also be present. ....***Pinus edulis – Juniperus spp. / Cercocarpus montanus*** **Woodland**

3 *Cercocarpus montanus* does not dominate the shrub layer.

4 Shrub layer is dominated by *Quercus gambelii*. Cover may be low, but always exceeds cover of associated shrubs, *Cercocarpus montanus* and *Arctostaphylos patula*.................... ....***Pinus edulis – Juniperus spp. / Quercus gambelii*** **Woodland**

4 *Quercus gambelii* does not dominate in the shrub layer.

5 Shrub layer is dominated by *Artemisia tridentata*. Cover may be only 5 to 15%. Other shrubs typically present are *Ephedra viridis* and *Amelanchier utahensis*......................... ....***Pinus edulis – Juniperus spp. / Artemisia tridentata*** **Woodland.**

5 *Artemisia tridentata* does not dominate shrub layer.

6 Shrub layer is dominated by *Purshia stansburiana*. Other shrubs present or that codominate are *Amelanchier utahensis* and *Arctostaphylos patula*. .... ***Pinus edulis – Juniperus osteosperma / Purshia stansburiana* Woodland.**

6 *Purshia stansburiana* does not dominate the shrub layer

7 Shrub layer is dominated by *Cercocarpus intricatus* on steep slickrock slopes. *Amelanchier utahensis* and *Quercus gambelii* are usually present across and may codominate. .... ***Pinus edulis – Juniperus osteosperma / Cercocarpus intricatus* Woodland.**

7 Shrub layer is dominated by *Cercocarpus ledifolius*. Though considered a shrub, *Cercocarpus ledifolius* may occur in robust tree form. It is accompanied by *Cercocarpus montanus, Amelanchier utahensis, Arctostaphylos patula* and *Quercus gambelii*. This association is restricted to the northern boundary of Zion NP at high elevations ....***Pinus edulis / Cercocarpus ledifolius* Woodland [Provisional].**

<u>H3 – *Pinus monophylla – Juniperus osteosperma*</u>

1 *Pinus monophylla* and *Juniperus osteosperma* make up the dominant strata with 20 to 60% combined cover. *Pinus monophylla* is of lower elevations and mostly occurs in the western side of Zion NP.

2 *Shepherdia rotundifolia* has greater than 5% cover. *Amelanchier utahensis* is usually present and codominant. Other shrubs typically present are *Quercus turbinella, Rhus trilobata,* and *Fraxinus anomala.* .... ***Pinus monophylla – Juniperus osteosperma / (Shepherdia rotundifolia – Amelanchier utahenis)* Woodland**

2 *Shepherdia rotundifolia* is not present or contributes less than 5% cover.

3 Shrub layer is dominated by *Quercus turbinella* with cover greater than 5%. Other shrubs commonly present are *Amelanchier utahensis, Quercus gambelii, Cercocarpus montanus, Arctostaphylos patula, Purshia* spp. and *Fraxinus anomala.* ....***Pinus monophylla – Juniperus osteosperma / Quercus turbinella* Woodland**

3 *Quercus turbinella* is not dominant, has less than 5% cover, or is a small component of dominant herbaceous understory.

4 Shrub layer is a mixture of *Cercocarpus montanus, Quercus gambelii,* and/or *Amelanchier utahenis. Quercus turbinella* is absent and other shrubs are insignificant. .... ***Pinus monophylla – Juniperus osteosperma / Cercocarpus montanus – Quercus gambelii* Woodland [Provisional]**

4 *Cercocarpus montanus, Quercus gambelii,* and/or *Amelanchier utahensis* do not codominate the shrub layer.

5 Shrub layer is dominated by *Artemisia tridentata*, cover usually less than 20%. *Amelanchier utahensis* may be present to abundant. .... ***Pinus monophylla – Juniperus osteosperma / Artemisia tridentata* Woodland**

5 Shrub layer is not dominated by *Artemisia tridentata*

6 *Coleogyne ramosissima* is present in the shrub layer and accompanied by *Artemisia tridentata* and *Ephedra nevadensis*. .... ***Pinus monophylla – Juniperus osteosperma / Coleogyne ramosissima* Woodland [Provisional]**

6 *Coleogyne ramosissima* is not present.

7 *Artemisia nova* and *Gutierrezia sarothrae* constitute the shrub layer. .... ***Pinus monophylla – Juniperus osteosperma / Artemisia nova* Woodland.**

7 Shrub stratum is absent or insignificant in comparison to herbaceous vegetation layer.

8 *Hesperostipa comata* dominates the herbaceous understory and shrub cover is less than 10%.. ....***Pinus monophylla – Juniperus osteosperma / Hesperostipa comata* Woodland**

8 *Hesperostipa comata* does not dominate the understory.

9 *Pleuraphis jamesii* dominates the herbaceous layer with greater than 10% cover. *Gutierrezia sarothrae* is also present with greater than 10% cover. . ...***Pinus monophylla – Juniperus osteosperma / Gutierrezia sarothrae / Pleuraphis jamesii* Woodland [Provisional]**

9 Dwarf shrubs present are *Gutierrezia sarothrae* and *Opuntia* spp. and contribute less than 10% cover. Herbaceous layer is insignificant. ....***Pinus monophylla – Juniperus osteosperma* / Sparse Understory Woodland**

H4 – *Juniperus osteosperma* or *Juniperus scopulorum*

1 *Juniperus osteosperma* is present, 20 to 30% cover, but is not associated with *Pinus monophylla*. Elevations are below 4000 feet. *Artemisia tridentata* clearly dominates the shrub layer..................... .... ***Juniperus osteosperma / Artemisia tridentata* Woodland**

1 *Juniperus scopulorum* and *Quercus gambelii* dominate the canopy layer. Commonly occurs in gentle to moderate drainages and on slopes in northern regions of the park. *Juniperus osteosperma, Pinus monophylla*, and *Pinus edulis* may be present, but do not contribute significant cover. ....***Juniperus scopulorum - Quercus gambelii* Woodland [Provisional]**

Key I: Forest and Woodland Plant Associations: Douglas-fir & White fir

1 *Abies concolor* is present to abundant in the forest canopy. *Pseudotsuga menziesii* and *Pinus ponderosa* may also be present, dominate and/or codominate these vegetation associations.

2 *Arctostaphylos patula* is present in the shrub layer. This association occurs at elevations above 7500 feet and is uncommon in Zion. ....***Abies concolor / Arctostaphylos patula*** **Forest**

2 *Arctostaphylos patula* is not present.

3 *Quercus gambelii* dominates the shrub layer and is usually present in the sub-canopy as a tall shrub or tree. *Abies concolor* dominates the tree canopy or is codominant with *Pseudotsuga menziesii, Pinus ponderosa,* and/or *Juniperus scopulorum. Acer grandidentatum* is absent. Other species likely to contribute cover in the shrub layer are *Amelanchier utahensis* and *Symphoricarpos oreophilus*.....................................***Abies concolor / Quercus gambelii*** **Forest**

3 *Quercus gambelii* is not dominant in the sub-canopy or shrub layer.

4 *Acer grandidentatum* is present to abundant in the sub-canopy. *Quercus gambelii*, *Acer negundo,* and *Pseudotsuga menziesii* may also contribute to sub-canopy cover in ravines at lower elevation. ....***Abies concolor / Acer grandidentatum*** **Forest**

4 *Acer grandidentatum* is not dominant in the sub-canopy or shrub layer.

5 *Abies concolor* dominates the canopy and *Symphoricarpos oreophilus* dominates the understory. Other shrubs that may be present are *Amelanchier utahensis, Amelanchier alnifolia, Prunus virginiana,* and *Quercus gambelii*...
.... ***Abies concolor / Symphoricarpos oreophilus*** **Forest**

5 *Symphoricarpos oreophilus* does not dominate the shrub layer and *Abies concolor* is not present or does not dominate.

1 *Pseudotsuga menziesii* dominates the tree canopy, but *Abies concolor* is not present. *Acer grandidentatum* or *Quercus gambelii* can be abundant.

6 *Quercus gambelii* dominates the sub-canopy, and also the shrub layer. ....
.... ***Pseudotsuga menziesii / Quercus gambelii Forest***

6 *Quercus gambelii* is not dominant in the sub-canopy or shrub layer.

7 *Acer grandidentatum* is present to abundant in the canopy or sub-canopy. *Quercus gambelii*, and *Acer negundo* may also contribute to sub-canopy cover
....***Pseudotsuga menziesii / Acer grandidentatum*** **Forest**

7 *Symphoricarpos oreophilus* and *Amelanchier utahensis* dominate the understory. ....
....***Pseudotsuga menziesii / Symphoricarpos oreophilus*** **Forest**

Key J: Forested Vegetation—Deciduous

1 The association occurs in riparian ecosystems including abandoned floodplains. *Populus fremontii* is present and dominant in the canopy layer.

2 Mature and young growth *Populus fremontii* dominate the banks of perennial streams. *Fraxinus velutina* and *Acer negundo* may occur in the sub-canopy. *Baccharis emoryi* is the dominant riparian shrub............................***Populus fremontii / Baccharis emoryi* Woodland [Provisional]**

2 *Baccharis emoryi* is not the dominant riparian shrub in the understory.

3 S*alix exigua* is the dominant riparian shrub under *Populus fremontii* canopy. ....***Populus fremontii / Salix exigua* Woodland**

3 *Salix exigua* is not the dominant shrub.

4 *Betula occidentalis* is dominant in the understory, or is mixed with small individuals of tree species. Tree species include *Populus fremontii, Populus angustifolia, Fraxinus velutina, Acer negundo*, *Pinus ponderosa,* and *Juniperus scopulorum*. Individual trees are young and included in tall shrub layer. Occasionally, mature individuals provide 20 to 40% cover. *Acer grandidentatum* and *Quercus gambelii* are often present in the shrub layer. .... ***Populus fremontii / Betula occidentalis* Wooded Shrubland**

4 *Betula occidentalis* is not the dominant shrub.

5 Mature *Populus fremontii* dominates riparian zone. *Fraxinus velutina* and *Acer negundo* are present in the canopy or sub-canopy. *Baccharis emoryi* or *Salix exigua* are **not** major components of the understory. Where the association occurs on the alluvial floodplain of the Park, the understory is highly disturbed and dominated by *Bromus tectorum* and *Bromus rigidus*. This association may also occur in less disturbed areas, low-elevation side canyons. In these situations, the association has more complex layers and species diversity, but with the same dominant components. ....***Populus fremontii – Fraxinus velutina* Woodland**

5 *Populus fremontii* is not the dominant tree in the canopy.

6 *Acer negundo* is dominant in the canopy of alluvial terraces. Herbaceous understory includes *Bromus tectorum* and *Bromus rigidus*. Shrubs may include *Ericameria nauseosus, Prunus virginiana*, and *Quercus gambelii.* .... ***Acer negundo /* Disturbed Understory Woodland [Provisional]**

6 *Acer negundo* is dominant in the canopy and *Brickellia grandiflora* is the dominant understory species.. . ...***Acer negundo / Brickellia grandiflora* Woodland [Provisional]**

1 The association does not occur in riparian zones, but exists in mesic or high-elevation environments.

7 Short woodland dominated by *Fraxinus anomala*, and associated with steep rocky ravines or seeps on colluvial slopes. Other species typically present are *Amelanchier alnifolia, Rhus trilobata,* and *Ericameria nauseosa*. ....***Fraxinus anomala* Woodland**

7 *Fraxinus anomala* is not present or has very low cover.

8 *Populus tremuloides* is present to abundant and codominant with *Abies concolo*r in the canopy. *Symphoricarpos oreophilus* dominates the shrub layer.. ....***Populus tremuloides – Abies concolor / Symphoricarpos oreophilus* Forest**

8 *Populus tremuloides* and *Abies concolor* codominate, but *Symphoricarpos oreophilus* is not a major component of the understory.

9 *Poa pratensis* dominates the understory.. .... ***Populus tremuloides – Abies concolor / Poa pratensis* Semi-natural Forest**

9 *Poa pratensis* is not dominant in the understory.

10 *Abies concolor* is not present and *Populus tremuloides* is the dominant species in the canopy. *Quercus gambelii* is present (sometimes in the tree canopy) with typical heights of 1 to 3 meters; *Symphoricarpos oreophilus* is co-dominant in the shrub layer, and up to one meter in height.............***Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus* Forest**

10 *Quercus gambelii* is absent or insignificant in shrub layer of *Populus tremuloides* Forest.

11 *Symphoricarpos oreophilus* dominates the shrub layer of *Populus tremuloides* Forest. ....***Populus tremuloides / Symphoricarpos oreophilus /* Tall Forbs Forest**

11 *Populus tremuloides* is not present. *Quercus gambelii* and *Acer grandidentatum* codominate the canopy, sub-canopy or shrub layer with total cover of 60 to 100%. This association may have an emergent tree canopy of *Pinus ponderosa* and *Juniperus scopulorum* (often occurs in shady ravines). If present, conifer canopy cover ranges from 10 to 30%. *Celtis reticulata* may be a major component of this woodland. ....***Acer grandidentatum / Quercus gambelii* Forest**

APPENDIX F: Vegetation Association Descriptions for ZION

(Produced by NatureServe 2001 Western Regional Office (Marion Reid and Keith Schulz)
(Local, Zion Specific Descriptions Written by Julie Thompson)

Plant Associations Table of Contents

I. FOREST

I.A.8.N.c. Conical-crowned temperate or subpolar needle-leaved evergreen forest

I.A.8.N.c.17. ABIES CONCOLOR FOREST ALLIANCE
White Fir Forest Alliance

ABIES CONCOLOR / ACER GRANDIDENTATUM FOREST

White Fir / Bigtooth Maple Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association has been reported from mountains in Utah, New Mexico and Arizona along the Mogollon Rim. Elevation ranges from 1525-2590 m (5000-8500 feet) This mesic community generally occurs on steep, lower slopes and benches with northern aspects and in narrow canyons and ravines. Soils are generally deep, coarse textured alluvium. *Abies concolor* and *Pseudotsuga menziesii* codominate the upper tree canopy with the subcanopy or tall-shrub layer dominated by *Acer grandidentatum, Quercus gambelii*, and *Acer negundo*. *Pinus strobiformis, Pinus ponderosa, Populus tremuloides*, and *Juglans major* may also be present. The short-shrub layer is variable. The herbaceous layer is moderately dense and may include *Carex siccata (= Carex foenea), Bromus ciliatus var. ciliatus, Bromus ciliatus var. richardsonii (= Bromus richardsonii), Koeleria macrantha, Thalictrum fendleri*, and *Aquilegia chrysantha*. This association transitions to *Abies concolor / Quercus gambelii* Forest (CEGL000261) in the drier uplands and to riparian types adjacent to streams.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations from 5000-8000 feet on steep northern to eastern slopes. It also occurs on other aspects of heavily shaded sites in narrow canyons. Soils are sandy and rapidly drained. Litter cover is high.

Global Environment: This forest association has been reported from mountains in New Mexico and Arizona along the Mogollon Rim, and Utah. Elevation ranges from 1525-2590 m (5000-8500 feet). This mesic community generally occurs on steep, lower slopes and benches with northern aspects and in narrow canyons and ravines. Soils are generally deep, coarse textured alluvium. The association transitions to *Abies concolor / Quercus gambelii* Forest (CEGL000261) in the drier uplands and to riparian types adjacent to streams.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Abies concolor* is well represented in the tree canopy with heights averaging 20-35 m. The subcanopy is dominated by *Acer grandidentatum*. Other species contributing 30-70% total subcanopy and canopy cover may include *Pseudotsuga menziesii, Acer negundo*, and *Quercus gambelii*. There are plots sampled without the presence of *Abies concolor*, with a canopy of *Pseudotsuga menziesii* and other characteristics are the same. The short-shrub layer of *Quercus gambelii* and *Acer grandidentatum* is usually sparse. Subshrubs include *Mahonia repens, Paxistima myrsinites*, and *Symphoricarpos oreophilus*. The herbaceous layer may be diverse, but does not contribute significant ground cover. Common species of the understory are *Thalictrum fendleri, Maianthemum stellatum, Clematis ligusticifolia, Osmorhiza occidentalis*, and *Poa fendleriana*.

Global Vegetation: This mesic forest association is characterized by a mixed-species tree canopy with *Abies concolor* and *Pseudotsuga menziesii* codominating the upper tree canopy with the subcanopy or tall-shrub layer dominated by *Acer grandidentatum, Quercus gambelii*, and *Acer negundo*. *Pinus strobiformis, Pinus ponderosa, Populus tremuloides*, and *Juglans major* may also be present. The short-shrub layer is variable. The herbaceous layer is moderately dense and may include *Carex siccata (= Carex foenea), Bromus ciliatus, Bromus ciliatus var. richardsonii (= Bromus richardsonii), Koeleria macrantha, Thalictrum fendleri*, and *Aquilegia chrysantha*.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Acer grandidentatum, Pseudotsuga menziesii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Acer grandidentatum, Quercus gambelii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Acer grandidentatum*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Acer grandidentatum*
TALL SHRUB	*Acer grandidentatum*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in Zion National Park's high-elevation narrow canyons and ravines. It has been documented specifically in Kolob Canyons and tributaries of Zion Canyon's Virgin River. It likely recurs in steep canyon crevices throughout the park that are not easily observable or accessible.

Global Range: This forest association has been reported from mountains in New Mexico, Arizona and Utah.

Nations: US

States/Provinces: AZ NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH27, 7, 24, 28, 37, 70, 104, 148, 363, 511
Classification Confidence: 2 **Identifier:** CEGL000241
REFERENCES: Alexander et al. 1984a, Alexander et al. 1987, Bourgeron and Engelking 1994, Driscoll et al. 1984, Fitzhugh et al. 1987, Moir and Ludwig 1979, Muldavin et al. 1996, Stuever and Hayden 1997b

ABIES CONCOLOR / ARCTOSTAPHYLOS PATULA FOREST

White Fir / Greenleaf Manzanita Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association has been reported from mountains and plateaus in southwestern Utah. Elevation ranges from 2390-2680 m (7840-8880 feet). Stands occur on a variety of sites including steep to gentle, middle to lower slopes and benches. Typically sites are relatively cool with northerly aspects common. Substrates are typically loamy soils derived from limestone parent materials. This association is characterized by an uneven-aged, open to moderately dense tree canopy that is dominated or codominated by *Abies concolor*. Codominants are *Pinus ponderosa* or *Pseudotsuga menziesii*. Dense patches of *Arctostaphylos patula* dominate the open to moderately dense shrub layer. Other shrub species present may include *Paxistima myrsinites, Symphoricarpos oreophilus, Mahonia repens, Ceanothus* spp., *Juniperus communis, Ribes cereum*, and *Purshia tridentata*. The herbaceous cover is sparse (<20% cover) and is primarily composed of graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 7700 feet on a steep north-facing slope of Timber Top Mountain. Soil texture is sandy loam with high litter/duff cover.

Global Environment: This woodland association has been reported from mountains and plateaus in southwestern Utah. Elevation ranges from 2390-2680 m (7840-8880 feet). Stands occur on a variety of sites including steep to gentle, middle to lower slopes and benches. Sites are relatively cool, often with northerly aspects common, but warmer than sites dominated by more mesic understory species such as *Symphoricarpos oreophilus* or *Mahonia repens*. Substrates range from sandy to silty loams that are typically derived from limestone parent materials. Bare soil averages 21% cover, but may be much higher (10-80% cover). Litter cover is generally patchy.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is uncommon in Zion National Park and likely occurs infrequently beyond the documented site. *Abies concolor* is present with 5% cover. *Pseudotsuga menziesii* and *Pinus ponderosa* are also present and are more abundant than their codominant *Abies concolor*. Canopy height is over 20 m with a subcanopy height of 2-10 m. Regeneration of *Pseudotsuga menziesii* is significant. At less than 2 m in height are shrubs *Arctostaphylos patula, Symphoricarpos oreophilus, Paxistima myrsinites* and the above-listed tree seedlings, together contributing 30% cover. Herbaceous species contribute insignificant cover.

Global Vegetation: This association is characterized by an uneven-aged, open to moderately dense tree canopy that is dominated or codominated by *Abies concolor*. Codominants are *Pinus ponderosa* or *Pseudotsuga menziesii*. Scattered *Juniperus scopulorum* or *Pinus flexilis* trees may also be present. Dense patches of *Arctostaphylos patula* dominate the open to moderately dense shrub layer. Other shrub species present may include *Paxistima myrsinites, Symphoricarpos oreophilus, Mahonia repens, Ceanothus* spp., *Juniperus communis, Ribes cereum*, and *Purshia tridentata*. The herbaceous cover is sparse (<20% cover) and is primarily composed of graminoids with scattered forbs. Common species include *Carex rossii, Achnatherum hymenoides, Elymus elymoides, Poa fendleriana, Achillea millefolium, Astragalus miser, Packera multilobata (= Senecio multilobatus)*, and *Frasera speciosa (= Swertia radiata)*.

Global Dynamics: These woodlands are thought to have longer fire-return intervals than other woodlands with *Arctostaphylos patula*-dominated understories. This is presumably due to the presence of *Abies concolor* and *Pseudotsuga menziesii* trees, which are both sensitive to fires when young (Roberts et al. 1992). The occurrence of a moderate-intensity fire would likely change the composition of individual stands, favoring the more resistant *Pinus ponderosa* and larger trees while killing small to intermediate *Abies concolor* and *Pseudotsuga menziesii* trees, which are less fire-resistant (Roberts et al. 1992). *Arctostaphylos patula* generally increases after fire (Roberts et al. 1992).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
TALL SHRUB	*Arctostaphylos patula, Paxistima myrsinites, Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
SHORT SHRUB	*Arctostaphylos patula, Juniperus communis, Mahonia repens, Paxistima myrsinites, Symphoricarpos oreophilus*
GRAMINOID	*Carex rossii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
TALL SHRUB	*Arctostaphylos patula, Paxistima myrsinites, Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
SHORT SHRUB	*Arctostaphylos patula*

GLOBAL SIMILAR ASSOCIATIONS:
- Pseudotsuga menziesii / Arctostaphylos patula Forest (CEGL000423)
- Pinus ponderosa / Arctostaphylos patula Woodland (CEGL000842)
- Abies concolor - Pinus ponderosa / Arctostaphylos patula - Mahonia spp. Forest (CEGL000017)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was documented on Timber Top Mountain located in Kolob Arch quadrangle. It may also occur in small stands on other high mesas.

Global Range: This plant association has been described only in Utah. It ranges across the southern portion of the state from the Pine Valley Mountains, Markagunt, Paunsaugunt, Aquarius plateaus east to the Abajo Mountains.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 300
Classification Confidence: 2 **Identifier:** CEGL000242
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Johnston 1987, Roberts et al. 1992, Youngblood and Mauk 1985

ABIES CONCOLOR / QUERCUS GAMBELII FOREST

White Fir / Gambel Oak Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association has been reported from mountains in New Mexico, Colorado, Utah, and in Arizona along the Mogollon Rim. Elevations range from 1890-2930 m (6200-9600 feet). This community is widespread and often occurs on middle and lower slopes and all aspects except south and southwestern. *Abies concolor* and *Pseudotsuga menziesii* typically codominate the upper tree canopy. *Pinus ponderosa, Pinus strobiformis*, and *Juniperus* spp. may also be present. *Quercus gambelii* dominates the subcanopy and undergrowth. Other shrub species may include *Amelanchier alnifolia, Symphoricarpos oreophilus, Robinia neomexicana*, and *Mahonia repens*. The sparse to moderately dense herbaceous layer is typically composed of *Carex rossii, Poa fendleriana, Lathyrus lanszwertii var. leucanthus (= Lathyrus arizonicus), Thalictrum fendleri*, and *Achillea millefolium*. Stands transition to *Pinus ponderosa / Quercus gambelii* Woodland (CEGL000870) in drier sites.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Sites with elevations of at least 5500 feet and steep, north- to east-facing slopes are indicative of this association's environmental characteristics. This association also occurs on gently sloping terrain when the elevation is above 7500 feet and thus cooler temperatures. Soils are loamy sands.

Global Environment: This forest association has been reported from mountains in New Mexico, Colorado, Utah, and in Arizona along the Mogollon Rim. Elevations range from 1890-2930 m (6200-9600 feet). This community is widespread and often occurs on middle and lower slopes and all aspects except south and southwestern. Stands transition to *Pinus ponderosa / Quercus gambelii* Woodland (CEGL000870) in drier sites.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association occurs in small stands on shaded colluvial slopes below canyon walls and on high mesas. *Abies concolor* has at least 5% cover. *Pseudotsuga menziesii*, when present, codominates with *A. concolor*. *Pinus ponderosa, Juniperus scopulorum*, and *Quercus gambelii* may also be present in the tree canopy. The prominent shrub *Quercus gambelii* often co-exists with *Symphoricarpos oreophilus* and *Amelanchier utahensis*. The sandy soil is sparsely vegetated with subshrubs *Mahonia repens* and *Paxistima myrsinites,* and has high litter cover.

Global Vegetation: *Abies concolor* and *Pseudotsuga menziesii* typically codominate the upper tree canopy. *Pinus ponderosa, Pinus strobiformis*, and *Juniperus* spp. may also be present. *Quercus gambelii* dominates the subcanopy and undergrowth. Other shrub species may include *Amelanchier alnifolia, Symphoricarpos oreophilus, Robinia neomexicana*, and *Mahonia repens*. The sparse to moderately dense herbaceous layer is composed of *Carex rossii, Poa fendleriana, Bromus* spp., *Lathyrus lanszwertii var. leucanthus (= Lathyrus arizonicus), Thalictrum fendleri*, and *Achillea millefolium*.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Juniperus scopulorum, Pinus ponderosa, Pseudotsuga menziesii, Quercus gambelii*
TALL SHRUB	*Amelanchier utahensis, Quercus gambelii, Symphoricarpos oreophilus*
SHORT SHRUB	*Mahonia repens, Paxistima myrsinites*
GRAMINOID	*Poa fendleriana*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor*
TALL SHRUB	*Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Juniperus scopulorum, Pseudotsuga menziesii, Quercus gambelii*
TALL SHRUB	*Quercus gambelii*
SHORT SHRUB	*Mahonia repens, Paxistima myrsinites*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor*
TALL SHRUB	*Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.
Global Comments: Note that this association does not include *Acer grandidentatum*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occupies high elevations in the northern half of the park.

Global Range: This forest association has been reported from mountains in New Mexico, Colorado, Utah, and in Arizona along the Mogollon Rim.

Nations: US
States/Provinces: AZ CO NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH19, 147, 200, 361.
Classification Confidence: 1 **Identifier:** CEGL000261
REFERENCES: Alexander et al. 1984a, Alexander et al. 1987, Bourgeron and Engelking 1994, DeVelice 1983, DeVelice and Ludwig 1983a, DeVelice et al. 1986, Driscoll et al. 1984, Fitzhugh et al. 1987, Johnston 1984, Johnston 1987, Larson and Moir 1987, Madany and West 1984, Moir and Ludwig 1979, Muldavin et al. 1996, Youngblood and Mauk 1985

ABIES CONCOLOR / SYMPHORICARPOS OREOPHILUS FOREST

White Fir / Mountain Snowberry Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association has been reported from mountains in Colorado, Utah, New Mexico and Arizona along the Mogollon Rim. Elevation ranges from 1740-3200 m (6800-10,500 feet). Stands are found on cool, dry sites often occurring on moderate to steep mid slopes with northern aspects, but they also occur on southern and western slopes at the higher elevations. Parent material often is limestone and Tertiary sandstone. Soil surface textures are sandy loam to loam and contain little gravel. The upper tree canopy is typically dominated by either *Pinus ponderosa* or *Pseudotsuga menziesii* with scattered *Abies concolor*. This association is characterized by the presence of successfully reproducing *Abies concolor*, which may also dominate or codominate the tree canopy or shrub layers. Associated trees include *Pinus flexilis, Populus angustifolia*, and *Populus tremuloides*. The sparse to moderately dense short-shrub layer is characteristically dominated by *Symphoricarpos oreophilus* often with *Rosa woodsii, Amelanchier alnifolia*, or several other shrubs present. The herbaceous layer is sparse. Common graminoids are *Carex rossii* and *Poa fendleriana*. Forbs are noticeably sparse.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on flat to gently sloping terrain above 7000 feet on loamy or clay loam soils.

Global Environment: This coniferous forest association has been reported from mountains in New Mexico and Arizona along the Mogollon Rim, Colorado and Utah. Elevation ranges from 1740-3200 m (6800-10,500 feet). Stands are found on cool, dry sites often occurring on moderate to steep mid slopes with northern aspects, but they also occur on southern and western slopes at the higher elevations. Parent material often is limestone and Tertiary sandstone. Soil surface textures are sandy loam to loam and contain little gravel. Litter depth averages 2.5 cm. Bare soil averages 7% and exposed rock averages 3%.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of *Abies concolor / Symphoricarpos oreophilus* occur sporadically throughout the white fir forests of the Upper Kolob Plateau. Mature *Abies concolor* dominates the tree canopy with greater than 50% cover and heights of 20 m. When the canopy is nearly closed, *Symphoricarpos oreophilus* is less dense, 10-20%. Other shrubs present with minimal cover are *Prunus virginiana, Amelanchier utahensis, Amelanchier alnifolia*, and *Quercus gambelii*. Open canopies have dense shrub cover with *Symphoricarpos oreophilus* dominating. Herbaceous cover is sparse.

Global Vegetation: Stands have a moderately dense to dense, evergreen needleleaf tree canopy typically dominated by either *Pseudotsuga menziesii* or *Pinus ponderosa* with scattered *Abies concolor*. This association is characterized by the presence of successfully reproducing *Abies concolor*, which may also dominate or codominate the tree canopy or shrub layers. Associated trees, including *Pinus flexilis, Pinus aristata, Populus angustifolia*, and *Populus tremuloides*, may also be present. The sparse to moderately dense short-shrub layer is dominated or codominated by *Symphoricarpos oreophilus* often with *Rosa woodsii, Amelanchier alnifolia*, or several other shrubs present including *Acer glabrum, Amelanchier utahensis, Jamesia americana, Juniperus communis, Mahonia repens, Physocarpus monogynus, Prunus virginiana, Quercus gambelii*, or *Ribes cereum*. The herbaceous layer is sparse. Common graminoids are *Carex rossii* and *Poa fendleriana*. Forbs are noticeably sparse, but may include *Balsamorhiza sagittata, Eriogonum racemosum, Lathyrus lanszwertii*, or *Thalictrum fendleri*.

Global Dynamics: The parasitic dwarf mistletoe *Arceuthobium douglasii* is relatively severe on the branches of *Pseudotsuga menziesii* in this association.

Abies concolor becomes increasingly more resistant to fire with age, and its cover value therefore increases in later seral stands. *Pseudotsuga menziesii* and *Pinus ponderosa* are favored in early seral stands because they are able to establish on open sites and are fire-resistant and, therefore, show a greater cover value. Steuver and Hayden (1987) described 2 phases: a *Pinus ponderosa* phase and a *Pinus flexilis* phase where these seral trees species are an important part of the tree canopy.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor*
TALL SHRUB	*Amelanchier utahensis, Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Pinus ponderosa, Pseudotsuga menziesii*
SHORT SHRUB	*Amelanchier alnifolia, Rosa woodsii, Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor*
TALL SHRUB	*Amelanchier utahensis, Prunus virginiana, Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor*
SHORT SHRUB	*Symphoricarpos oreophilus*

GLOBAL SIMILAR ASSOCIATIONS:
- Abies concolor - Pseudotsuga menziesii / Erigeron eximius Forest (CEGL000247)
- Pinus ponderosa / Symphoricarpos oreophilus Forest (CEGL000205)
- Pseudotsuga menziesii / Symphoricarpos oreophilus Forest (CEGL000462)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Two similar associations, *Abies concolor*/*Erigeron eximius* and *Abies concolor*/Sparse, are described by DeVelice et al. (1986) for northern New Mexico and southern Colorado.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the Upper Kolob Plateau, the northern most boundary of Zion National Park.

Global Range: This coniferous forest association has been reported from mountains in New Mexico, Colorado, Utah, and in Arizona along the Mogollon Rim.

Nations: US
States/Provinces: AZ CO? NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH07, 88, 119
Classification Confidence: 1 **Identifier:** CEGL000263
REFERENCES: Bourgeron and Engelking 1994, DeVelice et al. 1986, Driscoll et al. 1984, Edwards 1987, Freeman and Dick-Peddie 1970, Johnston 1984, Johnston 1987, Lamb 1975, Larson and Moir 1987, Roberts et al. 1992, Stuever and Hayden 1997b, Youngblood and Mauk 1985

I.A.8.N.c.22. PSEUDOTSUGA MENZIESII FOREST ALLIANCE
Douglas-fir Forest Alliance

PSEUDOTSUGA MENZIESII / QUERCUS GAMBELII FOREST

Douglas-fir / Gambel Oak Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west into Arizona and Utah. Elevation ranges from 1370-2870 m (4500-9400 feet). Stands are found along drainages, lower and middle slopes, steep upper slopes and ridgetops. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes (southern aspects at higher elevations). Soils vary, but are often shallow and rocky ranging from sandy loams to clay. The vegetation is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. The herbaceous layer is generally sparse and composed of mostly graminoids with scattered forbs, but can be moderately dense and diverse. Many other species are associated such as *Amelanchier* spp., *Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Robinia neomexicana, Rosa woodsii, Carex* spp., *Festuca arizonica, Muhlenbergia virescens, Poa fendleriana, Lathyrus lanszwertii var. leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association is dependent on cool and shady environmental conditions. Small stands occur on moderate to steep slopes of shaded stream terraces and slopes that receive minimal solar radiation at lower elevations. At higher elevations, this association occurs on north-facing slopes off mesas and ridges. Elevations for these sites range from 4500 to 7000 feet. Soils are very sandy and have high litter cover.

Global Environment: This forest association occurs on mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Utah. Elevation ranges from 1370-2870 m (4500-9400 feet). Stands are found along drainages, gentle to moderate lower and middle slopes, steep upper slopes and ridgetops. Aspects are variable. This forest occurs as both a non-obligate riparian community on the outer margins of riparian areas in desert canyons and steep draws, and as an upland forest forming extensive stands on typically north-facing hillslopes (southern aspects at higher elevations). Soils vary, but are often shallow and rocky ranging from sandy loams to clay. The surface is generally largely covered with a thin layer of litter. Parent materials include fractured limestone, sandstone, basalt and andesite.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pseudotsuga menziesii* is the prominent species in the canopy layer represented by few to several mature trees. Mature *Juniperus scopulorum* are likely to be present or represented in the subcanopy by young trees and seedlings. *Abies concolor* is present at one documented site. The subcanopy is dominated by *Quercus gambelii* in tree form. The canopy and subcanopy species combined provide high foliar cover. The less dense shrub layer is composed of *Acer grandidentatum* and *Quercus gambelii* and subshrubs *Paxistima myrsinites* and *Mahonia repens*. Herbaceous cover is sparse and commonly represented by mesic forest species *Maianthemum stellatum, Thalictrum fendleri*, and *Pteridium aquilinum*.

Global Vegetation: This association is characterized by a relatively sparse to moderately dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus strobiformis, Pinus edulis*, or *Juniperus* spp. (especially on drier sites). *Abies concolor* is typically not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the moderately dense tall-shrub layer that consists of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Pinus edulis, Juniperus osteosperma*, or *Juniperus deppeana* are often present. Other common shrub species depending on range may include *Acer glabrum, Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Holodiscus dumosus, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Ribes cereum, Robinia neomexicana*, and *Rosa woodsii*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs, but ranges to moderately dense and diverse. Associated graminoids may include *Bromus* spp., *Carex rossii, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Muhlenbergia virescens*, and *Poa fendleriana*. Common forbs include *Achillea millefolium, Lathyrus lanszwertii var. leucanthus, Thalictrum fendleri*, and *Vicia americana*. The shrub layer has equal or greater cover than graminoids. This open conifer forest transitions to *Quercus gambelii* woodlands in drier sites and at lower elevations.

Global Dynamics: This association represents mid- to late-seral forests that are dominated by *Pseudotsuga menziesii* with the diagnostic *Quercus gambelii*-dominated understory. Large, often fire-scarred *Pinus ponderosa* trees may be present to codominant in the canopy, but do not reproduce (Alexander et al. 1984, DeVelice et al. 1986).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Acer grandidentatum, Pseudotsuga menziesii, Quercus gambelii*
TALL SHRUB	*Quercus gambelii*
SHORT SHRUB	*Mahonia repens, Paxistima myrsinites*
FORB	*Maianthemum stellatum, Thalictrum fendleri*

Global

Stratum	Species
TREE CANOPY	*Pinus ponderosa, Pinus strobiformis, Pseudotsuga menziesii*
TALL SHRUB	*Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus scopulorum, Pseudotsuga menziesii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*
SHORT SHRUB	*Mahonia repens, Paxistima myrsinites*
FORB	*Maianthemum stellatum*
FERN	*Pteridium aquilinum*

Global

Stratum	Species
TREE CANOPY	*Pseudotsuga menziesii*
TALL SHRUB	*Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:
- Abies concolor / Quercus gambelii Forest (CEGL000261)
- Pinus ponderosa / Quercus gambelii Woodland (CEGL000870)
- Pseudotsuga menziesii / Holodiscus discolor Forest (CEGL000437)
- Pseudotsuga menziesii / Festuca arizonica Forest (CEGL000433)
- Pseudotsuga menziesii / Muhlenbergia virescens Forest (CEGL000444)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Within the Habitat Type literature there are four phases mentioned: *Festuca arizonica* phase, *Holodiscus dumosus* phase, *Muhlenbergia virescens* phase (all defined by having at least 5% cover of both *Quercus gambelii* and the nominal species), and *Quercus gambelii* (typic) phase by a undeveloped herbaceous layer (Alexander et al. 1984b, Alexander et al. 1987, DeVelice et al. 1986, Fitzhugh et al. 1987, Johnston 1987, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b). There are 3 similar USNVC *Pseudotsuga menziesii* associations that use these phase species as the nominal species. These phases represent "intermediate" vegetation. Review of these associations is needed to clarify relationships between associations.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in shady narrow canyons and high slopes of mesas in Temple of Sinawava and Guardian Angels quadrangles.

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

Nations: US
States/Provinces: AZ CO NM TX UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 54, 205, 526, 313
Classification Confidence: 2 **Identifier:** CEGL000452
REFERENCES: Alexander et al. 1984b, Alexander et al. 1987, Bader 1932, Blackhawk Coal Company 1981, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, DeVelice et al. 1986, Diamond 1993, Fitzhugh et al. 1987, Freeman and Dick-Peddie 1970, Hess and Wasser 1982, Johnston 1987, Keammerer 1974b, Kittel et al. 1994, Kittel et al. 1999, Komarkova et al. 1988a, Larson and Moir 1987, Muldavin et al. 1996, Stuever and Hayden 1997b, Tiedemann and Terwilliger 1978, Youngblood and Mauk 1985

PSEUDOTSUGA MENZIESII / SYMPHORICARPOS OREOPHILUS FOREST

Douglas-fir / Mountain Snowberry Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This widespread forest association occurs in foothills, mountains and plateaus from southwestern Montana to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2870 m (2310-9400 feet). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects with moderate to very steep mid- and upper slopes and ridges. Soils are variable, and range from deep silt loam, to shallow, rocky substrates. Some stands have high rock cover. The vegetation is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides, Juniperus scopulorum*, or *Juniperus occidentalis*, especially on drier sites. *Abies concolor* is typically not present. *Symphoricarpos oreophilus* dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on range and habitat and may include *Acer glabrum, Amelanchier* spp., *Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii*, or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was sampled on two north-facing mesa rims at 7000 feet. The site sampled in Zion Canyon is at an elevation of 4500 feet on a steep northeast-facing colluvial slope. Soil texture ranges from sandy loam to clay loam.

Global Environment: This widespread forest association occurs in foothills, mountains and plateaus from southwestern Montana to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington. Elevation ranges from 700-2870 m (2310-9400 feet). This broadly defined forest association occurs as both a non-obligate riparian community and as an upland community. In more arid regions stands occur along drainages along narrow riparian areas in ravines, canyons, and up steep draws. It continues upland on steep north-facing slopes in narrow canyons where dense shade and steepness preclude any significant shrub or herbaceous understory. Elsewhere at more northern latitudes, it occurs near lower treeline on warm, dry southern aspects on moderate to very steep mid- and upper slopes and ridges. Soils are variable, and range from deep silt loam, to shallow, rocky substrates. Parent materials are also variable and may include colluvium or residuum derived from calcareous shale, sandstone, granite, limestone, rhyolite and basalt. Some stands have high rock cover.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is dominated by mature *Pseudotsuga menziesii* with cover of 40-60% and heights 20-35 m. *Pinus ponderosa* and/or *Abies concolor* are occasionally present, but with less cover than *Pseudotsuga menziesii*. The indicator shrub *Symphoricarpos oreophilus* is at least present, but with insignificant cover. *Amelanchier utahensis* is usually present in the shrub layer. Herbaceous species are diverse and contribute minimal cover.

Global Vegetation: This forest association is characterized by a relatively sparse to dense evergreen tree canopy dominated by *Pseudotsuga menziesii* sometimes with scattered large *Pinus ponderosa, Pinus flexilis, Populus tremuloides, Juniperus scopulorum*, or *Juniperus occidentalis*, especially on drier sites. *Abies concolor* is typically not present. *Symphoricarpos oreophilus* is present and usually dominates the sparse to moderately dense short-shrub layer. Shrub associates vary depending on range and habitat and may include *Acer glabrum, Amelanchier* spp., *Artemisia tridentata ssp. vaseyana, Cercocarpus montanus, Holodiscus dumosus, Juniperus communis, Mahonia repens, Paxistima myrsinites, Prunus virginiana, Quercus gambelii, Ribes cereum, Ribes inerme, Rosa woodsii*, or *Shepherdia canadensis*. The generally sparse herbaceous layer is composed of mostly graminoids with scattered forbs. Associated graminoids may include *Bromus* spp., *Carex geyeri, Carex rossii, Festuca idahoensis, Leucopoa* *kingii, Koeleria macrantha*, and *Poa fendleriana*. Common forbs include *Achillea millefolium, Arnica cordifolia, Artemisia frigida, Thalictrum fendleri*, and *Vicia americana*.

Global Dynamics: This association occurs over a wide range of environmental conditions. Where precipitation and temperature are adequate, it occurs as an upland association. Where it occurs as a riparian forest, it is limited to very narrow canyon bottoms where narrow canyons with steep slopes create pockets of cool, moist air by funneling cold air downwards, thus providing a microsite for *Pseudotsuga menziesii* (Kittel et al. 1999, Kittel et al. 1999b). Often the coarse colluvial substrates provide deep moisture for trees and shrubs but little moisture for herbaceous layer.

Both diagnostic species are tolerant of ground fire. *Pseudotsuga menziesii* develops thick fire-resistant bark with age, and *Symphoricarpos oreophilus* resprouts after burning (Fischer and Bradley 1987, Wright et al. 1979). Ground fires occur at less than 30-year intervals in the Rocky Mountains (Pfister et al. 1977). Fire-return interval can be much less frequent in cool, dry stands in Utah were ground fire is limited by lack of continuous fine fuels or moist forest areas that rarely burn (about every 140 years) (Arno 1980,Youngblood and Mauk, 1985). In many cases, past fire suppression has allowed dense stands to form which provide a continuous fuel ladder to the crown of overstory trees and have increased the potential for severe, stand-destroying wildfires.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Pinus ponderosa, Pseudotsuga menziesii*
TALL SHRUB	*Amelanchier utahensis, Symphoricarpos oreophilus*

Global

Stratum	Species
TREE CANOPY	*Pseudotsuga menziesii*
SHORT SHRUB	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Pinus ponderosa, Pseudotsuga menziesii*
TALL SHRUB	*Amelanchier utahensis, Symphoricarpos oreophilus*

Global

Stratum	Species
TREE CANOPY	*Pseudotsuga menziesii*
SHORT SHRUB	*Symphoricarpos oreophilus*

GLOBAL SIMILAR ASSOCIATIONS:

- Pinus ponderosa / Symphoricarpos oreophilus Forest (CEGL000205)
- Abies concolor / Symphoricarpos oreophilus Forest (CEGL000263)
- Populus tremuloides - Pseudotsuga menziesii / Symphoricarpos oreophilus Forest (CEGL000546)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This is a broadly defined *Pseudotsuga menziesii* association which includes a variety of stands from different environments that are tied together by a common widespread species, *Symphoricarpos oreophilus*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented at Herb's Point in Kolob Canyons, Big Bend in Zion Canyon and on the mesa north of Wynopits Mesa in Zion National Park.

Global Range: This widespread montane forest association occurs in foothills, mountains and plateaus from southwestern Montana to Trans-Pecos Texas, west to Arizona, Utah, and into eastern Oregon and Washington.

Nations: US
States/Provinces: AZ? CO ID MT NM OR TX UT WA WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 254, 273, 14
Classification Confidence: 1 **Identifier:** CEGL000462
REFERENCES: Arno 1980, Bourgeron and Engelking 1994, Diamond 1993, Fischer and Bradley 1987, Hess and Wasser 1982, Johnson and Clausnitzer 1992, Johnson and Simon 1987, Johnston 1987, Kittel et al. 1994, Kittel et al. 1999, Kittel et al. 1999b, Komarkova et al. 1988b, Lillybridge et al. 1995, Mauk and Henderson 1984, Muldavin et al. 1996, Pfister et al. 1977, Reed 1976, Steele et al. 1981, Steele et al. 1983, Williams and Lillybridge 1983, Williams and Lillybridge 1985, Williams et al. 1990b, Wright et al. 1979, Youngblood and Mauk 1985

PSEUDOTSUGA MENZIESII / ACER GRANDIDENTATUM FOREST

Douglas-fir / Bigtooth Maple Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association has been reported from mountains in south-central New Mexico, southwestern Utah, and Arizona. This forest association has been reported from two locations, the Organ Mountains in New Mexico and Zion NP, Utah. In both areas it generally occurs above 1525 m (5000 ft), and often much higher, in north-facing ravines and canyons. It is a relatively mesic forest due to the north-facing, shaded nature of the sites where it's found. Slopes are steep, but positions on the slopes ranch from canyon bottom to upper slopes. Muldavin et al. (1994) report the soils as deep, and fine textured, while those in Zion NP tend to be coarser and rockier. In obth cases, the litter/duff layer is deep and has high cover. Some stands in Zion NP had a significant component of large rocks on the ground surface. This mesic forest association is characterized by a tree canopy with *Pseudotsuga menziesii* dominating the upper tree canopy with a subcanopy or tall-shrub layer dominated by *Acer grandidentatum. Pinus ponderosa* is present in some stands. Tree canopy cover ranges from 30% to well over 70%, and in Zion NP heights ranged from 15 to 35 m. The short tree / subcanopy layer is quite dense, shading the forest floor. In addition to *Acer granditentatum,* the tall shrub layer has abundant *Quercus gambelii*, and in Zion *Acer negundo* or *Betula occidentalis*. The short-shrub layer may contain *Mahonia repens, Paxistima myrsinites*, or *Symphoricarpos oreophilus*, but is not abundant. The herbaceous layer is typically sparse due to the shading of the woody species. Common species include *Claytonia perfoliata, Maianthemum stellatum, Vitis arizonica , Thalictrum fendleri*, and *Poa fendleriana.*

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations from 4480 - 6400 feet on steep slopes, generally with northern or northwestern aspects. Sites include canyons, and ravines, and in one case the channel bed of a narrow canyon. These are all heavily shaded locations, with mesic conditions due to the northerly aspect and shading. Soils are sandy and rapidly drained, and in some cases rocky. Litter cover is generally high, and in some stands there is substantial cover of downed wood or large rocks on the ground surface.

Global Environment: This forest association has been reported from two locations, the Organ Mountains in New Mexico and Zion NP, Utah. In both areas it generally occurs above 1525 m (5000 ft), and often much higher, in north-facing ravines and canyons. It is a relatively mesic forest due to the north-facing, shaded nature of the sites where it's found. Slopes are steep, but positions on the slopes ranch from canyon bottom to upper slopes. Muldavin et al. (1994) report the soils as deep, and fine textured, while those in Zion NP tend to be coarser and rockier. In obth cases, the litter/duff layer is deep and has high cover. Some stands in Zion NP had a significant component of large rocks on the ground surface.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pseudotsuga menziesii* is well represented in the tree canopy with heights ranging from 10 to 35 m. *Pinus ponderosa* is present is a few stands, but with low cover. The subcanopy or tall shrub layer is dominated by *Acer grandidentatum*. Other species are common in the subcanopy and tall shrub layers, including *Acer negundo, Quercus gambelii,* and *Betula occidentalis*. The short-shrub layer includes *Quercus gambelii* and *Acer grandidentatum,* is usually somewhat sparse. Subshrubs include *Mahonia repens, Paxistima myrsinites*, and *Symphoricarpos oreophilus*. The herbaceous layer is not particularly diverse, and does not contribute significant ground cover. Common species of the understory are *Claytonia perfoliata, Maianthemum stellatum, Vitis arizonica,* and *Poa fendleriana*.

Global Vegetation: This mesic forest association is characterized by a tree canopy with *Pseudotsuga menziesii* dominating the upper tree canopy with a subcanopy or tall-shrub layer dominated by *Acer grandidentatum. Pinus ponderosa* is present in some stands. Tree canopy cover ranges from 30% to well over 70%, and in Zion NP heights ranged from 15 to 35 m. The short tree / subcanopy layer is quite dense, shading the forest floor. In addition to *Acer granditentatum,* the tall shrub layer has abundant *Quercus gambelii*, and in Zion *Acer negundo* or *Betula occidentalis*. The short-shrub layer may contain *Mahonia repens, Paxistima myrsinites*, or *Symphoricarpos oreophilus*, but is not abundant. The herbaceous layer is typically sparse due to the shading of the woody species. Common species include *Claytonia perfoliata, Maianthemum stellatum, Vitis arizonica , Thalictrum fendleri*, and *Poa fendleriana.*

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Pseudotsuga menziesii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*
SHORT SHRUB	*Mahonia repens, Paxistima myrsinites*
FORB	*Claytonia perfoliata, Maianthemum stellatum*

Global

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Pseudotsuga menziesii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pseudotsuga menziesii, Acer grandidentatum*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Pseudotsuga menziesii, Acer grandidentatum*
TALL SHRUB	*Acer grandidentatum*

GLOBAL SIMILAR ASSOCIATIONS:
- Abies concolor / Acer grandidentatum Forest (CEGL000241)
- Pseudotsuga menziesii / Quercus gambelii Forest (CEGL000452)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4

Global Comments: This is a very poorly known and documented association; no reports or studies have been found to document it in Arizona, but ecologists report it occurs there. Further inventory is clearly needed.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in Zion National Park's high-elevation narrow canyons and ravines. It has been documented specifically in Kolob Canyons and tributaries of Zion Canyon's Virgin River. It likely recurs in steep canyon crevices throughout the park that are not easily observable or accessible.

Global Range: This forest association has been reported from mountains in south-central New Mexico, southwestern Utah, and Arizona.

Nations: US

States/Provinces: AZ:S?, NM:S4, UT:S2?

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 148. AA points: ZION96, ZION.879, ZION.957, ZION.1145, ZION.1255
Classification Confidence: 3 **Identifier:** CEGL000419
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin et al. 1994a

I.B.2.N.b. Montane or boreal cold-deciduous forest

I.B.2.N.b.1. ACER GRANDIDENTATUM MONTANE FOREST ALLIANCE

Bigtooth Maple Montane Forest Alliance

ACER GRANDIDENTATUM / QUERCUS GAMBELII FOREST

Bigtooth Maple / Gambel Oak Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This forest association has been reported from mountains and plateaus of Utah. Elevations range from 1220-2620 m. Sites include moderate to steep, middle and lower slopes with cool northern or eastern aspects, intermittently flooded canyon bottoms, alluvial benches, and shaded colluvial slopes. *Acer grandidentatum* and *Quercus gambelii* codominate the tree canopy. The understory is variable and may be dominated by tall or short shrubs. Species include *Prunus virginiana, Rosa woodsii, Symphoricarpos oreophilus, Physocarpus malvaceus, Mahonia repens*, and seedling trees. The herbaceous layer is generally sparse because of heavy shading. Stands transition to *Quercus gambelii* woodland in the drier uplands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on moderate to steep, northerly and easterly slopes, canyon-shaded colluvial slopes, and ravines at elevations of 4000-8000 feet. Soils are variable, ranging from sand to clay loam.

Global Environment: This forest association occurs in the mountains and plateaus of Utah. Elevations range from 1220-2620 m. Sites include moderate to steep, middle and lower slopes with cool northern or eastern aspects, intermittently flooded canyon bottoms, alluvial benches, and shaded colluvial slopes. These forests typically occur on these relatively mesic sites, especially at lower latitudes and elevations. However, stands have been reported on dry, open slopes in the northern part of its range in the Wasatch Mountains where fire suppression may be allowing oak-dominated stands to succeed to mixed maple-oak. Substrates are generally calcareous and rocky with soil textures ranging from sand to clay loam.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association *Acer grandidentatum* cover is frequently over 50% in the tree and shrub layers combined. *Quercus gambelii* is absent to abundant in both the tree and shrub layers and may exceed cover of *Acer grandidentatum*. *Celtis laevigata var. reticulata* may be present in the canopy. Canopy trees average 10-15 m in height and 15 cm dbh. *Juniperus scopulorum* and/or *Pinus ponderosa* occasionally occur in ravines as an emergent tree layer, and contribute 10-30% cover with a dense subcanopy of *Acer grandidentatum* and *Quercus gambelii*. *Symphoricarpos oreophilus* contributes minor cover in the shrub layer, and few other shrubs are present with the *Acer grandidentatum* and *Quercus gambelii*. Herbaceous cover is variable, 5-30%, and most commonly represented by *Pteridium aquilinum, Poa pratensis, Bromus diandrus*, and *Poa fendleriana*.

Global Vegetation: This association is characterized by a moderately dense to dense tree canopy of *Acer grandidentatum* that is typically codominated by *Quercus gambelii*. *Celtis laevigata var. reticulata, Juniperus scopulorum*, or *Juniperus osteosperma* may also be present to abundant. The shrub layer is variable, depending on the stand age, elevation and habitat. It ranges from dense *Quercus gambelii*-dominated tall-shrub stratum to a mixed short-shrub layer that includes *Symphoricarpos oreophilus, Prunus virginiana, Amelanchier utahensis, Mahonia repens, Physocarpus malvaceus, Paxistima myrsinites*, and *Rosa woodsii*. The herbaceous layer is generally sparse because of shading. Associates such as *Elymus glaucus, Poa fendleriana, Heterotheca villosa, Thalictrum fendleri, Carex hoodii, Vicia americana*, and species of *Lathyrus, Osmorhiza, Eriogonum*, and *Polygonum* may be present.

Global Dynamics: This association is closely related to oakbrush types of Utah (*Quercus gambelii*-dominated and codominated communities), sharing many of the same species (Reem 1960, 1964, Kunzler et al. 1981). Kunzler et al. (1981) suggested that the maple stands sampled by Reem (1960, 1964) in the Wasatch Mountains are likely late-seral stages of the oakbrush types.

Quercus gambelii is a fire-adapted rhizomatous shrub that can form dense clones and will vigorously resprout after a burn (FEIS 2001). *Acer grandidentatum* is also rhizomatous, but resprouts much less vigorously after burning, so *Quercus gambelii* is favored by frequent fires (FEIS 2001). However, throughout much of this association's range, stands are restricted to relatively mesic sites such as along streams, shady canyon bottoms, and on cool northern aspects at higher elevations where fire is less frequent. Where stands are more widespread in the northern part of its range in the Wasatch Mountains, *Acer grandidentatum* has recently been invading *Quercus gambelii* stands growing on open slopes with warm aspects. Harper et al. (1985) suggested these drier sites had greater fire frequency prior to fire suppression that favored the more fire-adapted oak. Now with fire suppression, *Acer grandidentatum* has been slowly colonizing these relatively xeric habitats. Research is needed to verify this hypothesis.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Quercus gambelii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii, Symphoricarpos oreophilus*
GRAMINOID	*Bromus diandrus, Poa fendleriana, Poa pratensis*

Global

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Juniperus scopulorum, Quercus gambelii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*
SHORT SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Poa fendleriana*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Quercus gambelii*
TALL SHRUB	*Acer grandidentatum, Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Acer grandidentatum, Quercus gambelii*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Bromus diandrus, Bromus tectorum, Poa pratensis*

GLOBAL SIMILAR ASSOCIATIONS:

- Abies concolor / Acer grandidentatum Forest (CEGL000241)
- Pseudotsuga menziesii / Acer grandidentatum Forest (CEGL000419)
- Acer grandidentatum / Calamagrostis rubescens Forest (CEGL000558)
- Populus angustifolia / Acer grandidentatum Forest (CEGL000646)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4G5.

Global Comments: *Acer grandidentatum* and *Quercus gambelii* both are widespread western species and occur in the understory of several conifer-dominated associations. There are several similar forest associations that are dominated by *Acer grandidentatum* with one of several oak species codominant or in the understory. Both *Acer grandidentatum* and *Quercus gambelii* have shrub and tree forms which complicate the vegetation classification of this mixed type. This association is typically late seral with some large single- or few-stemmed maples and oaks that are over 5 m tall.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs throughout the park in shaded canyon bottoms, alluvial benches, and high-elevation mountain toeslopes.

Global Range: This forest association is documented from the Wasatch and Uinta ranges in northeastern Utah and the Markagunt Plateau in southwestern Utah.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH28, RH66, RH74, 15, 27, 123, 209, 260
Classification Confidence: 2 **Identifier:** CEGL000559
REFERENCES: Allman 1952, Bourgeron and Engelking 1994, Christensen 1955, Driscoll et al. 1984, FEIS 2001, Harper et al. 1985, Kunzler et al. 1981, Ream 1960, Ream 1964

I.B.2.N.b.10. POPULUS TREMULOIDES FOREST ALLIANCE
Quaking Aspen Forest Alliance

POPULUS TREMULOIDES / SYMPHORICARPOS OREOPHILUS / TALL FORBS FOREST

Quaking Aspen / Mountain Snowberry / Tall Forbs Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This deciduous forest association is widespread in the Intermountain region on the western U.S. It is found at montane and subalpine elevations from 1890-2960 m (6200-9700 feet) across its latitudinal range. Sites include lower slopes and benches, draws, sheltered slopes, and high benches that range from flat to moderate slopes of any aspect. Northern to eastern aspects are common in the drier and warmer environments in the southern portions of its range . Soils are variable but include loams or sandy loams that are often derived from sandstone parent material. The vegetation is characterized by a moderately dense to dense tree canopy of *Populus tremuloides* with a short-shrub layer with at least 10% cover that is dominated by *Symphoricarpos oreophilus*. The herbaceous layer present with at least 10% cover is dominated by tall forbs such as *Agastache urticifolia, Eucephalus engelmannii, Hackelia floribunda, Mertensia arizonica, Osmorhiza occidentalis, Senecio serra*, and *Valeriana occidentalis*. Occasional conifer trees are possible in a stand, but do not make up more than 10% of the tree canopy.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of *Populus tremuloides / Symphoricarpos oreophilus* occur on flat to gentle slopes with northern to eastern aspects and elevations of 7000 to 8000 feet. Soil texture is loam or sandy loam and entirely covered with vegetation, litter, and downed aspen trees.

Global Environment: This deciduous forest association is widespread in the Intermountain region of the western U.S. It is found at montane and subalpine elevations from 1890-2960 m (6200-9700 feet) across its latitudinal range. Sites include lower slopes and benches, draws, sheltered slopes, and high benches that range from flat to moderate slopes of any aspect. Northern to eastern aspects are common in the drier and warmer environments in the southern portions of its range . Soils are variable, but are generally well-developed, well-drained loams or sandy loams that are often derived from sandstone parent material.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Populus tremuloides* may have a cover of 30-60%. Canopy openings and mesic conditions allow lush understory vegetation to exist. *Symphoricarpos oreophilus* has a foliar cover ranging from 10-40% and is always the dominant shrub in this association. *Quercus gambelii, Rosa woodsii*, and *Populus tremuloides* seedlings may also be present but usually contribute less than 5% of woody species cover. Herbaceous cover is variable, but generally dominated by *Poa pratensis* and *Mertensia arizonica*. *Elymus glaucus* and other wheat grasses may also be present as well as exotics.

Global Vegetation: This deciduous forest association is characterized by a moderately dense to dense tree canopy of *Populus tremuloides* with a short-shrub layer with at least 10% (typically 30%) cover that is dominated by *Symphoricarpos oreophilus*. Occasional *Prunus virginiana* or *Amelanchier alnifolia* tall shrubs may be present. Other short shrubs include *Rosa woodsii, Mahonia repens, Paxistima myrsinites*, and *Ceanothus velutinus*. An herbaceous layer present with at least 10% cover is characteristically dominated by tall forbs such as *Agastache urticifolia, Eucephalus engelmannii, Hackelia floribunda, Mertensia arizonica, Osmorhiza occidentalis , Senecio serra*, and *Valeriana occidentalis*. Other forbs may include *Lathyrus* spp., *Geranium viscosissimum, Osmorhiza berteroi (= Osmorhiza chilensis), Rudbeckia occidentalis, Thalictrum fendleri*, and *Vicia americana*. Graminoids may be present and often include taller species like *Bromus carinatus, Elymus glaucus*, and introduced species *Thinopyrum intermedium* or *Poa pratensis*. Occasional conifer trees are possible in stands, but do not make up more than 25% of the tree canopy.

Global Dynamics: These communities can provide good forage for livestock, especially sheep (Mueggler 1988). However, with excessive livestock grazing *Lathyrus* spp., *Rudbeckia occidentalis, Vicia americana*, and *Poa pratensis* will dominate the understory.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Populus tremuloides*
SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Elymus glaucus, Elymus repens, Poa pratensis*
FORB	*Achillea millefolium, Agastache urticifolia, Maianthemum stellatum, Mertensia arizonica, Osmorhiza occidentalis, Vicia americana*

Global

Stratum	**Species**
TREE CANOPY	*Populus tremuloides*
SHORT SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Bromus carinatus, Elymus glaucus*
FORB	*Agastache urticifolia, Mertensia arizonica, Osmorhiza berteroi, Rudbeckia occidentalis, Senecio serra, Thalictrum fendleri*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Populus tremuloides*
SHRUB	*Quercus gambelii, Rosa woodsii, Symphoricarpos oreophilus*
GRAMINOID	*Elymus glaucus, Poa pratensis*
FORB	*Maianthemum stellatum, Mertensia arizonica, Vicia americana*

Global

Stratum	**Species**
TREE CANOPY	*Populus tremuloides*
SHORT SHRUB	*Symphoricarpos oreophilus*
FORB	*Agastache urticifolia, Eucephalus engelmannii, Hackelia floribunda, Mertensia arizonica, Osmorhiza occidentalis, Senecio serra, Valeriana occidentalis*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Elytrigia intermedia, Poa pratensis*

GLOBAL SIMILAR ASSOCIATIONS:

- Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Bromus carinatus Forest (CEGL000566)
- Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Calamagrostis rubescens Forest (CEGL000567)
- Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Tall Forbs Forest (CEGL000568)
- Populus tremuloides / Amelanchier alnifolia - Symphoricarpos oreophilus / Thalictrum fendleri Forest (CEGL000569)
- Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus Forest (CEGL000598)
- Populus tremuloides / Symphoricarpos oreophilus Forest (CEGL000610)
- Populus tremuloides / Symphoricarpos oreophilus / Bromus carinatus Forest (CEGL000611)
- Populus tremuloides / Symphoricarpos oreophilus / Calamagrostis rubescens Forest (CEGL000612)
- Populus tremuloides / Symphoricarpos oreophilus / Carex rossii Forest (CEGL000613)
- Populus tremuloides / Symphoricarpos oreophilus / Festuca thurberi Forest (CEGL000614)
- Populus tremuloides / Symphoricarpos oreophilus / Thalictrum fendleri Forest (CEGL000616)
- Populus tremuloides / Symphoricarpos oreophilus / Wyethia amplexicaulis Forest (CEGL000617)
- Populus tremuloides / Tall Forbs Forest (CEGL000618)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3G5.

Global Comments: Confusion between this association and the more broadly defined and distributed *Populus tremuloides / Symphoricarpos oreophilus* Forest (CEGL000610) is not uncommon. This association was once part of the more broadly defined association, which needs review and refinement. Currently this aspen forest association is characterized by the presence of (1) a low-shrub layer with over 10% cover that is dominated by *Symphoricarpos oreophilus*, (2) an herbaceous layer with at least 10% cover that is dominated by one or more of several tall forb species, and (3) the absence of a tall-shrub layer (<10% cover) (Mueggler 1988).

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in small stands scattered infrequently across Horse Ranch Mountain and the Upper Kolob Plateau, specifically Lava Point and Oak Spring Valley.

Global Range: This deciduous forest association occurs in the mountains and plateaus of Utah, western Wyoming, northern Nevada, and southern Idaho.

Nations: US
States/Provinces: ID NV UT WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH57, 87, 114, 353
Classification Confidence: 1 **Identifier:** CEGL000615
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Mueggler 1988, Mueggler and Campbell 1982, Mueggler and Campbell 1986, Youngblood and Mueggler 1981

I.B.2.N.d. Temporarily flooded cold-deciduous forest

I.B.2.N.d.38. POPULUS FREMONTII TEMPORARILY FLOODED FOREST ALLIANCE

Fremont Cottonwood Temporarily Flooded Forest Alliance

POPULUS FREMONTII / SALIX EXIGUA FOREST

Fremont Cottonwood / Coyote Willow Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This association is documented from along large rivers in Utah, southwestern New Mexico, and may occur in southern Arizona. Stands are found on stable bars at mid elevations of the floodplain. Substrates are typically relatively recently deposited alluvium. Periodic flooding is required for the growth, maintenance and reproduction of this forest. Characteristic of this deciduous forest is the dominance of *Populus fremontii* in the moderately dense to dense tree canopy and *Salix exigua* in the tall-shrub layer. *Salix gooddingii* or *Baccharis salicifolia* are not abundant or are absent. Other associated species include *Distichlis spicata, Muhlenbergia asperifolia, Phragmites australis*, and species of *Equisetum, Juncus*, and *Carex*. Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Poa pratensis, Melilotus* spp., and other exotic forage species are often present in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs along streambanks of canyon drainages at elevations of 4000 and 5600 feet. Stream gradient is gentle and soils are sandy.

Global Environment: This riparian forest association is documented from along large rivers in southwestern Utah, southwestern New Mexico, and Arizona. Elevation ranges from 1220-1700 m. Stands are found on stable bars in floodplains and along streambanks in canyon drainages. Substrates are typically relatively recently deposited alluvium. Stream gradient is typically gentle, and soils are sandy.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of *Populus fremontii / Salix exigua* are small and scattered infrequently along canyon streams in the park. *Populus fremontii* trees are mostly immature, with a canopy height of 5-10 m and foliar cover of 10-20%. Mature trees may be present with cover of 10%. *Acer negundo* is occasionally present in the stand. The shrub layer is a mixture of upland species and riparian species, but clearly dominated by *Salix exigua*. The herbaceous layer is also variable. *Poa pratensis, Equisetum* spp., *Melilotus officinalis*, and a variety of other riparian species of minimal cover occupy sampled sites.

Global Vegetation: This association is characterized by an open to dense deciduous tree canopy that is dominated by *Populus fremontii*, with *Salix exigua* dominating the tall-shrub layer. *Acer negundo* may also be present in the tree canopy, but *Salix gooddingii* is typically not present. *Baccharis salicifolia* is also typically not abundant in the shrub layer, but a variety of other riparian and upland shrub species may be present, including *Betula occidentalis, Ericameria nauseosa, Artemisia tridentata*, or *Quercus gambelii*. The herbaceous layer is generally sparse, depending on the density of the shrub and tree layers. *Distichlis spicata, Muhlenbergia asperifolia, Phragmites australis*, and species of *Equisetum, Juncus*, and *Carex* are commonly present. Introduced species such as *Elaeagnus angustifolia, Tamarix* spp., *Melilotus* spp., *Bromus* spp., and *Poa pratensis* are often present in disturbed stands.

Global Dynamics: Periodic flooding is required for the growth, maintenance and reproduction of this forest.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo, Populus fremontii*
TALL SHRUB	*Betula occidentalis, Salix exigua*

Global

Stratum	**Species**
TREE CANOPY	*Populus fremontii*
TALL SHRUB	*Salix exigua*
GRAMINOID	*Phragmites australis*
FORB	*Artemisia ludoviciana*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo, Populus fremontii*
TALL SHRUB	*Salix exigua*

Global

Stratum	**Species**
TREE CANOPY	*Populus fremontii*
TALL SHRUB	*Salix exigua*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
TREE CANOPY	*Elaeagnus angustifolia*
GRAMINOID	*Bromus tectorum*

GLOBAL SIMILAR ASSOCIATIONS:
- Populus fremontii - Salix gooddingii / Salix exigua Forest (CEGL002684)
- Populus fremontii / Baccharis salicifolia Woodland (CEGL000941)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: This association was not reported in the Handbook of Wetland Vegetation Communities of New Mexico (Muldavin et al. 2000a) and needs further review to distinguish it from similar associations such as *Populus fremontii - Salix gooddingii / Salix exigua* Forest (CEGL002684). Part of the confusion is related to a taxonomic change in Rio Grande cottonwood from *Populus fremontii var. wislizeni* S. Wats. to *Populus deltoides ssp. wislizeni* (S. Wats.) Eckenwalder. This change resulted in part of this association (central NM along the Rio Grande) being moved into *Populus deltoides / Salix exigua* Woodland (CEGL002685). More work is needed to determine the range and possible areas of overlap between these two cottonwood species, and vegetation types in which they are important.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was documented in the Kolob Canyons area of the park and the East Fork of the Virgin River.

Global Range: This riparian forest is known from southwestern New Mexico along the Gila River and the East Fork of the Virgin River in southwestern Utah. It likely occurs elsewhere in Utah and Arizona.

Nations: US
States/Provinces: AZ? NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 25, 521
Classification Confidence: 3 **Identifier:** CEGL000666
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin et al. 1993b, Muldavin et al. 2000a, Szaro 1989

I.B.2.N.d.25. POPULUS TREMULOIDES TEMPORARILY FLOODED FOREST ALLIANCE

Quaking Aspen Temporarily Flooded Forest Alliance

POPULUS TREMULOIDES / QUERCUS GAMBELII / SYMPHORICARPOS OREOPHILUS FOREST

Quaking Aspen / Gambel Oak / Mountain Snowberry Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This deciduous forest is documented from central New Mexico and southwestern Utah where it occurs along drainages on plateaus and on mountain slopes. Elevations range from 2240-2460 m. Stands occur along intermittent streams on moderately steep to steep slopes with western aspects. Soils tend to be fine-textured. The vegetation is characterized by a moderately dense to dense tree canopy dominated by *Populus tremuloides*. *Quercus gambelii* dominates the tall-shrub layer and may be present in the tree canopy. *Symphoricarpos oreophilus* is typically present and may form the short-shrub layer with several other shrub species. The herbaceous layer may be diverse but is generally sparse.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This is represented by one stand in Zion NP, found on a steep, southwest-facing slope. Soils are clay loam, and moisture conditions appear to be intermittently mesic.

Global Environment: This deciduous forest is known from central New Mexico and southwestern Utah where it occurs along drainages on plateaus and in mountain slopes. Elevations range from 2240-2460 m. Stands occur along intermittent streams on moderately steep to steep slopes with western aspects. Soils tend to be fine-textured.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association *Populus tremuloides* is unmistakably dominant in the tree canopy layer. *Quercus gambelii* in tree form may also contribute to the canopy. The shrub layer is dominated by *Quercus gambelii*, and *Symphoricarpos oreophilus* may be well represented or simply present. Various grasses and forbs, commonly *Vicia americana, Achillea millefolium, Poa pratensis*, and *Mertensia arizonica*, represent the herbaceous understory.

Global Vegetation: The association is characterized by a moderately dense to dense tree canopy dominated by *Populus tremuloides*. *Quercus gambelii* dominates the tall-shrub layer and may be present in the tree canopy. *Symphoricarpos oreophilus* forms the short-shrub layer with several other shrub species such as *Amelanchier* spp. , *Rosa woodsii*, and small *Quercus gambelii*. The herbaceous layer may be diverse but is generally sparse. Herbaceous species include *Achillea millefolium, Bromus anomalus, Senecio eremophilus, Solidago velutina, Thalictrum fendleri, Vicia americana*, and the introduced perennial graminoid *Poa pratensis*.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Populus tremuloides, Quercus gambelii*
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*

Global

Stratum	Species
TREE CANOPY	*Populus tremuloides, Quercus gambelii*
SHORT SHRUB	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Populus tremuloides, Quercus gambelii*
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Populus tremuloides*
SHORT SHRUB	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Poa pratensis*

GLOBAL SIMILAR ASSOCIATIONS:
- Populus tremuloides / Symphoricarpos oreophilus Forest (CEGL000610)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: This poorly known association is reported from only 2 locations and needs additional classification work to further define the type and its range.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in the intermittent stream of Little Creek, which is located near the Kolob Terrace Road.

Global Range: This association is known from central New Mexico and southwestern Utah, and may occur in similar riparian habitats in Arizona and possibly southern Colorado.

Nations: US
States/Provinces: NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH56
Classification Confidence: 2 **Identifier:** CEGL000598
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Freeman and Dick-Peddie 1970

I.C.3.N.a. Mixed needle-leaved evergreen - cold-deciduous forest

I.C.3.N.a.39. ABIES CONCOLOR - POPULUS TREMULOIDES FOREST ALLIANCE
White Fir - Quaking Aspen Forest Alliance

POPULUS TREMULOIDES - ABIES CONCOLOR / POA PRATENSIS SEMI-NATURAL FOREST

Quaking Aspen - White Fir / Kentucky Bluegrass Semi-natural Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations above 7000 feet on flat to gently sloping terrain. Soils are somewhat poorly drained clays.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Populus tremuloides* and *Abies concolor* are prominent in the canopy layer of this association. The shrub layer is not significant, but there may be a presence of *Quercus gambelii* or *Symphoricarpos oreophilus*. The herbaceous layer is clearly dominated by *Poa pratensis* (over 40% cover). Other herbaceous species that are commonly present and contribute minor cover are *Lupinus argenteus, Vicia americana, Achillea millefolium*, and *Tragopogon dubius*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Abies concolor, Populus tremuloides*
TALL SHRUB	*Quercus gambelii*
GRAMINOID	*Poa pratensis*
FORB	*Vicia americana*

Global

Stratum **Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Abies concolor, Populus tremuloides*
GRAMINOID	*Poa pratensis*

Global

Stratum **Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: This association was described by Mueggler (1988) in his comprehensive report on aspen communities of the Intermountain West. Because it is a grazing-induced type it was not recognized in the USNVC until now (2002). It is likely to be widely distributed in the mountains of Utah and Nevada, and may also occur in Colorado.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is restricted to the vicinity of Lava Point on Kolob Reservoir quadrangle. It also is likely to occur outside the park boundary on the Upper Kolob Plateau.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT, NV, CO?

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH18
Classification Confidence: 3 **Identifier:** CEGL002947
REFERENCES: Mueggler 1988

POPULUS TREMULOIDES - ABIES CONCOLOR / SYMPHORICARPOS OREOPHILUS FOREST

Quaking Aspen - White Fir / Mountain Snowberry Forest

ELEMENT CONCEPT

GLOBAL SUMMARY: This mixed evergreen-deciduous forest is documented from the mountains and plateaus of Utah and northern Nevada at montane elevations. Stands are characterized by a moderately dense to dense tree canopy codominated by *Populus tremuloides* and *Abies concolor* with *Symphoricarpos oreophilus* dominating the short-shrub layer. Often the conifers form a subcanopy that will eventually overtake the *Populus tremuloides*. Adjacent vegetation is usually forests dominated by *Abies concolor* or *Pseudotsuga menziesii*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: In the park this association occurs at elevations above 7000 feet on flat to gently sloping terrain. Soils are loamy. Litter cover is at least 50%, and the remaining ground cover is bare ground or volcanic rock.

Global Environment: These montane, mixed evergreen-deciduous forests have been reported from mountain and plateau environments of the Great Basin and Colorado Plateau, where they occur between 2100-2800 m. Sites are gently to moderately steep slopes on all aspects. Ground cover is dominated by litter, bare ground and rock. Parent materials are sedimentary (sandstone) or volcanic. Soils are generally well-drained loams or sandy loams with substantial organic matter. Past disturbance appears to be a key factor in distribution of these forests. At drier or rocky sites these forests may be somewhat stable, but in mesic areas they are seral communities which become established following fire.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association occurs in small stands in the midst of surrounding *Abies concolor* (white fir) -dominated forests. The few remaining stands of this successional type are at different stages of succession. *Populus tremuloides* generally has greater foliar cover than *Abies concolor* in this association, but young conifer seedlings and emergent conifers show evidence of eventually dominating these stands. *Pinus ponderosa* may also be present. *Symphoricarpos oreophilus* is well represented in the shrub layer at 10-30% cover. Other shrubs present are *Acer grandidentatum, Quercus gambelii*, and *Amelanchier alnifolia*. Herbaceous cover is inconsistent. In stands where canopy cover is less than 50%, a diverse array of montane forbs and grasses contribute up to 30% cover. Some herbaceous species documented for this association include *Vicia americana, Osmorhiza occidentalis, Maianthemum stellatum, Thalictrum fendleri, Achillea millefolium*, and *Poa pratensis*.

Global Vegetation: This association is characterized by a moderately dense to dense, mixed evergreen-deciduous tree canopy that is codominated by *Populus tremuloides* and *Abies concolor*. *Abies lasiocarpa* is typically not present, but individuals of *Pseudotsuga menziesii, Picea engelmannii, Picea pungens*, or *Pinus ponderosa* are not uncommon. Often the conifers form a subcanopy that will eventually overtake the *Populus tremuloides* in this early seral type. *Symphoricarpos oreophilus* is the characteristic species of the short-shrub layer and typically dominates. Associates include several other common species in lesser amounts such as *Amelanchier* spp., *Arctostaphylos patula, Mahonia repens, Juniperus communis, Paxistima myrsinites*, and *Rosa woodsii*. The moderately dense herbaceous layer is usually luxuriant and species-rich in comparison to adjacent conifer forests because light is able to penetrate the *Populus tremuloides* tree canopy. Herbaceous species are diverse and variable. Common graminoids are *Achnatherum occidentale, Bromus anomalus, Bromus carinatus, Carex geyeri, Carex rossii, Elymus glaucus, Elymus trachycaulus, Festuca arizonica, Poa fendleriana*, and *Poa nervosa*. Forbs may include *Achillea millefolium, Eucephalus engelmannii, Frasera speciosa, Geranium* spp., *Lathyrus* spp., *Rudbeckia occidentalis, Osmorhiza berteroi (= Osmorhiza chilensis)*, and *Thalictrum fendleri*. The introduced graminoids *Poa pratensis* and *Dactylis glomerata* are common in many stands.

Global Dynamics: *Abies concolor* is much more shade-tolerant than *Populus tremuloides* and is the most important regenerating species under closed-canopy conditions. Most of these mixed stands are seral and, in the absence of fire will eventually be dominated by *Abies concolor*. This unique forest alliance is linked to gap-forming disturbances, such as fire or windthrow, which allow regeneration of *Populus tremuloides* and limit abundances of *Abies concolor* (Mueggler 1988, Mueggler and Campbell 1986).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Populus tremuloides*
TALL SHRUB	*Acer grandidentatum, Symphoricarpos oreophilus*
GRAMINOID	*Poa pratensis*
FORB	*Achillea millefolium, Vicia americana*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Populus tremuloides, Pseudotsuga menziesii*
SHORT SHRUB	*Symphoricarpos oreophilus*
FORB	*Osmorhiza berteroi*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Abies concolor, Populus tremuloides*
TALL SHRUB	*Symphoricarpos oreophilus*

Global

Stratum	**Species**
TREE CANOPY	*Abies concolor, Populus tremuloides*
SHORT SHRUB	*Symphoricarpos oreophilus*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Poa pratensis*

GLOBAL SIMILAR ASSOCIATIONS:

- Populus tremuloides - Abies concolor / Arctostaphylos patula Forest (CEGL000522)--the only other mixed aspen-white fir association in the classification; described from Nevada.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is restricted to the vicinity of Lava Point on Kolob Reservoir quadrangle. It may occur outside the park boundary on the Upper Kolob Plateau.

Global Range: This forest association is widespread in the mountains of Utah and northern Nevada, and likely occurs in adjacent states where *Abies concolor* and *Populus tremuloides* co-occur.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH8, RH9, 105
Classification Confidence: 2 **Identifier:** CEGL000523
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Mueggler 1988, Mueggler and Campbell 1986

II. WOODLAND

II.A.4.N.a. Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

II.A.4.N.a.38. JUNIPERUS OSTEOSPERMA WOODLAND ALLIANCE
Utah Juniper Woodland Alliance

JUNIPERUS OSTEOSPERMA / ARTEMISIA TRIDENTATA WOODLAND

Utah Juniper / Big Sagebrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1220-2260 m (4000-7400 feet). This community generally occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-textured, calcareous alluvium derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable. The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 15%. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia stansburiana*, may be present, but generally with low cover. The sparse to moderately dense herbaceous layer is dominated by graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on flat to gentle terrain at or below 4000 feet in elevation. Soils are sandy.

Global Environment: This sparse woodland association has been reported from semi-arid foothills, plateaus and mountains throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin. Elevation ranges from 1220-2260 m (4000-7400 feet). This community generally occurs on a variety of slopes and aspects, often at the break between foothill and basin. Soils are generally coarse-texture, calcareous alluvium derived from sandstone and shale. Evidence of erosion such as gullies and rills is not uncommon. There are generally significant amounts of bare ground, litter, and desert pavement at the soil surface. Rock cover is variable.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Juniperus osteosperma* has 20% cover in this association and ranges 5-10 m in height. The understory is prominently *Artemisia tridentata* accompanied by sparse cover of *Ephedra nevadensis, Gutierrezia sarothrae*, and *Opuntia macrorhiza*. The herbaceous layer is absent or very sparse.

Global Vegetation: The vegetation is characterized by an open tree canopy dominated by *Juniperus osteosperma* with *Artemisia tridentata* dominating the sparse to moderately dense short-shrub layer. Tree canopy cover values are over 5%, but typically less than 15%. Other shrubs, such as *Atriplex canescens, Atriplex confertifolia, Artemisia nova, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae, Opuntia* spp., or *Purshia stansburiana*, may be present, but generally with low cover. The sparse to moderately dense herbaceous layer is dominated graminoids such as *Achnatherum hymenoides, Aristida* spp., *Bouteloua* spp., *Carex filifolia, Elymus elymoides, Hesperostipa comata, Pleuraphis jamesii (= Hilaria jamesii), Pascopyrum smithii, Poa secunda, Pseudoroegneria spicata, Sporobolus* spp., and introduced annual *Bromus* spp. Associated forbs may include *Artemisia frigida, Eriogonum* spp., *Gayophytum racemosum, Leptodactylon pungens, Phlox hoodii*, and *Plantago patagonica*.

Global Dynamics: Fires in this association are thought to be infrequent because smaller *Juniperus osteosperma* and *Artemisia tridentata* are easily killed by burns and do not resprout (Barney and Frischknecht 1974, Everett 1987). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Barney and Frischknecht 1974, Bunting 1987). However, *Juniperus osteosperma* is relatively slow to recover following fire, and sagebrush may dominate the sites for decades (Jameson et al. 1962). If fire-return intervals are more frequent than 10 years then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). This community may be increasing in extent by invading adjacent grasslands and steppe, where there has been a reduction of fire frequency due to fire suppression and fine fuels removal by grazing livestock that would allow fires to spread (Johnson and Payne 1968). Fire, drought and competition with grasses are thought to have kept *Juniperus* spp. communities in the past restricted to rocky areas that do not burn frequently (Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
TALL SHRUB	*Artemisia tridentata*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
SHORT SHRUB	*Artemisia tridentata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
TALL SHRUB	*Artemisia tridentata*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
SHORT SHRUB	*Artemisia tridentata*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs at the southern boundary of Zion National Park on the mesa overlooking Huber Wash. It is uncommon within the park boundaries.

Global Range: This sparse woodland association occurs throughout much of the western Rocky Mountains, Colorado Plateau, and Great Basin region.

Nations: US
States/Provinces: AZ CA CO ID MT NM NV UT WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 504
Classification Confidence: 2 **Identifier:** CEGL000730
REFERENCES: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969a, Blackburn et al. 1969e, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bradley 1964, Brotherson and Evenson 1983, Bunting 1987, Dastrup 1963, DeVelice and Lesica 1993, Donart et al. 1978b, Driscoll et al. 1984, Everett 1987, Francis 1986, Isaacson 1967, Johnson and Payne 1968, Larson and Moir 1987, Milton and Purdy 1983, Moir and Carleton 1987, Stuever and Hayden 1997a, USFS 1983a, West et al. 1998, Wright et al. 1979

II.A.4.N.a.8. JUNIPERUS SCOPULORUM WOODLAND ALLIANCE

Rocky Mountain Juniper Woodland Alliance

JUNIPERUS SCOPULORUM - QUERCUS GAMBELII WOODLAND [PROVISIONAL]

Rocky Mountain Juniper - Gambel Oak Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at gentle to moderate drainage bottoms and occasionally on hillsides. Elevation ranges 5400 to 6700 feet. Leaf litter is usually above 50%, and soil texture has not been documented.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Juniperus scopulorum, Juniperus osteosperma*, and *Quercus gambelii* dominate the canopy in some combination with total cover of 20-80%. *Pinus monophylla* may also occur in the canopy with minimal cover. If *Quercus gambelii* is not in the canopy, it occurs in the tall-shrub layer with high cover. Other shrubs may be present, but have minimal cover. Herbaceous cover is usually absent, and the ground is covered with leaf litter. In the northeastern corner of the park, this association occurs again with a canopy cover of *Juniperus scopulorum* and *Quercus gambelii*. *Pinus edulis* is also present in the canopy. Associated shrubs are *Artemisia tridentata* and *Purshia tridentata*. These shrubs are a major component of surrounding shrubland vegetation. This association was observed and documented during the Accuracy Assessment phase of project and needs more plot data.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIESZION NATIONAL PARK

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Juniperus scopulorum, Quercus gambelii*
TALL SHRUB	*Quercus gambelii*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Quercus gambelii*
TALL SHRUB	*Quercus gambelii*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs throughout the northern half of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 108, 525. AA Plots: 68, 70, 288, 412, 435, 436, 452, 458, 646, 647, 798, 801
Classification Confidence: 3 **Identifier:** CEGL002967
REFERENCES: None available.

II.A.4.N.a.18. PINUS EDULIS - (JUNIPERUS SPP.) WOODLAND ALLIANCE
Two-needle Pinyon - (Juniper species) Woodland Alliance

PINUS EDULIS - JUNIPERUS OSTEOSPERMA / ARCTOSTAPHYLOS PATULA WOODLAND

Two-needle Pinyon - Utah Juniper / Greenleaf Manzanita Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was sampled on mesas above 6200 feet with gentle to steep slopes, and southern to western aspects. Soil textures are sandy loam and clay loam.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus edulis* and *Juniperus osteosperma* canopy cover ranges 15-30%, and heights are 5-10 m. The shrub layer is 1-2 m high and dominated by *Arctostaphylos patula*, 5-30% cover. *Amelanchier utahensis* and *Quercus gambelii* are commonly present and contribute less than 10% cover combined. *Poa fendleriana* is usually present. Other herbaceous species are sparse and inconsistently represented among the stands sampled.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
SHORT SHRUB	*Amelanchier utahensis, Arctostaphylos patula*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
SHORT SHRUB	*Arctostaphylos patula*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on high-elevation mesas on the eastern side of the park, from The Great White Throne north to the mesas rimming Goose Creek.

Global Range:

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 9, 11, 99, 100, 373, 380
Classification Confidence: 3 **Identifier:** CEGL002939
REFERENCES: None available.

PINUS EDULIS - JUNIPERUS OSTEOSPERMA / CERCOCARPUS INTRICATUS WOODLAND
Two-needle Pinyon - Utah Juniper / Littleleaf Mountain-mahogany Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, and colluvial slopes at moderate elevations (1740-2380 m) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common. Exposed bedrock and large rock may cover over 50% of the stand with vegetation growing in the cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Bare soil is common. The vegetation is characterized by an open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (10-25% cover). *Amelanchier utahensis, Arctostaphylos patula, Quercus gambelii*, or *Yucca* spp. are often present in many stands. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses such as species of *Cryptantha, Penstemon*, and *Opuntia, Gutierrezia sarothrae, Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis*, and *Poa fendleriana*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on steep sandstone slopes above 6500 feet with southern to southwestern aspects. Shallow sandy soils develop in crevices and depressions in sandstone, allowing vegetation to take hold on the steep slopes.

Global Environment: This woodland association occurs on dry, sandstone ridgetops, mesa edges, outcrops, and colluvial slopes at moderate elevations (1740-2380 m) on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming. South and southwest aspects are common. Exposed bedrock and large rock may cover over 50% of the stand with vegetation growing in the cracks. These sandstone-derived soils are generally poorly developed, coarse-textured and skeletal. Bare soil is common.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Vegetation is sparse with total foliar cover averaging 25%. *Pinus edulis* and *Pinus monophylla* hybrids may occur, but the dominant species is more likely to be *Pinus edulis* at elevations above 6500 feet. *Cercocarpus intricatus* is the indicator species of this association, but is sparse with only 10% cover. Other species that commonly contribute to the short-shrub layer are *Amelanchier utahensis, Quercus gambelii*, and the dwarf-shrub *Yucca elata var. utahensis*. The herbaceous layer is sparse, yet diverse. Species that are commonly represented are *Poa fendleriana* and *Penstemon* spp.

Global Vegetation: The association is characterized by an open tree canopy (10-25% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*, and by the dominance of *Cercocarpus intricatus* in the relatively sparse short-shrub layer (10-25% cover). *Amelanchier utahensis, Arctostaphylos patula, Quercus gambelii*, or *Yucca* spp. are often present in many stands. Herbaceous cover is sparse (<5% cover) and is composed of scattered forbs and grasses such as species of *Cryptantha, Penstemon*, and *Opuntia, Gutierrezia sarothrae, Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis*, and *Poa fendleriana*.

Global Dynamics: Fire is not frequent because open tree and shrub canopies and lack of continuous fine fuel prevent the spread.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus intricatus*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus intricatus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis, Pinus monophylla*
TALL SHRUB	*Cercocarpus intricatus*

Global

Stratum	**Species**
TREE CANOPY	*Pinus edulis*
TALL SHRUB	*Cercocarpus intricatus*

GLOBAL SIMILAR ASSOCIATIONS:

- Juniperus osteosperma / Cercocarpus intricatus Woodland (CEGL000733)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3.

Global Comments: Compare this association with *Juniperus osteosperma / Cercocarpus intricatus* Woodland (CEGL000733) which is very similar, but lacks *Pinus edulis*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was documented in remote regions of the Temple of Sinawava quadrangle. It is likely that it occurs occasionally throughout the east-central region of the park.

Global Range: This plant association is found on the Colorado Plateau and in extreme northwestern Colorado, adjacent Utah, and possibly Wyoming.

Nations: US
States/Provinces: CO UT WY?

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 304
Classification Confidence: 2 **Identifier:** CEGL000779
REFERENCES: Baker 1983b, Baker 1983c, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Driscoll et al. 1984, Zimmerman 1978

PINUS EDULIS - JUNIPERUS OSTEOSPERMA / PURSHIA STANSBURIANA WOODLAND

Two-needle Pinyon - Utah Juniper / Stansbury Cliff-rose Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association is known from the Colorado Plateau south to central Arizona. It occurs on dry hillslopes and mesas. Elevations range from 1825-2075 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow, calcareous and rocky, ranging from sand to sandy loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale. The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer often with *Artemisia tridentata* in the northern part of its range. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present including *Amelanchier utahensis, Arctostaphylos patula, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Mahonia trifolioliata, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on moderate slopes, and eastern to southwestern aspects at 6200 to 7000 feet. Soil texture is sandy loam.

Global Environment: This woodland occurs on the Colorado Plateau south to central Arizona, on dry hillslopes and mesas. Elevations range from 1825-2075 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are generally shallow, calcareous and rocky, ranging from sand to sandy loam in texture. Rock outcrop and bare soil are common. Parent materials include sandstone and shale.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Mature stands of *Pinus edulis* and *Juniperus osteosperma* in this association have canopy cover of 20-30%. *Pinus monophylla* may occur with *Pinus edulis* or as a hybrid in this area of the park. The tall-shrub layer is conspicuously represented (especially when in flower) by few, but large, mature *Purshia stansburiana*. Foliar cover is usually no more than 10%. *Amelanchier utahensis, Quercus gambelii*, and *Arctostaphylos patula* are commonly present as a short-shrub layer with cover less than 10%. Herbaceous cover is inconsistently represented and very sparse.

Global Vegetation: This association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus osteosperma*. *Purshia stansburiana* dominates or codominates the sparse to moderately dense short-shrub layer often with *Artemisia tridentata* in the northern part of its range. *Cercocarpus montanus* and *Purshia tridentata* are scarce or absent. Other shrubs may be present including *Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata, Chamaebatiaria millefolium, Ephedra viridis, Gutierrezia sarothrae, Mahonia trifoliolata, Quercus gambelii* (<5% cover), or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Elymus elymoides, Hesperostipa comata, Hesperostipa neomexicana, Koeleria macrantha, Poa fendleriana*, and *Schizachyrium scoparium*. Forbs may include *Artemisia ludoviciana, Artemisia frigida, Calliandra humilis, Penstemon linarioides*, and *Polygala alba*.

Global Dynamics: Stuever and Hayden (1997) described two phases of this plant community, an *Artemisia tridentata* phase and a *Purshia stansburiana* phase. Both are restricted geographically with the *Artemisia tridentata* phase common in northern Arizona, southern Utah, northern New Mexico, and southwestern Colorado where winter precipitation is higher than summer. The *Purshia stansburiana* phase, which lacks *Artemisia tridentata*, occurs in central Arizona where summer monsoon precipitation is higher than winter (Stuever and Hayden 1997). Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Purshia stansburiana* is also generally killed by fire; however, it is known to resprout after cool burns (Britton and Wright 1983, Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Purshia stansburiana*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Artemisia tridentata, Purshia stansburiana*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Purshia stansburiana*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Purshia stansburiana*

GLOBAL SIMILAR ASSOCIATIONS:

- Pinus edulis - Juniperus spp. / Artemisia tridentata Woodland (CEGL000776)--This association is similar to the *Artemisia tridentata* phase of this association except *Purshia stansburiana* not codominant.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4?.

Global Comments: *Pinus edulis / Purshia mexicana* Woodland was changed to *Pinus edulis / Purshia stansburiana* Woodland (CEGL000782) on 2001-09-04 because of a taxonomic change of the nominal species. *Purshia mexicana var. stansburiana* (Torr.) Welsh is now recognized as *Purshia stansburiana* (Torr.) Henrickson (Kartesz 1999). *Purshia mexicana* (D. Don) Henrickson, a closely related species, occurs in Chihuahua, Durango and Zacateca, Mexico, and possibly extreme southern Arizona, and is not known to be present in this association (Cronquist et al. 1997).

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on high-elevation mesas and drainages in the vicinity of Highway 9 on the eastern side of the park.

Global Range: This woodland association occurs from central Arizona, western New Mexico, southwestern Colorado, and southern Utah.

Nations: US
States/Provinces: AZ CO NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 10, 212, 316
Classification Confidence: 1 **Identifier:** CEGL000782
REFERENCES: BIA 1979, Baker 1980a, Baker 1984a, Bourgeron and Engelking 1994, Britton and Wright 1983, Cronquist et al. 1997, Driscoll et al. 1984, Isaacson 1967, Kartesz 1999, Larson and Moir 1987, Moir and Carleton 1987, Northcutt 1978, Stuever and Hayden 1997a, USFS 1982, USFS 1985c

PINUS EDULIS - JUNIPERUS SPP. / ARTEMISIA TRIDENTATA WOODLAND

Two-needle Pinyon - Juniper species / Big Sagebrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This broadly defined woodland association is common in the Colorado Plateau, but also occurs on dry foothills and mesas from north-central New Mexico and southern Colorado west to the eastern Mojave Desert, in extreme northwestern Colorado and adjacent Utah. Elevations range from 1830-2440 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are generally poorly developed, coarse-textured and skeletal, and bare soil is common. Parent material includes sandstone and shale. The vegetation is characterized by a typically open tree canopy (10-30% cover, but ranges to 50% cover) that is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common from northwestern New Mexico west and north into Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* dominates a sparse to moderately dense short-shrub layer (10-35% cover). *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, but generally sparse and dominated by graminoids (<5% cover) with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs contiguously across several square miles of the gently sloping mesas and high valleys at elevations between 5600 and 6000 feet. Aspect is southeasterly and soils are well-drained loamy sands.

Global Environment: This broadly defined woodland association is known from the Colorado Plateau, occurring on dry foothills and mesas from north-central New Mexico and southern Colorado west to the eastern Mojave Desert, and in extreme northwestern Colorado and adjacent Utah. Elevations range from 1830-2440 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are generally poorly developed, coarse-textured and skeletal. Bare soil is common. Parent material includes sandstone and shale.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In the southeast corner of the park, old-growth or mature stands of *Pinus edulis* and *Juniperus osteosperma* contribute to a canopy cover of 20-50%. The shrub layer is sparse, only 5-15% cover and dominated by *Artemisia tridentata*. *Ephedra viridis* may codominate or is at least present. Other shrubs commonly present are *Amelanchier utahensis* and *Opuntia macrorhiza*. The herbaceous layer is of significance in this association. Grasses contribute up to 25% cover. *Bouteloua gracilis* and *Muhlenbergia pungens* are well represented. *Hesperostipa comata* is present in stands with open canopies. *Poa fendleriana* and the forbs *Artemisia dracunculus* and *Artemisia campestris* are commonly present. Where this association occurs near the park's East Entrance, the environment is less pristine. Trees are of a younger age class, and the herbaceous understory is primarily *Bromus tectorum*.

Global Vegetation: This woodland is characterized by a typically open tree canopy (10-30% cover, but ranges to 50% cover) that is codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus osteosperma* is common from northwestern New Mexico, western Colorado, Arizona and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Artemisia tridentata* dominates a sparse to moderately dense short-shrub layer (10-35% cover). *Purshia stansburiana* is typically absent or scarce. Other shrubs present may include *Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Ephedra viridis, Gutierrezia sarothrae, Quercus gambelii*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, but is generally sparse and dominated by graminoids (<5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex filifolia, Hesperostipa comata, Koeleria macrantha, Muhlenbergia torreyi, Pascopyrum smithii, Pleuraphis jamesii*, and *Poa fendleriana*. Forbs include species of *Cryptantha, Eriogonum, Penstemon*, and *Phlox*.

Global Dynamics: Stuever and Hayden (1997) described two phases of this plant community, a *Juniperus osteosperma* and a *Juniperus monosperma* phase. Both are restricted by its geographic range, and where the

Juniperus spp. are sympatric, *Juniperus osteosperma* generally occurs at high elevations. Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma, Juniperus monosperma*, and *Artemisia tridentata* are killed by burns and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). However, *Pinus edulis, Juniperus osteosperma* and *Juniperus monosperma* are relatively slow to recover following fire, and sagebrush may dominate the sites for decades (Jameson et al. 1962, Erdman 1970). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
SHORT SHRUB	*Amelanchier utahensis, Artemisia tridentata, Ephedra viridis, Opuntia macrorhiza*
GRAMINOID	*Bouteloua gracilis, Muhlenbergia pungens, Poa fendleriana*

Global

Stratum	Species
TREE CANOPY	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
SHORT SHRUB	*Artemisia tridentata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
SHORT SHRUB	*Artemisia tridentata, Ephedra viridis, Opuntia macrorhiza*
GRAMINOID	*Bouteloua gracilis, Muhlenbergia pungens*

Global

Stratum	Species
TREE CANOPY	*Pinus edulis*
SHORT SHRUB	*Artemisia tridentata*

GLOBAL SIMILAR ASSOCIATIONS:
- Juniperus osteosperma / Artemisia tridentata Woodland (CEGL000730)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs near the East Entrance and the southeast corner of the park.

Global Range: This woodland association is common on the Colorado Plateau, occurring from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona and the eastern Mojave Desert, and in extreme northwestern Colorado and adjacent Utah.

Nations: US
States/Provinces: AZ CA? CO NM NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 43, 45, 48
Classification Confidence: 1 **Identifier:** CEGL000776
REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, Dick-Peddie 1993, Driscoll et al. 1984, Erdman 1970, Everett 1987, Heinze et al. 1962, Isaacson 1967, Jameson et al. 1962, Johnston 1987, Larson and Moir 1987, Mason et al. 1967, Moir and Carleton 1987, Stuever and Hayden 1997a, Tiedemann 1978, USFS 1983a, USFS 1985a, USFS 1985e, Wright et al. 1979

PINUS EDULIS - JUNIPERUS SPP. / CERCOCARPUS MONTANUS WOODLAND

Two-needle Pinyon - Juniper species / Mountain-mahogany Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This broadly defined woodland association is common on the Colorado Plateau, occurring on dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in extreme northwestern Colorado and adjacent Utah. Elevations range from 1830-2440 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are variable, but generally shallow, poorly developed and skeletal, ranging from clayey marl to sandy loam. Rock outcrop and bare soil are common. Parent materials include sandstone and shale. The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Cercocarpus montanus* dominates the moderately dense short-shrub layer (>25% cover). Other shrubs may be present including *Amelanchier* spp., *Ephedra viridis, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of *Pinus edulis – Juniperus* spp. */ Cercocarpus montanus* occur on gentle to steep slopes of mesa rims at elevations of 5800 to 7000 feet. The aspects of these slopes are most commonly eastern and northern, and occasionally western. The soils are shallow, clayey to loamy sand, and usually with high ground cover of shale rock fragments.

Global Environment: This broadly defined woodland association is common on the Colorado Plateau, occurring on dry foothills and mesas from north-central New Mexico and southern Colorado west to the Mogollon Rim of Arizona, and in extreme northwestern Colorado and adjacent Utah. Elevations range from 1830-2440 m. Stands occur on gentle to moderately steep slopes on all aspects. The soils are variable, but generally shallow, poorly developed and skeletal, ranging from clayey marl to sandy loam. Rock outcrop and bare soil are common. Parent materials include sandstone and shale.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus edulis* and *Juniperus osteosperma* dominate the canopy layer with 20-40% cover and heights averaging 5 m. *Cercocarpus montanus* is present to well represented in the shrub layer and is usually codominated or sub-dominated by *Amelanchier utahensis*. *Quercus gambelii* is usually present and contributes significant cover at some sites. Herbaceous species commonly present with minimal cover are *Poa fendleriana, Carex rossii*, and *Achnatherum hymenoides*.

Global Vegetation: This association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common from northwestern New Mexico west into Arizona and north into western Colorado and Utah. *Juniperus scopulorum* is more common in higher elevation stands. *Cercocarpus montanus* dominates the moderately dense short-shrub layer (>25% cover). Other shrubs may be present including *Amelanchier* spp., *Ephedra viridis, Gutierrezia sarothrae, Fendlera rupicola, Garrya ovata, Mahonia* spp., *Nolina microcarpa, Quercus gambelii, Quercus grisea, Rhus trilobata*, or species of *Yucca* and *Opuntia*. Herbaceous cover is variable, ranging from sparse to moderately dense, and generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Andropogon gerardii, Bouteloua curtipendula, Bouteloua gracilis, Bouteloua hirsuta, Carex rossii, Leymus salinus (= Elymus salinus), Hesperostipa comata, Koeleria macrantha, Muhlenbergia pauciflora, Pascopyrum smithii, Pleuraphis jamesii, Poa fendleriana, Pseudoroegneria spicata*, and *Schizachyrium scoparium*. Common forbs include species of *Cryptantha, Eriogonum, Penstemon* and *Phlox*.

Global Dynamics: Fires in this association are thought to be infrequent because *Pinus edulis, Juniperus osteosperma*, and *Juniperus monosperma* are killed or severely damaged by burns and do not resprout (Wright et al. 1979). *Cercocarpus montanus*, however, resprouts after burning and will re-establish relatively quickly (Bradley et al. 1992, Pase and Lindenmuth 1971). Conifers will re-establish more slowly. Stands occur in dry and often rocky habitats where fire frequency is low because of fuel discontinuity. When fire occurs, it will likely be severe because of greater fuel loads from decadent shrubs (Bradley et al. 1992).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*

Global

Stratum	Species
TREE CANOPY	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Cercocarpus montanus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Cercocarpus montanus*

Global

Stratum	Species
TREE CANOPY	*Juniperus monosperma, Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Cercocarpus montanus*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on high mesas of the East Rim from White Cliffs north to the source of the Virgin River, and above Camp Creek, north of the Kolob Canyons area.

Global Range: This widespread woodland association is found from southern Colorado and north-central New Mexico to the Mogollon Rim of Arizona, north across the Colorado Plateau into western Colorado and adjacent Utah.

Nations: US
States/Provinces: AZ CO NM OK? UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH81, 68, 308, 357
Classification Confidence: 2 **Identifier:** CEGL000780
REFERENCES: Baker 1983b, Baker 1984a, Baker and Kennedy 1985, Bourgeron and Engelking 1994, Bradley et al. 1992, Driscoll et al. 1984, Erdman 1962, Erdman 1969, Hess and Wasser 1982, Isaacson 1967, Johnston 1987, Kennedy 1983a, Larson and Moir 1987, Marr et al. 1979, Medina 1986, Moir 1963, Moir and Carleton 1987, Moir and Ludwig 1979, Pase and Lindenmuth 1971, Stuever and Hayden 1997a, USFS 1981a, USFS 1981b, USFS 1983a, USFS 1985d, USFS 1985e, USFS 1985g, Vories 1974, Wright et al. 1979

PINUS EDULIS - JUNIPERUS SPP. / QUERCUS GAMBELII WOODLAND

Two-needle Pinyon - Juniper species / Gambel Oak Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1580-2440 m, but may be higher in stands in southern New Mexico. Sites are variable, but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep, rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, on northern aspects or where shaded by upper canyon walls. The soils are variable and range from deep to shallow, silty clay to sandy loam, and often gravelly. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). The vegetation is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present in some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often over 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of *Pinus edulis – Juniperus* spp. / *Quercus gambelii* occur on flat to moderately steep slopes of mesas at elevations of 6000 to 7500 feet. The aspects of these slopes are generally eastern to southern, and occasionally western. The soils are mostly loamy sand and with greater than 50% litter cover.

Global Environment: This widespread woodland association is known from the Colorado Plateau and southern Rocky Mountains, occurring from south-central Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado. Elevations normally range from 1580-2440 m, but may be higher in stands in southern New Mexico. Sites are variable, but generally are relatively mesic. Stands occur on flat to moderate slopes along drainages and on mesa tops, and on moderate to steep, rocky slopes of foothills, mountains and canyons, especially in draws where soil moisture is concentrated, on northern aspects or where shaded by upper canyon walls. Stands may occur on any aspects, but are less common on hot south-facing slopes. The soils are variable and range from deep to shallow, silty clay to sandy loam, and are often gravelly. Litter from *Quercus gambelii* and other shrubs is often extensive (over 50% cover). Parent materials include sandstone, limestone and rhyolite.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus edulis* and *Juniperus osteosperma* codominate this association with a total canopy cover of 20-40% and height averaging 5-10 m. In the northeast corner of the park, *Juniperus scopulorum* may occur. *Quercus gambelii* is the dominant shrub with minimum cover of 5%. Other shrubs commonly present or well represented are *Amelanchier utahensis, Cercocarpus montanus, Purshia tridentata, Peraphyllum ramosissimum, Artemisia tridentata*, and *Arctostaphylos patula*. Frequently occurring species in the understory are *Opuntia macrorhiza, Mahonia repens, Poa fendleriana, Helianthella uniflora*, and *Phlox austromontana*.

Global Vegetation: This widespread association is characterized by an open to moderately dense tree canopy (10-60% cover) codominated by *Pinus edulis* and *Juniperus* spp. The species of *Juniperus* varies with geography and elevation. *Juniperus monosperma* is common in north-central New Mexico and southern Colorado. *Juniperus deppeana* is common in southern New Mexico, and *Juniperus osteosperma* is common in northwestern New Mexico, northern Arizona and in Utah. *Juniperus scopulorum* is more common in higher elevation stands. An occasional *Pinus ponderosa* tree may be present is some stands. *Quercus gambelii* dominates the often patchy, moderately dense tall-shrub layer with at least 5% cover, but often over 25% cover. *Amelanchier utahensis, Cercocarpus montanus, Symphoricarpos oreophilus*, or species of *Yucca* and *Opuntia* are common shrub associates. Other shrubs, depending on geography, may include *Artemisia tridentata, Artemisia nova, Arctostaphylos patula, Cercocarpus ledifolius, Ephedra viridis, Fendlera rupicola, Gutierrezia sarothrae, Garrya* spp., *Ptelea trifoliata, Prunus* spp., *Quercus X pauciloba, Robinia neomexicana*, or *Rosa* spp. Herbaceous cover is variable, ranging from sparse to moderately dense, but generally dominated by graminoids (>5% cover) with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Carex geyeri, Carex rossii, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia montana, Poa fendleriana*, and *Schizachyrium scoparium*. Common forbs may include *Artemisia frigida, Balsamorhiza sagittata, Geranium caespitosum, Packera neomexicana, Thalictrum fendleri*, or *Vicia americana*.

Global Dynamics: *Quercus gambelii* is adapted to fire and will re-sprout profusely after a burn, forming a dense thicket (Wright 1972). *Pinus edulis, Juniperus monosperma, Juniperus osteosperma*, and *Juniperus scopulorum* are killed or severely damaged by fire and do not resprout after burning (Wright et al. 1979). When burned these woodlands will convert to oak shrublands. However, because *Juniperus deppeana* resprouts after burning, it will not be eliminated from the site (Bassett 1987, Wright 1972). Frequent burning will reduce cover of both *Quercus gambelii* and *Juniperus deppeana* (Erdman 1970, Kallender 1959).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Quercus gambelii*
GRAMINOID	*Poa fendleriana*

Global

Stratum	Species
TREE CANOPY	*Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*
SHORT SHRUB	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Quercus gambelii*

Global

Stratum	Species
TREE CANOPY	*Juniperus deppeana, Juniperus monosperma, Juniperus osteosperma, Juniperus scopulorum, Pinus edulis*
TALL SHRUB	*Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on high mesas and plateaus on the eastern side of the park, from the southeast corner to Dakota Hill.

Global Range: This woodland association occurs in foothills and mesas from southern Colorado to south-central New Mexico, west along the Mogollon Rim of Arizona, and north into Utah and western Colorado.

Nations: US
States/Provinces: CO NM UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH31, RH79, 33, 34, 374, 371, 263, 211, 272, 265, 310
Classification Confidence: 2 **Identifier:** CEGL000791
REFERENCES: Bassett 1987, Bourgeron and Engelking 1994, Driscoll et al. 1984, Harmon 1980, Hess and Wasser 1982, Holm 1927, Isaacson 1967, Johnston 1987, Kallender 1959, Larson and Moir 1987, Marr et al. 1973b, Steinhoff 1978, Vories 1974, Wright 1972, Wright et al. 1979

PINUS EDULIS / CERCOCARPUS LEDIFOLIUS WOODLAND [PROVISIONAL]

Two-needle Pinyon / Curl-leaf Mountain-mahogany Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 7900 feet on the west rim of the Upper Kolob Plateau. Soil texture is moderately deep clay.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is known from only one location in Zion National Park, likely due to its high elevation and dry climate requirements. *Pinus edulis* is 5-10 m high and has foliar cover of less than 10%. It is codominated by *Cercocarpus ledifolius* in tree form. *Juniperus scopulorum* is present in the vicinity. The short-shrub layer is composed of the shrubs *Amelanchier utahensis, Cercocarpus montanus, Arctostaphylos patula*, and *Quercus gambelii*, having a combined foliar cover of 20%. Herbaceous cover is extremely sparse. Species present are *Achnatherum hymenoides, Poa fendleriana, Carex* spp., *Balsamorhiza sagittata*, and *Petradoria pumila*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Pinus edulis*
TALL SHRUB	*Cercocarpus ledifolius*
SHORT SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Pinus edulis*
TALL SHRUB	*Cercocarpus ledifolius*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented from the northern boundary of the park on a ridge north of Camp Creek. It may occur elsewhere in small stands along the northern boundary.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 120
Classification Confidence: **Identifier:** CEGL002940
REFERENCES:

II.A.4.N.a.45. PINUS MONOPHYLLA - (JUNIPERUS OSTEOSPERMA) WOODLAND ALLIANCE

Singleleaf Pinyon - (Utah Juniper) Woodland Alliance

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / (SHEPHERDIA ROTUNDIFOLIA, AMELANCHIER UTAHENSIS) WOODLAND

Singleleaf Pinyon - Utah Juniper / (Roundleaf Buffaloberry, Utah Serviceberry) Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association appears to be related to more mesic sites than sites of *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland (CEGL002941). Elevations range from 4500-5600 feet with slope aspects commonly north to east. Soils are sandy or, in some cases, clay or silt loams.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association has comparatively diverse species composition and moderate cover for upland pinyon-juniper vegetation types. *Juniperus osteosperma* and *Pinus monophylla* have combined foliar cover of over 20% and heights averaging 5 m. The indicator species of this association is *Shepherdia rotundifolia*. This species is always present, but has low cover. *Amelanchier utahensis* is commonly present, also with low cover. Other shrubs that may be present are *Quercus turbinella, Fraxinus anomala*, and *Rhus trilobata*. Subshrubs *Yucca* spp., *Opuntia* spp., and *Gutierrezia sarothrae* are nearly always present, but each species contributes less than 5% cover. Herbaceous species may include *Poa fendleriana, Hesperostipa comata, Pleuraphis jamesii*, with 5-30% cover, and a wide variety of forbs with minimal cover. (There have been situations where all species are present except *Shepherdia rotundifolia*, and classification is still appropriate. It is likely nearby.)

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Quercus turbinella, Shepherdia rotundifolia*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Fraxinus anomala, Shepherdia rotundifolia*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on colluvial slopes of Zion Canyon, Parunaweep Canyon, Right and Left Fork of North Creek canyons, and Kolob Canyons of Zion National Park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH63, RH64, RH69, 110, 131, 135, 140, 384, 520
Classification Confidence: 3 **Identifier:** CEGL002942
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / ARTEMISIA NOVA WOODLAND

Singleleaf Pinyon - Utah Juniper / Black Sagebrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association occurs in the Great Basin. Elevations range from 1830-2030 m (6000-6650 feet). Stands occur on mesas, hills and rocky ridges. Aspects are variable with southeast and northeast reported. Slopes are gentle to moderate. The soils are variable but typically shallow, fine-textured and lithic. Clay loams are common, but soil texture ranges to clay. Litter from trees may cover up to half the ground surface. Pavement is often high with 30-40% cover. Cover of rock or bare ground may also be significant (to 25%). The vegetation is characterized by an open to dense tree canopy (10-80% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. The short-shrub layer is sparse to moderately dense (10-25% cover) and is dominated by *Artemisia nova*. *Chrysothamnus viscidiflorus* and *Gutierrezia sarothrae* are frequent associates. Other associated shrubs may include low cover of *Ephedra nevadensis, Ericameria nauseosa, Grayia spinosa*, and trace *Quercus gambelii*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Hesperostipa comata, Achnatherum thurberianum, Poa secunda*, and *Pseudoroegneria spicata ssp. inermis*. Although forb cover is generally sparse, it may be very diverse. Common forbs include *Cryptantha cinerea var. jamesii (= Cryptantha jamesii), Eriogonum caespitosum, Gilia ochroleuca, Lomatium foeniculaceum ssp. macdougalii (= Lomatium macdougalii)*, and *Sphaeralcea coccinea*. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum* or *Halogeton glomeratus*, an introduced forb.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations above 6000 feet in clayey, rocky soils and gentle to moderate slopes.

Global Environment: This woodland is known from the Great Basin. Elevations range from 1830-2030 m (6000-6650 feet). Stands occur on mesas, hills and rocky ridges Aspects are variable with southeast and northeast reported. Slopes are gentle to moderate. The soils are variable but typically shallow, fine-textured and lithic. Clay loams are common, but soil texture ranges to clay. Litter from trees often covers up to half the ground surface. Pavement is often high with 30-40% cover. Cover of rock or bare ground may also be significant (to 25%).

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Juniperus osteosperma* dominates this association with 10-30% foliar cover and heights averaging 2-5 m. Subshrubs *Artemisia nova* and *Gutierrezia sarothrae* constitute the shrub layer. Their combined cover is sparse, competing with large basalt rock deposits for available soil. *Poa secunda* commonly occurs with minimal cover.

Global Vegetation: This plant association is characterized by an open to dense tree canopy (10-80% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. The short-shrub layer is sparse to moderately dense (10-25% cover) and is dominated by *Artemisia nova*. *Chrysothamnus viscidiflorus* and *Gutierrezia sarothrae* are frequent associates. Other associated shrubs may include low cover of *Ephedra nevadensis, Ericameria nauseosa, Grayia spinosa*, and trace *Quercus gambelii*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Hesperostipa comata, Achnatherum thurberianum (= Stipa thurberiana), Poa secunda*, and *Pseudoroegneria spicata ssp. inermis*. Although forb cover is generally sparse, it may be very diverse. Common forbs include *Cryptantha cinerea var. jamesii (= Cryptantha jamesii), Eriogonum caespitosum, Gilia ochroleuca, Lomatium foeniculaceum ssp. macdougalii (= Lomatium macdougalii)*, and *Sphaeralcea coccinea*. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum* or *Halogeton glomeratus*, an introduced forb.

Global Dynamics: *Pinus monophylla* and *Juniperus osteosperma* trees are highly susceptible to fire because of highly flammable foliage, and they do not self-prune their dead branches. When burned these trees are usually killed or severely damaged and do not resprout. However, because these woodlands often have low tree density and lack fine fuel needed to spread ground fire, fire frequency is relatively low, needing extreme conditions to carry a crown fire (Bradley et al. 1992, Wright et al. 1979). *Artemisia nova* is easily killed by all fire intensities. It does not resprout and reestablishment is dependant on off-site seed sources (Wright et al. 1979). Fire frequency typically is very low because the sparse ground vegetation typically precludes the occurrence of fire and often acts as a natural firebreak.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
SHORT SHRUB	*Artemisia nova, Gutierrezia sarothrae*
GRAMINOID	*Elymus elymoides, Poa secunda*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
SHORT SHRUB	*Artemisia nova*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma*
SHORT SHRUB	*Artemisia nova*
GRAMINOID	*Poa secunda*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
SHORT SHRUB	*Artemisia nova*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the mountain ridge between Timber Creek and the Hurricane Cliffs in the Kolob Canyons area and may occur infrequently in small stands on mesas or basalt outcrops in the northern region of the park.

Global Range: This Great Basin woodland association is reported from Nevada, southwestern Utah, California, and southern Idaho.

Nations: US
States/Provinces: CA ID NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 58
Classification Confidence: 1 **Identifier:** CEGL000831
REFERENCES: Blackburn et al. 1968c, Blackburn et al. 1969c, Blackburn et al. 1969d, Bourgeron and Engelking 1994, Bradley et al. 1992, Driscoll et al. 1984, Ostler et al. 2000, Wright et al. 1979

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / ARTEMISIA TRIDENTATA WOODLAND

Singleleaf Pinyon - Utah Juniper / Big Sagebrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association occurs in the Great Basin. Elevations range from 1220-2300 m (4000-7550 feet). Stands occur on mesas, hills and rocky ridges on gentle to steep slopes on all aspects. The soils are shallow to moderately deep, calcareous, lithic loams or clays. The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. *Juniperus osteosperma* is often more abundant at lower elevation. The short-shrub layer is typically sparse (10-15% cover) and is dominated by *Artemisia tridentata*. *Chrysothamnus viscidiflorus* or *Purshia tridentata* are frequent associates. Other associated shrubs may include low cover of *Amelanchier* spp., *Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, and species of *Gutierrezia, Opuntia, Tetradymia*, and *Yucca*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Frequent graminoids are *Elymus elymoides* and *Poa secunda*. Although forb cover is generally sparse, it may be very diverse. Frequent forbs include species of *Astragalus, Balsamorhiza, Machaeranthera, Eriogonum*, and *Phlox*. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of *Pinus monophylla - Juniperus osteosperma / Artemisia tridentata* occur at an elevation of around 4000 feet on gentle to moderate slopes and sandy loam soils.

Global Environment: This woodland association occurs in the Great Basin. Elevations range from 1220-2300 m (4000-7550 feet). Stands occur on mesas, hills and rocky ridges on gentle to steep slope on all aspects. The soils are shallow to moderately deep, calcareous, lithic loams or clays. Litter from trees may cover up to half the ground surface (30-55%). Cover of rock (about 10%), pavement (10-25%), and bare ground (10-20%) are generally less.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Juniperus osteosperma* and *Pinus monophylla* codominate the canopy layer with less than 30-60% cover. Tree canopy height ranges 2-5 m. *Artemisia tridentata* dominates the shrub layer, but is usually sparse with 10-20% foliar cover. Other shrubs present in this association may include *Amelanchier utahensis, Ephedra nevadensis*, and *Ephedra viridis*. Subshrubs *Gutierrezia* spp., *Opuntia* spp., and *Yucca* spp. are commonly present with minimal cover. *Bromus tectorum* is present to abundant where this association occurs. Other graminoids that may be present are *Pleuraphis jamesii* and *Elymus elymoides*.

Global Vegetation: The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) typically codominated by *Pinus monophylla* and *Juniperus osteosperma*. *Juniperus osteosperma* is often more abundant at lower elevation. The short-shrub layer is typically sparse (10-15% cover) and is dominated by *Artemisia tridentata*. *Chrysothamnus viscidiflorus* or *Purshia tridentata* are frequent associates. Other associated shrubs may include low cover of *Amelanchier* spp., *Ephedra nevadensis, Ephedra viridis, Ericameria nauseosa, Grayia spinosa*, and species of *Gutierrezia, Opuntia, Tetradymia* and *Yucca*. The sparse to moderately dense herbaceous layer is dominated by graminoids with scattered forbs. Frequent graminoids are *Elymus elymoides* and *Poa secunda*. Other associated graminoids may include *Achnatherum hymenoides (= Oryzopsis hymenoides), Achnatherum thurberianum (= Stipa thurberiana), Koeleria macrantha, Pleuraphis jamesii*, or *Pseudoroegneria spicata*. Although forb cover is generally sparse, it may be very diverse. Common forbs include *Astragalus* spp., *Balsamorhiza sagittata, Cryptantha cinerea var. jamesii (= Cryptantha jamesii), Lomatium* spp., *Machaeranthera canescens, Eriogonum* spp., *Gayophytum ramosissimum*, and *Phlox* spp. Disturbed stands may have high cover of the introduced annual grass *Bromus tectorum*.

Global Dynamics: *Pinus monophylla* and *Juniperus osteosperma* trees and *Artemisia tridentata* are highly susceptible to fire because of highly flammable foliage, and they do not self-prune their dead branches. When burned they are killed or severely damaged and do not resprout. *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years), if a seed source is nearby (Barney and Frischknecht 1974, Bunting 1987, Wright et al. 1979). However, *Pinus monophylla* and *Juniperus osteosperma* are relatively slow to recover following fire, and sagebrush may dominate the burned sites for decades (Jameson et al. 1962). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987).

This community may be increasing in extent by invading adjacent grasslands and steppe because of reduction of fire frequency due to fire suppression and fine fuels removal by grazing livestock that would allow fires to spread (Blackburn 1967, Johnson and Payne 1968). Fire, drought and competition with grasses are thought to have kept *Juniperus* spp. communities restricted to rocky areas that do not burn frequently (Wright et al. 1979). When understory is more continuous, fires will be more frequent. The invasion of *Bromus tectorum* across the western U.S. is changing fire frequencies by providing a continuous layer of fine fuel. However, these woodlands often have low tree density, and if they lack fine fuel needed to spread ground fire, fire frequency is relatively low, needing extreme conditions to carry a crown fire (Bradley et al. 1992, Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Artemisia tridentata, Ephedra* spp.
SHORT SHRUB	*Gutierrezia* spp., *Opuntia* spp., *Yucca* spp.
GRAMINOID	*Bromus tectorum*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Artemisia tridentata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Artemisia tridentata*

Global

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus edulis*
TALL SHRUB	*Artemisia tridentata*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in small stands in sandy washes, alluvial benches and interfluves in the southwestern region of the park.

Global Range: This Great Basin association is known from Nevada and Utah.

Nations: US
States/Provinces: NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH2, RH12, RH85, RH87, RH88, 386
Classification Confidence: 2 **Identifier:** CEGL000832
REFERENCES: Barney and Frischknecht 1974, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1969b, Blackburn et al. 1969c, Bourgeron and Engelking 1994, Bradley et al. 1992, Bunting 1987, Driscoll et al. 1984, Everett 1987, Johnson and Payne 1968, Koniak 1985, Ostler et al. 2000, Wright et al. 1979

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / CERCOCARPUS MONTANUS - QUERCUS GAMBELII WOODLAND [PROVISIONAL]

Singleleaf Pinyon - Utah Juniper / Mountain-mahogany - Gambel Oak Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle to moderately steep mountain ridge slopes and low colluvial slopes. Elevations range from 4600 to 6300 feet. Soil texture was not documented, but is likely to be sandy or clay loam. Slope aspects are variable. Ground cover is mostly litter with some small and large rocks.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus monophylla* and *Juniperus osteosperma* constitute the canopy layer with 20-50% cover. Lack of *Quercus turbinella* distinguishes this association from the more widely distributed pinyon-juniper woodlands with a mixed montane shrub layer. *Cercocarpus montanus, Quercus gambelii*, and *Amelanchier utahensis* are the dominant shrubs in this association and at least two of these shrubs are present. Total shrub cover ranges from 10-70%. Common herbaceous species present are *Poa fendleriana* and *Cordylanthus* spp.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*

Global

Stratum	**Species**
Information not available.	

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*

Global

Stratum	**Species**
Information not available.	

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in the Kolob Arch quadrangle and extensively on eastern slopes of Black Ridge.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 136. AA Plots: 46, 349, 367, 369, 370, 372, 376, 384, 387, 389, 391, 395, 446, 450, 451, 453, 454, 455, 456, 457, 459, 460, 462, 463, 466, 467, 469, 470, 471, 474, 475, 476, 477
Classification Confidence: 3 **Identifier:** CEGL002968
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / COLEOGYNE RAMOSISSIMA WOODLAND [PROVISIONAL]

Singleleaf Pinyon - Utah Juniper / Blackbrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of *Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* occur on gentle to moderate sandy slopes at elevations below 4500 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus monophylla* dominates the tree layer in this association with cover of 20% and average height of 5 m. *Juniperus osteosperma* is present or may be codominant. *Coleogyne ramosissima* dominates the shrub layer and is accompanied by *Purshia tridentata, Artemisia tridentata, Ephedra nevadensis*, and *Opuntia macrorhiza*, all of minimal cover. The herbaceous layer is absent.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Coleogyne ramosissima, Purshia tridentata*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Coleogyne ramosissima*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the southwest corner of the park, specifically Springdale West quadrangle and southern low-elevation regions of the Springdale East quadrangle.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 503 & multiple AA points
Classification Confidence: 3 **Identifier:** CEGL002971
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / GUTIERREZIA SAROTHRAE / PLEURAPHIS JAMESII WOODLAND [PROVISIONAL]

Singleleaf Pinyon - Utah Juniper / Snakeweed / James' Galleta Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle to moderate slopes with mostly southeastern aspects. Elevation ranges 4200 to 4600 feet. Soil texture was not documented for this association, but it is known that this area has a clay texture to its soils. Ground cover of litter and small rocks are less than 50%, leaving 50% bare ground.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus monophylla* and *Juniperus osteosperma* constitute the tree layer with cover of 20-50%. *Gutierrezia sarothrae* is always present in a short shrub layer with an average 10% cover. A taller shrub layer, if present, has 10% cover, and commonly includes *Psorothamnus fremontii, Salvia dorrii*, and *Ephedra viridis*. The perennial grass *Pleuraphis jamesii* typically has 10% cover and may be codominant with *Aristida purpurea* and *Bromus tectorum*. This type is distinguished from *Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland by the lack of *Coleogyne ramosissima*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Psorothamnus fremontii*
DWARF SHRUB	*Gutierrezia sarothrae*
GRAMINOID	*Aristida purpurea, Bromus tectorum, Pleuraphis jamesii*

Global

Stratum	Species

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
DWARF SHRUB	*Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the Coalpits Plateau in vicinity of the Chinle Trail.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: AA Plots: 154, 155, 156, 162, 224, 229,230, 515. This association was not sampled in collection of plot data, but only observed during the Accuracy Assessment phase of project.
Classification Confidence: 3 **Identifier:** CEGL002970
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / HESPEROSTIPA COMATA WOODLAND
Singleleaf Pinyon - Utah Juniper / Needle-and-Thread Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on flat plateaus and steep colluvial slopes with commonly southern to southwestern aspects. Soil texture is sandy. Elevation ranges from 4000 to 5800 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus monophylla* and *Juniperus osteosperma* dominate the canopy layer with 20-40% cover. The shrub layer cover is less than 15%. Common shrubs that may occur are *Quercus turbinella, Amelanchier utahensis, Shepherdia rotundifolia, Ephedra viridis, Ericameria nauseosa*, and the dwarf-shrub *Gutierrezia sarothrae*. *Hesperostipa comata* is dominant in the herbaceous layer with 10-50% cover. Other graminoids that may codominate or sub-dominate are *Poa fendleriana, Bouteloua gracilis, Bouteloua eriopoda, Aristida purpurea, Bromus tectorum*, and *Muhlenbergia pungens*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
GRAMINOID	*Hesperostipa comata*

Global

Stratum	**Species**
Information not available.	

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
GRAMINOID	*Hesperostipa comata*

Global

Stratum	**Species**
Information not available.	

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments:

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in various locations south of Highway 9 that bisects the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: AA Plots: 2, 3, 14, 31, 34, 39, 111, 220, 222, 250
Classification Confidence: 3 **Identifier:** CEGL002969
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / QUERCUS TURBINELLA WOODLAND
Singleleaf Pinyon - Utah Juniper / Turbinella Live Oak Woodland

ELEMENT CONCEPT
GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION
USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations of 4000 to 6000 feet on gentle to moderately steep colluvial slopes and hillsides throughout the western side of the park. Slope aspect is generally eastern to southern. Some sites with northern aspects have been documented in Zion Canyon. Soils are sandy loam.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION
Zion National Park Vegetation: In this association, *Juniperus osteosperma* and *Pinus monophylla* codominate with 20-60% cover. Tree canopy height averages 5 m. *Quercus turbinella*, with cover of 5-50%, dominates or codominates the shrub layer with a mixture of shrubs. Other shrubs that are commonly well represented are *Amelanchier utahensis, Arctostaphylos patula*, and *Cercocarpus montanus*. Shrubs that may be present with less cover are *Arctostaphylos pungens, Purshia stansburiana, Purshia tridentata, Fraxinus anomala*, and *Quercus gambelii*. Subshrubs *Gutierrezia sarothrae, Opuntia* spp., and *Yucca* spp. are usually present with minimal cover. Herbaceous cover is minimal and inconsistent. The most commonly found forbs and graminoids are *Heterotheca villosa, Arenaria fendleri, Penstemon* spp., *Bromus tectorum*, and *Poa fendleriana*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES
Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Quercus turbinella*
SHORT SHRUB	*Gutierrezia sarothrae, Opuntia* spp., *Yucca* spp.

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES
Zion National Park

Stratum	Species
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*
TALL SHRUB	*Quercus turbinella*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS
Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: Singleleaf pinyon woodland associations are restricted to the western side of the park including Zion and Parunaweep canyons. *Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland is distributed abundantly in the Kolob Canyons, the Right and Left Fork of North Creek, Zion Canyon, Coalpits and Parunaweep Canyon. It is also found on the low-elevation mesa tops in the southwest region of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH14, RH39, RH42, RH43, 3, 6, 42, 112
Classification Confidence: 3 **Identifier:** CEGL002941
REFERENCES: None available.

PINUS MONOPHYLLA - JUNIPERUS OSTEOSPERMA / SPARSE UNDERSTORY WOODLAND

Singleleaf Pinyon - Utah Juniper / Sparse Understory Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This widespread woodland association is known from the Great Basin and northern Mojave Desert. Elevations normally range from 1370-2135 m (4500-7000 feet). Stands occur on flat to moderately sloping sites on all aspects. The soils are variable, but typically shallow and lithic. Litter from trees often covers about half the ground surface. Cover of rock, pavement or bare ground may also be significant depending on the site. The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) dominated by *Pinus monophylla* without a significant understory. *Juniperus osteosperma* may be present to codominant. Shrub cover, if present, is sparse (<10% cover). *Artemisia tridentata, Purshia tridentata*, and *Chrysothamnus viscidiflorus* are most consistent. Other shrubs include *Amelanchier* spp., *Eriogonum microthecum, Cercocarpus montanus, Gutierrezia sarothrae, Purshia tridentata, Quercus gambelii, Quercus turbinella*, and species of *Opuntia*. Herbaceous cover is typically sparse and dominated by perennial graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations ranging from 4500 to 6500 feet on all aspects of ridges, slopes, and alluvial fan deposits. Soil substrates are gravelly, rocky, or highly weathered clays at these sites.

Global Environment: This widespread woodland association is known from the Great Basin and northern Mojave Desert. Elevations normally range from 1370-2135 m (4500-7000 feet). Stands occur on flat to moderately sloping sites on all aspects. The soils are variable, but typically shallow and lithic. Litter from trees often covers about half the ground surface. Cover of rock, pavement or bare ground may also be significant depending on the site.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of *Pinus monophylla - Juniperus osteosperma* Woodland with sparse understory are scattered throughout the western region of the park. Gravelly, rocky, and weathered clays are typical of the soil substrate where this type exists. *Juniperus osteosperma* commonly has higher cover than *Pinus monophylla*. Their combined cover is 20-40%. Shrub cover is very sparse, less than 10%, and most commonly composed of *Quercus turbinella, Quercus gambelii, Amelanchier utahensis*, and *Cercocarpus montanus*. Subshrubs *Opuntia* spp. and *Gutierrezia sarothrae* are nearly always present with minimal cover. Common herbaceous species are *Pleuraphis jamesii, Bromus tectorum, Aristida purpurea, Hesperostipa comata*, and *Poa fendleriana*.

Global Vegetation: The vegetation is characterized by an open to moderately dense tree canopy (10-40% cover) dominated by *Pinus monophylla* without a significant understory. *Juniperus osteosperma* may be present to codominant. Shrub cover, if present, is sparse (<10% cover). *Artemisia tridentata, Purshia tridentata*, and *Chrysothamnus viscidiflorus* are most consistent. Other shrubs include *Amelanchier* spp., *Eriogonum microthecum, Cercocarpus montanus, Gutierrezia sarothrae, Purshia tridentata, Quercus gambelii, Quercus turbinella*, and species of *Opuntia*. Herbaceous cover is typically sparse and dominated by graminoids with scattered forbs. Associated graminoids include *Achnatherum hymenoides (= Oryzopsis hymenoides), Bouteloua gracilis, Leymus cinereus (= Elymus cinereus), Elymus elymoides, Hesperostipa comata, Achnatherum thurberianum (= Stipa thurberiana), Poa fendleriana*, or *Poa secunda*. Although forb cover is generally sparse, it may be diverse. Common forbs include *Comandra umbellata ssp. pallida (= Comandra pallida), Cryptantha cinerea var. jamesii (= Cryptantha jamesii)*, and species of *Astragalus, Eriogonum*, and *Phlox*.

Global Dynamics: *Pinus monophylla* and *Juniperus osteosperma* trees are highly susceptible to fire because of highly flammable foliage, and they do not self-prune their dead branches. When burned these trees are usually killed or severely damaged and do not resprout. However, because these woodlands often have an open canopy and sparse understory and lack fine fuels needed to spread ground fire, fire frequency is relatively low, needing extreme conditions (high winds) to carry a crown fire (Bradley et al. 1992, Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus monophylla*

GLOBAL SIMILAR ASSOCIATIONS:
- Pinus monophylla Woodland (CEGL000825)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This pinyon-juniper type may have several shrub species but all occur in small amounts usually totaling less than 10% cover.

ELEMENT DISTRIBUTION

Zion National Park Range: Singleleaf pinyon woodland associations are restricted to the western side of the park and Zion and Parunaweep canyons. *Pinus monophylla - Juniperus osteosperma* Woodland is widespread in this area and occurs on mid-elevation colluvial slopes, ridges, and alluvial fan deposits west of the Kolob Canyons and south along the western boundary of the park.

Global Range: This woodland association occurs in the Great Basin and northern Mojave Desert.

Nations: US
States/Provinces: CA NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH01, RH13, RH52, 59, 130, 137, 141
Classification Confidence: 2 **Identifier:** CEGL000829
REFERENCES: Armstrong 1969, Blackburn 1967, Blackburn et al. 1968a, Blackburn et al. 1968c, Blackburn et al. 1969c, Blackburn et al. 1969d, Blackburn et al. 1969e, Bourgeron and Engelking 1994, Bradley et al. 1992, Driscoll et al. 1984, Heinze et al. 1962, Peterson 1984, Sawyer and Keeler-Wolf 1995, Wright et al. 1979

II.A.4.N.a.32. PINUS PONDEROSA WOODLAND ALLIANCE
Ponderosa Pine Woodland Alliance

PINUS PONDEROSA / ARCTOSTAPHYLOS PATULA WOODLAND

Ponderosa Pine / Greenleaf Manzanita Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association has been reported from the mountains and plateaus in Colorado, Utah and California. Elevation ranges from 1770-2600 m (5800-8500 feet). Sites are dry, warm, mid to lower slopes, benches and ridges often with southerly aspects. Soils are typically sandy loams but vary from sand to silt loam. Parent materials are sandstone, limestone and occasionally basalt and andesite. The tree canopy is typically open (about 30% cover), but can range from 10-80% cover and is dominated by *Pinus ponderosa*. Scattered *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer. Others shrub species present may include *Amelanchier utahensis, Ceanothus* spp., *Cercocarpus montanus, Mahonia repens, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids such as *Carex rossii, Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Leymus salinus (= Elymus salinus)*, and *Poa fendleriana*. Forbs are sparse and may include *Achillea millefolium, Balsamorhiza sagittata*, and *Eriogonum racemosum*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle to moderate slopes of various aspects at elevations between 5600 and 8000 feet. It is found on high mesa tops, plateaus and Navajo sandstone formation benches and basins. Soil texture is sandy loam with moderate cover of pine needle duff.

Global Environment: This woodland association has been reported from the Colorado Plateau and eastern Sierra Nevada from mountains and plateaus in Colorado, Utah and California. Elevation ranges from 1770-2600m (5800-8500 feet). Sites are dry, warm, mid to lower slopes, benches and ridges often with southerly aspects. Soils are typically sandy loams but vary from sand to silt loam. Parent materials are sandstone, limestone and occasionally basalt and andesite.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Pinus ponderosa* dominates the tree canopy with 20-70% cover and heights 15-20 m. *Arctostaphylos patula* is always present with at least 10% cover. Various combinations of *Amelanchier utahensis, Quercus gambelii, Cercocarpus montanus, Quercus turbinella*, and *Purshia tridentata* are also present. Shrubs contribute 20-50% cover. Herbaceous cover is commonly minimal. It may be extensive when shrub cover is very low and the association occurs in a gently sloping drainage. Herbaceous species often occurring are *Heterotheca villosa, Elymus elymoides, Poa pratensis, Muhlenbergia pungens, Bouteloua gracilis*, and *Poa fendleriana*. This association is often found adjacent to *Pinus ponderosa* Slickrock Sparse Vegetation and *Cercocarpus intricatus* Slickrock Sparse Vegetation.

Global Vegetation: This woodland association is characterized by a tree canopy that is typically open (about 30% cover), but can range from 10-80% cover and is dominated by *Pinus ponderosa*. Scattered *Juniperus scopulorum* trees may also be present. *Arctostaphylos patula* dominates the moderate to sparse shrub layer. Others shrub species present may include *Amelanchier utahensis, Ceanothus* spp., *Cercocarpus montanus, Mahonia repens, Purshia tridentata, Quercus gambelii, Symphoricarpos oreophilus*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids such as *Carex rossii, Achnatherum hymenoides (= Oryzopsis hymenoides), Elymus elymoides, Leymus salinus (= Elymus salinus)*, and *Poa fendleriana*. Forbs are sparse and may include *Achillea millefolium, Balsamorhiza sagittata*, and *Eriogonum racemosum*.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
TALL SHRUB	*Arctostaphylos patula*

Global

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Pinus ponderosa*
SHORT SHRUB	*Arctostaphylos patula*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus osteosperma, Pinus edulis, Pinus ponderosa*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Purshia tridentata, Quercus gambelii, Quercus turbinella*

Global

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
SHORT SHRUB	*Arctostaphylos patula*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This plant association is seral in California.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is widespread at the higher elevations in Zion National Park, specifically at Langston Mountain, Horse Pasture Plateau, Lower Kolob Terrace, Dakota Hill, Jolly Gulch, and the southeast Navajo sandstone region of the park.

Global Range: This coniferous woodland association has been reported from the Colorado Plateau and eastern Sierra Nevada.

Nations: US
States/Provinces: CA? CO UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH59, RH80, 31, 44, 72, 208
Classification Confidence: 2 **Identifier:** CEGL000842
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Graybosch and Buchanan 1983, Johnston 1987, Roberts et al. 1992, Youngblood and Mauk 1985

PINUS PONDEROSA / ARTEMISIA NOVA WOODLAND

Ponderosa Pine / Black Sagebrush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This woodland association is found in the mountains and plateaus in southern Utah. Stands occur on gentle lower slopes and benches with various aspects. Elevation ranges from 2340-2750 m (7660-9000 feet). Substrates are typically shallow, gravelly loam or silt loam soils derived from basalt. The tree canopy is open (10-30% cover) and is dominated by *Pinus ponderosa*. Scattered *Juniperus scopulorum* or *Pinus flexilis* trees may also be present. *Artemisia nova* or *Artemisia arbuscula* dominates the typically sparse dwarf-shrub layer. Others shrub species present may include *Purshia tridentata, Chrysothamnus viscidiflorus, Ericameria parryi, Gutierrezia sarothrae, Quercus gambelii*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids with scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations ranging 6900 to 7900 feet on volcanic rock, clay soils, and gentle slopes.

Global Environment: This woodland association is known from the mountains and plateaus in southern Utah. Stands occur on gentle lower slopes and benches with various aspects. Elevation ranges from 2340-2750 m (7660-9000 feet). Substrates are typically shallow, gravelly loam or silt loam soils derived from basalt, often with an impermeable subsurface horizon that restricts rooting. Some sites are known to have seasonally high water tables.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus ponderosa* dominates this association with 10-30% cover. *Artemisia nova* has 10-20% cover and is evenly distributed in the stand. Clumps of *Quercus gambelii* are scattered and contribute less than 10% cover. Herbaceous species contribute minimal cover. Prominent species are *Carex rossii, Elymus elymoides*, and *Poa secunda*. Dense stands of *Quercus gambelii* occur adjacent to this association.

Global Vegetation: This association is characterized by an open tree canopy (10-30% cover) that is dominated by *Pinus ponderosa*. Scattered *Juniperus scopulorum* or *Pinus flexilis* trees may also be present. *Artemisia nova* or *Artemisia arbuscula* dominates the typically sparse dwarf-shrub layer. Others shrub species present may include *Purshia tridentata, Chrysothamnus viscidiflorus, Ericameria parryi, Gutierrezia sarothrae, Quercus gambelii*, and *Tetradymia canescens*. The sparse herbaceous layer (<20% cover) is primarily composed of graminoids with scattered forbs such as *Achnatherum hymenoides, Bouteloua gracilis, Carex rossii, Elymus elymoides, Leymus salinus (= Elymus salinus), Piptatherum micranthum, Poa fendleriana, Poa secunda, Eriogonum alatum, Eriogonum racemosum, Opuntia* spp., and *Penstemon caespitosus*.

Global Dynamics: These woodlands are thought to have a longer fire-return interval than other *Pinus ponderosa*-dominated woodlands because of the presence of *Artemisia nova*, which is easily killed by all fire intensities (Roberts et al. 1992). *Artemisia nova* does not sprout after burning; sites must be re-established by seed from off-site plants. However, the typically sparse cover of most black sagebrush occurrences precludes the occurrence of fire and may act as natural firebreaks (FEIS 2001).

When exposed to fire, West and Hassan (1985) found no evidence of *Artemisia nova* re-establishment up to 2 years following a late-July fire. Most black sagebrush seeds are dispersed close to the parent plant; therefore, mosaic burning patterns which leave unburned patches speed recovery. Favorable precipitation following burning also aids in seedling establishment (Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
TALL SHRUB	*Quercus gambelii*
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Carex rossii, Elymus elymoides, Poa secunda*

Global

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
DWARF SHRUB	*Artemisia nova*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
DWARF SHRUB	*Artemisia nova*

Global

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
DWARF SHRUB	*Artemisia nova*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the Upper and Lower Kolob plateaus of the northern part of Zion National Park.

Global Range: This association occurs in the mountains and plateaus in southern Utah.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 89. AA plots: 317 (possibly a few more)
Classification Confidence: 2 **Identifier:** CEGL000846
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Johnston 1987, Roberts et al. 1992, West and Hassan 1985, Wright et al. 1979, Youngblood and Mauk 1985

PINUS PONDEROSA / BROMUS INERMIS SEMI-NATURAL WOODLAND

Ponderosa Pine / Smooth Brome Semi-natural Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on a gently eastern sloping drainage of Horse Pasture plateau on moderately well-drained sandy loam soil. Elevation is 6700 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Spring snowmelt provides seasonally saturated soils in the shallow and wide drainage of Corral Hollow setting up favorable conditions for 40% cover of *Bromus inermis* and presence of *Poa pratensis*. Mature *Pinus ponderosa* solely represents the tree canopy with over 20% cover and heights of over 20 m. Other characteristic species present are *Heterotheca villosa, Lupinus argenteus, Lotus utahensis*, and *Achillea millefolium*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Pinus ponderosa*
GRAMINOID	*Bromus inermis*

Global

Stratum	Species

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Pinus ponderosa*
GRAMINOID	*Bromus inermis, Poa pratensis*
FORB	*Heterotheca villosa, Lotus utahensis, Lupinus argenteus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association has been documented in Corral Hollow on Horse Pasture Plateau and observed on the East Rim of Zion National Park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 97
Classification Confidence: 3 **Identifier:** CEGL002943
REFERENCES: None available.

PINUS PONDEROSA / PTERIDIUM AQUILINUM WOODLAND [PROVISIONAL]
Ponderosa Pine / Northern Bracken Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Small stream channels meander through Pine Valley from the Upper Kolob Plateau feeding ponderosa pine woodlands and grassland meadows at an elevation of 6900 feet. Following a prescribed surface fire in 1998, bracken fern established as dense understory vegetation. The terrain is gentle with moderately well-drained sandy soils.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pinus ponderosa* has 50-60% canopy cover with an understory dominated by *Pteridium aquilinum* at 80% foliar cover. Grasses and forbs are present and contribute less than 5% cover. Where openings in the canopy of the mature ponderosa pine occur, grasses and sedges dominate mesic meadows.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
FERN	*Pteridium aquilinum*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
FERN	*Pteridium aquilinum*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This unique association was documented at the base of a sandstone outcrop, Pocket Mesa, in Pine Valley of Zion National Park. This association occurs infrequently in small mesic pockets of ponderosa pine woodlands.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 93 Park Special
Classification Confidence: 3 **Identifier:** CEGL002944
REFERENCES: None available.

PINUS PONDEROSA / QUERCUS GAMBELII WOODLAND
Ponderosa Pine / Gambel Oak Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This major woodland association is widespread and has been reported from foothills, mountains and plateaus from Colorado to Texas, west to Arizona and Nevada. Elevation ranges from 1830-2800 m (6000-9200 feet). Stands often occur along drainages, on lower and middle slopes and benches on all aspects. Soils are typically shallow and rocky ranging from sandy loams to clay loams. *Pinus ponderosa* dominates the sparse to moderately dense tree canopy sometimes with scattered *Pinus edulis* and *Juniperus* spp. and rarely *Pseudotsuga menziesii*. *Abies concolor* is not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the typically moderately dense tall-shrub layer consisting of dense clumps of oak. *Quercus gambelii* must have at least 5% cover, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in the short-shrub layer. At lower elevations, scattered *Artemisia tridentata ssp. vaseyana, Pinus edulis*, and *Juniperus osteosperma* are often present. Other common shrub species may include *Amelanchier* spp., *Mahonia repens*, and *Rosa woodsii*. The herbaceous layer is generally sparse and composed of mostly graminoids and scattered forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations between 5700 and 8000 feet on gently sloping terrain of mesas and plateaus. Soils are variable, ranging from sand to clay loam.

Global Environment: This woodland association is widespread and has been reported from foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Nevada. Elevation ranges from 1830-2800 m (6000-9200 feet). Stands often occur along drainages, on lower and middle slopes and benches on all aspects. Slopes are typically gentle or moderate, but may also be steep (>45%). Soils are typically shallow and rocky ranging from sandy loams to clay loams. Parent materials are commonly sandstones, but fractured limestone, basalt, andesite, and alluvium are also reported. High litter cover (70-90%) about 5 cm deep is common in many stands. Rock outcrops (about 10%) and some bare soil are not uncommon. This conifer woodland transitions to *Quercus gambelii* shrubland in drier sites and at lower elevations. This community is the highest elevation *Pinus ponderosa* / oak woodland present in Trans-Pecos Texas. It typically grades downslope to *Pinus ponderosa / Quercus hypoleucoides* Woodland (CEGL000872).

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Pinus ponderosa* has at least 20% cover and average height of 15-20 m. *Juniperus scopulorum* is occasionally present and in some cases has significant cover. *Quercus gambelii* is present as a tall and/or short shrub. Other shrubs commonly present with variable cover include *Arctostaphylos patula, Amelanchier utahensis, Purshia tridentata, Symphoricarpos oreophilus, Artemisia tridentata, Mahonia repens*, and *Artemisia nova*. Herbaceous cover is usually low, but has been observed with up to 40% cover. Common herbaceous species are *Poa fendleriana, Elymus elymoides, Heterotheca villosa, Carex rossii, Penstemon* spp., *Hymenopappus filifolius, Packera multilobata*, and *Arenaria fendleri*.

Global Vegetation: This broadly defined coniferous woodland is widespread and is characterized by a sparse to moderately dense, evergreen needle-leaved tree canopy dominated by *Pinus ponderosa*, sometimes with scattered *Pinus edulis, Juniperus scopulorum*, in southern stands and *Juniperus deppeana* and *Pinus strobiformis*. *Pseudotsuga menziesii* is accidental and *Abies concolor* is not present. *Quercus gambelii* dominates both the subcanopy (tree form, if present) and the typically moderately dense tall-shrub layer, which consists of dense clumps of oak. This community must have at least 5% cover of *Quercus gambelii*, but there is frequently over 25%. At higher elevations, the *Quercus gambelii* are more tree-like and *Symphoricarpos oreophilus* will be present with significant cover in a short-shrub layer. At lower elevations, scattered *Artemisia tridentata ssp. vaseyana, Pinus edulis*, and *Juniperus osteosperma* are often present. Other common shrub species may include *Arctostaphylos patula, Amelanchier* spp., *Cercocarpus montanus, Juniperus communis, Mahonia repens, Robinia neomexicana, Rosa woodsii*, and *Shepherdia rotundifolia*. The herbaceous layer is generally sparse (<10% cover), but may equal the shrub cover. It is composed of mostly graminoids such as *Bouteloua gracilis, Elymus elymoides, Festuca arizonica, Koeleria macrantha, Muhlenbergia longiligula, Muhlenbergia montana, Poa fendleriana, Schizachyrium scoparium*, and *Carex* spp., especially *Carex geyeri* and *Carex rossii*. Scattered forbs include *Artemisia ludoviciana,* *Balsamorhiza sagittata, Eriogonum* spp., *Erigeron* spp., *Hymenoxys* spp., *Lithospermum multiflorum, Packera multilobata*, and *Wyethia amplexicaulis*.

Global Dynamics: *Pinus ponderosa* is a drought-resistant, shade-intolerant conifer that when mature has thick bark that allows it to withstand ground fires (Bradley et al. 1992). Natural fire frequency is estimated to be 3-20 years for this community (Young and Mauk 1982). *Quercus gambelii* is a fire-adapted species (Clary 1992). The root systems are well-developed and draw moisture from a large volume of soil allowing for rapid resprouting after fire. Both species are well-adapted to relatively frequent ground fires that prevent *Pseudotsuga menziesii* or *Abies concolor* from regenerating.

These woodlands grade into *Abies concolor / Quercus gambelii* Forest (CEGL000261) or *Pseudotsuga menziesii / Quercus gambelii* Forest (CEGL000452) as sites become cooler and wetter (DeVelice et al. 1986). Mosaics of *Pinus ponderosa* stands with grass- or oak-dominated understories occur in response to different substrates with *Quercus gambelii* dominating the rocky sites and grass understory woodland types (*Festuca* spp., *Muhlenbergia montana*) in areas with deeper soils (DeVelice et al. 1986, Peet 1981).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
TALL SHRUB	*Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
TALL SHRUB	*Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Pinus ponderosa*
TALL SHRUB	*Arctostaphylos patula, Quercus gambelii*

Global

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*
TALL SHRUB	*Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:

- Abies concolor / Quercus gambelii Forest (CEGL000261)
- Pseudotsuga menziesii / Quercus gambelii Forest (CEGL000452)
- Pinus edulis - Juniperus spp. / Quercus gambelii Woodland (CEGL000791)
- Pinus monophylla - Juniperus osteosperma - Quercus gambelii / Artemisia tridentata Woodland (CEGL000837)
- Pinus monophylla - Quercus gambelii / Artemisia tridentata Woodland (CEGL000838)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: Stands of *Pinus ponderosa / Quercus gambelii* are widespread at high elevations in Zion National Park. This association was sampled on mesas and plateaus of Kolob Arch, Guardian Angels, Kolob Reservoir, and Temple of Sinawava quadrangles.

Global Range: This ponderosa pine woodland association is widespread in the southern Rocky Mountains and southwestern U.S. and occurs in foothills, mountains and plateaus from Colorado to Trans-Pecos Texas, west to Arizona and Nevada.

Nations: US
States/Provinces: AZ CO NM NV TX UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH10, RH48, RH54, RH62, RH89, 101, 203, 257, 258, 264, 372
Classification Confidence: 1 **Identifier:** CEGL000870

REFERENCES: Alexander et al. 1984a, Alexander et al. 1987, Bader 1932, Blackburn et al. 1969d, Blackburn et al. 1969e, Bourgeron and Engelking 1994, Bradley et al. 1992, Bunin 1975c, Clary 1992, DeVelice et al. 1986, Diamond 1993, Dixon 1935, Donart et al. 1978a, Driscoll et al. 1984, Fitzhugh et al. 1987, Hanks et al. 1983, Hanson and Ball 1928, Harmon 1980, Helm 1977, Hess and Wasser 1982, Johnston 1987, Johnston and Hendzel 1985, Larson and Moir 1987, Marr et al. 1973a, Muldavin et al. 1996, Peet 1975, Peet 1981, Roberts et al. 1992, Schmoll 1935, Somers et al. 1980, Steinhoff 1978, Terwilliger et al. 1979a, USFS 1983b, Wasser and Hess 1982, Wright et al. 1973, Youngblood and Mauk 1985

II.B.2.N.a. Cold-deciduous woodland

II.B.2.N.a.402. ELAEAGNUS ANGUSTIFOLIA SEMI-NATURAL WOODLAND ALLIANCE

Russian-olive Semi-natural Woodland Alliance

ELAEAGNUS ANGUSTIFOLIA SEMI-NATURAL WOODLAND
Russian-olive Semi-natural Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This widespread Russian-olive woodland type is found in the northern Great Plains, Utah, and probably throughout much of the western United States and adjacent Canada. It is a naturalized type that has been widely planted in hedgerows for windbreaks. It has since spread to a variety of native habitats, particularly more mesic ones, such as near streams and rivers. The vegetation is dominated by *Elaeagnus angustifolia*. In Badlands National Park, this type occupies a portion of shoreline along the White River, upstream of a highway bridge. In Ouray National Wildlife Refuge in Utah these woodlands are found in the floodplain along the Green River and in upland basins and drainages. Stands tend to be small and linear, with canopy cover varying from 40% to well over 80%. The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Associated species have not been thoroughly characterized, but can include the shrubs *Salix exigua, Tamarix ramosissima,* and *Amorpha fruticosa,* as well as a variety of herbaceous species, many of them introduced, such as*Pascopyrum smithii, Sporobolus airoides, Distichlis spicata*, *Hordeum jubatum, Lepidium latifolium, Descurainia sophia*, and *Bassia scoparia (= Kochia scoparia)*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was not sampled at Zion NP, but occurred in the environs and was mapped.

Global Environment: This type is naturalized, probably spreading as a result of being widely planted in hedgerows for windbreaks. It has spread to a variety of native habitats, particularly more mesic ones, such as near streams and rivers. In Badlands National Park, this type occupies a portion of shoreline along the White River, upstream of a highway bridge (Von Loh et al. 1999). In Ouray National Wildlife Refuge in Utah these woodlands are found in the floodplain along the Green River and in upland basins and drainages (Von Loh et al. 2002). Stands tend to be small and linear. Adjacent vegetation includes other riparian shrublands and wetlands dominated by *Salix exigua* or *Schoenoplectus* spp. Upland vegetation is variable.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association was not sampled at Zion NP, but occurred in the environs and was mapped.

Global Vegetation: The vegetation is dominated by the tree *Elaeagnus angustifolia* with a variety of native and introduced species in the shrub and herbaceous layers. Associated species have not been characterized. In a stand in Badlands National Park of South Dakota, *Elaeagnus angustifolia* is dominant. Canopy closure approaches 40-50%, about equal to the tall-shrub cover provided by *Salix exigua*. *Amorpha fruticosa* and *Pascopyrum smithii* make up the short-shrub and herbaceous cover, which are less than 10%. At Ouray National Wildlife Refuge in Utah, tree canopies were denser to (80% cover) and had remnant *Populus fremontii* trees (to 10% cover). Other than a few native grasses (*Sporobolus airoides, Distichlis spicata*, and *Hordeum jubatum*) and *Atriplex patula* in the herbaceous layer, the understory was dominated by introduced species, both in the moderately dense to dense tall-shrub layer (*Tamarix ramosissima*) and in the herbaceous layer (*Lepidium latifolium, Descurainia sophia*, and *Bassia scoparia* (= *Kochia scoparia*) (Von Loh et al. 2002).

Global Dynamics: *Elaeagnus angustifolia* has been planted widely across the western U.S. in windbreaks and as an ornamental. This tree species has bird-dispersed seeds and has invaded riparian woodlands extensively, replacing the native tree species, especially where flood control efforts limit regeneration of native trees such as *Populus deltoides* and *Populus fremontii*.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Elaeagnus angustifolia*
TALL SHRUB	*Tamarix ramosissima*
GRAMINOID	*Bromus rigidus, Poa pratensis*

Global

Stratum	**Species**
TREE CANOPY	*Elaeagnus angustifolia*
TALL SHRUB	*Tamarix ramosissima, Salix exigua*
SHORT SHRUB	*Amorpha fruticosa*
GRAMINOID	*Pascopyrum smithii, Bromus inermis, Poa pratensis*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Elaeagnus angustifolia*

Global

Stratum	**Species**
TREE CANOPY	*Elaeagnus angustifolia*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Bromus tectorum*

GLOBAL SIMILAR ASSOCIATIONS:
- Populus fremontii / Salix exigua Forest (CEGL000666)
- Populus deltoides - (Salix amygdaloides) / Salix (exigua, interior) Woodland (CEGL000659)
- Populus deltoides ssp. wislizeni / Baccharis sarothroides Forest (CEGL000663)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: *Populus deltoides*- and *Populus fremontii*-dominated associations may have significant cover of *Elaeagnus angustifolia* in the tree canopy, but are generally considered native woodlands until *Elaeagnus angustifolia* comprises over 80-90% of the tree cover. Some stands have a nearly closed tree canopy (80% cover), or may have significant gaps in the tree canopy.

ELEMENT DISTRIBUTION

Zion National Park Range: This was not sampled at Zion NP, but occurred in the environs and was mapped. It likely occurs in lowlands along stream channels and in disturbed riparian forest in canyons.

Global Range: This widespread Russian-olive woodland type is reported from the northern Great Plains, Utah, and probably occurs throughout much of the western United States and adjacent Canada along rivers and streams where it replaces the native *Populus* spp.- and *Acer negundo*-dominated forests and woodlands.

Nations: US
States/Provinces: ND SD UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: None
Classification Confidence: 3 **Identifier:** CEGL005269
References: Great Plains Flora Association 1986, Von Loh et al. 1999, Von Loh et al. 2002

II.B.2.N.b. Temporarily flooded cold-deciduous woodland

II.B.2.N.b.10. ACER NEGUNDO TEMPORARILY FLOODED WOODLAND ALLIANCE

Box-elder Temporarily Flooded Woodland Alliance

ACER NEGUNDO / BRICKELLIA GRANDIFLORA WOODLAND [PROVISIONAL]

Box-elder / Tasselflower Brickelbush Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs on a narrow valley floor at an elevation of 5500 feet on sandy soils.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Acer negundo* has a canopy cover of 20-30% and heights ranging from 5-15 m. Shrubs are scarce or absent. The herbaceous layer has significant cover of *Brickellia grandiflora*. Other herbaceous species present are variable and contribute minimal cover.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Acer negundo*
FORB	*Brickellia grandiflora*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Acer negundo*
FORB	*Brickellia grandiflora*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs along the South Fork of Taylor Creek in Kolob Canyons of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH75, RH76
Classification Confidence: **Identifier:** CEGL002692
REFERENCES: None available.

ACER NEGUNDO / DISTURBED UNDERSTORY WOODLAND [PROVISIONAL]
Box-elder / Disturbed Understory Woodland

ELEMENT CONCEPT
GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION
USFWS Wetland System: PALUSTRINE

Zion National Park Environment: Mature stands of *Acer negundo* occupy flat to gentle sloping stream terraces above the stream channel at elevations of 5500-5700 feet. Soils are sandy and well-drained.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION
Zion National Park Vegetation: This association occurs frequently on stream terraces or cut banks well above the current stream channel and at the base of colluvial slopes in Lee Valley and Hop Valley. *Acer negundo* is mature, many-stemmed and sprawling. A few trees provide 10-30% cover and average 10 m in height. Shrubs present include *Prunus virginiana* and *Quercus gambelii*. The understory is variable and dominated by the exotic grass *Bromus tectorum*. Other grasses that may be present include *Sporobolus cryptandrus, Poa pratensis*, and *Poa fendleriana*. Forbs may include *Senecio spartioides, Verbascum thapsus, Phacelia heterophylla, Solidago velutina, Sisymbrium altissimum*, and *Tradescantia occidentalis*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES
Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo*
GRAMINOID	*Bromus tectorum*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES
Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo*
GRAMINOID	*Bromus tectorum*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS
Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on stream terraces along Timber Creek and Hop Valley.

Global Range: This association has currently only been described from Zion NP in southwestern Utah. However, it is likely to be widely distributed across the Colorado Plateau region, and elsewhere in the southwestern U.S.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 26, 77, 81
Classification Confidence: **Identifier:** CEGL002693
REFERENCES: None available.

II.B.2.N.b.400. FRAXINUS ANOMALA TEMPORARILY FLOODED WOODLAND ALLIANCE

Single-leaf Ash Temporarily Flooded Woodland Alliance

FRAXINUS ANOMALA WOODLAND

Single-leaf Ash Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This locally occurring association is found in deep canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado. This vegetation is restricted to mesic sites such as near seeps, springs and ephemeral stream channels, or on lower colluvial slopes where additional soil moisture is available. Substrates often are derived from colluvium and have large amounts of gravel and cobbles. Parent material is typically sandstone. The vegetation is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub canopy that is dominated by *Fraxinus anomala* with *Quercus gambelii* codominating the Colorado stand. Associated shrubs include *Amelanchier alnifolia, Ericameria nauseosa, Holodiscus dumosa, Rhus trilobata*, and *Symphoricarpos rotundifolius.* Herbaceous species are variable and contribute minimal cover.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 4300 feet in a moderately steep, east-facing drainage. Soil texture is loamy sand.

Global Environment: This woodland association is found in deep canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado. Elevation ranges from 1430-2000 m (4300-5825 feet). Climate is semi-arid; however, this vegetation is restricted to mesic sites such as near seeps, springs and ephemeral stream channels, or on lower colluvial slopes where additional soil moisture is available. Substrates often are derived from colluvium and have large amounts of gravel and cobbles. Parent material is typically sandstone.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association, though only documented once in the park, likely occurs in small pockets where moisture collects at the base of boulders in ravines and colluvial slopes. *Fraxinus anomala* is dominant with 30% cover and heights of approximately 5 m. Shrubs that are likely to occur are *Amelanchier alnifolia, Rhus trilobata*, and *Ericameria nauseosa*. Herbaceous species are variable and contribute minimal cover.

Global Vegetation: This association is characterized by a moderately dense (30-50%) cold-deciduous tall-shrub canopy that is dominated by *Fraxinus anomala* with *Quercus gambelii* codominating the Colorado stand. Associated shrubs include *Amelanchier alnifolia, Ericameria nauseosa, Holodiscus dumosa, Rhus trilobata*, *Symphoricarpos rotundifolius,* and the vine *Vitis arizonica*. Herbaceous species are variable and contribute minimal cover. Common species include *Achnatherum hymenoides,* Asteraceae spp., *Eriogonum* spp., and *Poa fendleriana*.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Fraxinus anomala*

Global

Stratum	Species
TALL SHRUB	*Fraxinus anomala, Quercus gambelii, Amelanchier alnifolia*
SHORT SHRUB	*Ericameria nauseosa, Rhus trilobata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier alnifolia, Fraxinus anomala*
SHORT SHRUB	*Ericameria nauseosa, Rhus trilobata*

Global

Stratum	**Species**
TALL SHRUB	*Fraxinus anomala*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GUQ.

Global Comments: This association is known from only 2 stands, one on the Roan Plateau in western Colorado and one in Zion National Park. More survey and classification work are needed to fully describe this association rangewide. *Fraxinus anomala* is present in many montane shrubland and woodland communities on the Colorado Plateau, but is only a dominant species in this association.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in drainage that empties into Shune's Creek at the western border of the park.

Global Range: This woodland association occurs in canyons and mountains on the Colorado Plateau in southwestern Utah and western Colorado, and may occur in similar habitats in Arizona and New Mexico.

Nations: US
States/Provinces: AZ? CO NM? UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 523. This association was never seen again during Accuracy Assessments.
Classification Confidence: 3 **Identifier:** CEGL002752
REFERENCES: Kittel et al. 1999b, Welsh et al. 1987

II.B.2.N.b.12. POPULUS FREMONTII TEMPORARILY FLOODED WOODLAND ALLIANCE

Fremont Cottonwood Temporarily Flooded Woodland Alliance

POPULUS FREMONTII - FRAXINUS VELUTINA WOODLAND

Fremont Cottonwood - Velvet Ash Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This is a lowland forested riparian association known from central and southeastern Arizona, southwestern New Mexico and southwestern Utah. Elevations range from 1200-1550 m . Sites are typically rocky or sandy banks of moderate-gradient streams (1.5%) that are frequently flooded (two-year recurrence interval). Soils have been reported as coarse-loamy over fragmental Typic Torrifluvents, and as cobbly riverwash, reflecting the coarse substrates of sites. *Populus fremontii* and *Fraxinus velutina* codominate young, moderate to dense canopies (>50% cover). *Acer negundo, Salix gooddingii, Juglans major, Alnus oblongifolia*, and *Celtis laevigata var. reticulata* are occasional canopy or subcanopy associates. Undergrowth is moderately diverse, but cover is low. In the shrub layer there are usually scattered individuals of *Baccharis salicifolia* and *Amorpha fruticosa*. The herbaceous layer has sparse to moderate cover. Common associates may include *Juncus saximontanus, Sphenopholis obtusata, Sporobolus cryptandrus, Muhlenbergia wrightii*, and *Datura wrightii*. Disturbed stands often have high cover of the introduced *Bromus diandrus, Bromus tectorum*, or some other exotics.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs on sandy alluvial terraces and streambanks. Slopes are gentle to moderate at elevations around 4000 feet. On the edge of its range, in Pine Creek Wash, it occurs at a higher elevation in the cool drainage or ravine.

Global Environment: This is a lowland forested riparian association known from central and southeastern Arizona, southwestern New Mexico and southwestern Utah. Elevations range from 1200-1550 m . Sites are typically rocky or sandy banks of moderate-gradient streams (1.5%) that are frequently flooded (two-year recurrence interval). However, stands are also reported from higher elevations in cool drainages or ravines. Soils have been reported as coarse-loamy over fragmental Typic Torrifluvents, and as cobbly riverwash, reflecting the coarse substrates of sites.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is widespread along the Virgin River in Zion Canyon, which is heavily disturbed from human activity. Herbaceous cover in the river corridor is strongly dominated by exotic species *Bromus diandrus* and *Bromus tectorum*. Native species in the understory have minimal cover and are inconsistent and, thus, cannot be described as regular inhabitants here. *Populus fremontii* is present in the floodplain and widely spaced on the riverbank. Mature trees emerge from the canopy at more than 20 m in height and contribute 10-30% foliar cover. Young cottonwood may be present in the subcanopy layer. *Acer negundo* contributes 1-20% cover in the subcanopy and usually co-exists with abundant *Fraxinus velutina*. *Quercus gambelii* in tree form may also contribute significant cover to the subcanopy. Total canopy cover is 30-60%. In some cases, it may be higher, as in Pine Creek Wash, where canopy cover is nearly 100%, and a lush, comparatively undisturbed understory exists. At this middle elevation, cool drainage, *Populus angustifolia* is a major contributor to the canopy cover.

Global Vegetation: This riparian association is characterized by an open to moderately dense canopy (20-60% cover) that is codominated by large *Populus fremontii* and *Fraxinus velutina* trees. *Acer negundo, Salix gooddingii, Juglans major, Alnus oblongifolia, Celtis laevigata var. reticulata*, and *Populus angustifolia* (at higher elevations) are occasional canopy associates, but may be more common in the subcanopy (if present). Undergrowth is moderately diverse, but cover is low. In the shrub layer there are usually scattered individuals of *Amorpha fruticosa, Baccharis salicifolia*, and several other shrubs including *Baccharis emoryi, Brickellia californica*, and *Ericameria nauseosa*. The herbaceous layer has sparse to moderate cover. Common associates may include *Juncus saximontanus, Sphenopholis obtusata, Sporobolus cryptandrus, Muhlenbergia wrightii*, and *Datura wrightii*. Disturbed stands often have high cover of the introduced *Bromus diandrus, Bromus tectorum*, or some other exotics.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo, Fraxinus velutina, Populus fremontii, Quercus gambelii*
GRAMINOID	*Bromus diandrus, Bromus tectorum*

Global

Stratum	**Species**
TREE CANOPY	*Acer negundo, Fraxinus velutina, Populus fremontii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Acer negundo, Fraxinus velutina, Populus fremontii*

Global

Stratum	**Species**
TREE CANOPY	*Fraxinus velutina, Populus fremontii*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Bromus diandrus, Bromus tectorum*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G2G3.

Global Comments: Szaro (1989) describes a *Populus fremontii - Fraxinus pennsylvanica* Community Type that is synonymous. Similarly, Boles and Dick-Peddie (1983) report *Populus fremontii - Fraxinus pennsylvanica* type in the Mimbres watershed that is possibly also synonymous.

ELEMENT DISTRIBUTION

Zion National Park Range: Stands of *Populus fremontii - Fraxinus velutina* are common along the Virgin River from the top of Zion Canyon to the Visitors Center. Small stands of similar species composition occur on permanent streams in the park, specifically Pine Creek Wash, a tributary of the Left Fork of the North River.

Global Range: This association occurs in lowlands of southwestern New Mexico, southern Arizona, southwestern Utah, and may occur in western Texas.

Nations: US
States/Provinces: AZ NM TX? UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH15, RH 21, RH40, 2, 145
Classification Confidence: 2 **Identifier:** CEGL000942
REFERENCES: Boles and Dick-Peddie 1983, Bourgeron and Engelking 1994, Driscoll et al. 1984, Muldavin et al. 2000a, Szaro 1989

POPULUS FREMONTII / BACCHARIS EMORYI WOODLAND [PROVISIONAL]

Fremont Cottonwood / Emory Seepwillow Woodland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs on flat, sandy streambanks and terraces at elevations around 4000 feet. River or stream water is present year round and the floodplain is broad.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This riparian association is heavily impacted by human disturbance. Stands of *Populus fremontii* along the Virgin River are mature with no apparent regeneration occurring. Cottonwoods are 10-15 m tall and average 30% foliar cover. *Baccharis emoryi* grows in close proximity to the river, its cover ranging from 5-80%. *Salix* spp. often exist with the Emory seepwillow, but with minimal cover. Shrubs that occur farther up the stream's bank are *Ericameria nauseosa* and *Artemisia filifolia*. The herbaceous layer is sparse and dominated by exotics in Zion Canyon and farther downstream along the Virgin River. Stands that occur in the moderately disturbed Right Fork of North Creek have herbaceous cover of nearly 50%, though exotic herbaceous species are still prevalent.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Populus fremontii*
SHORT SHRUB	*Baccharis emoryi, Ericameria nauseosa*
GRAMINOID	*Bromus diandrus, Bromus tectorum, Muhlenbergia asperifolia*
FORB	*Melilotus officinalis*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Populus fremontii*
SHORT SHRUB	*Baccharis emoryi*

Global

Stratum	Species

Information not available.

OTHER NOTEWORTHY SPECIES

Zion National Park

Salix spp. are also dominant and diagnostic.

Global

Stratum	Species

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on streambanks in the Virgin River corridor and Right Fork of North Creek.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH22, RH23, RH46, RH84, 17, 142
Classification Confidence: **Identifier:** CEGL002946
REFERENCES: None available.

III. SHRUBLAND

III.A.2.N.c. Sclerophyllous temperate broad-leaved evergreen shrubland

III.A.2.N.c.35. ARCTOSTAPHYLOS PATULA SHRUBLAND ALLIANCE
Greenleaf Manzanita Shrubland Alliance

ARCTOSTAPHYLOS PATULA - ARTEMISIA TRIDENTATA SSP. VASEYANA SHRUBLAND

Greenleaf Manzanita - Mountain Big Sagebrush Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 6400 feet on gentle east-facing slopes of a small isolated mesa. Soil texture is loamy sand.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This shrubland was only documented at one site in Zion National Park. It is likely to occur in equally remote areas in the near vicinity. *Arctostaphylos patula* dominates this shrubland as it does on mesa tops throughout the park. In this association, however, *Artemisia tridentata ssp. vaseyana* is codominant. Total shrub cover is over 60%. *Quercus gambelii* is a likely component of this shrubland. Other shrubs that may occur are *Tetradymia canescens, Ericameria nauseosa, Yucca* spp., and *Opuntia* spp. The herbaceous layer is very sparse, but will commonly include *Comandra umbellata, Eriogonum umbellatum, Poa fendleriana*, and *Bouteloua gracilis*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Arctostaphylos patula, Artemisia tridentata ssp vaseyana, Quercus gambelii*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Arctostaphylos patula, Artemisia tridentata ssp vaseyana, Quercus gambelii*
FORB	*Comandra umbellata, Eriogonum umbellatum*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
- Tetradymia canescens - Ephedra viridis Shrubland (CEGL002973)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was found on an unnamed mesa south of Mystery Canyon in the Temple of Sinawava quadrangle.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 314, 315. This association could be confused with *Tetradymia canescens* Mixed Shrubland.
Classification Confidence: 3 **Identifier:** CEGL002694
REFERENCES: None available.

ARCTOSTAPHYLOS PATULA - QUERCUS GAMBELII - (AMELANCHIER UTAHENSIS) SHRUBLAND
Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations between 6000 and 8000 feet on gentle to moderately steep slopes of mesas or high-elevation plateaus. Slope aspects are variable. Soils texture is mostly sandy loam.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of this association are common and widespread at the high elevations of Zion National Park. *Arctostaphylos patula* and *Quercus gambelii* codominate, each with cover ranging from 5-50%. Other shrubs that occur with less than 10% cover are *Cercocarpus montanus, Amelanchier utahensis, Symphoricarpos oreophilus, Quercus turbinella*, and *Ericameria nauseosa*. Total shrub cover is variable, 20-80%. Graminoid species that commonly occur are *Poa fendleriana, Bouteloua gracilis*, and *Sporobolus cryptandrus*. Single trees of *Juniperus osteosperma* and *Pinus edulis* have been noted in some stands.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Arctostaphylos patula, Quercus gambelii*

Global

Stratum	Species
Information not available.	

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Quercus gambelii, Symphoricarpos oreophilus*
GRAMINOID	*Bouteloua gracilis, Poa fendleriana, Sporobolus cryptandrus*

Global

Stratum	Species
Information not available.	

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs frequently on high mesas throughout the park, specifically on Great White Throne, Burnt Top Mountain, Timber Top Mountain, mesa near Wynopits, Beehives, Altar of Sacrifice, and Horse Mountain Plateau.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 12, 95, 267, 270, 274, 301, 351, 381
Classification Confidence: 2 **Identifier:** CEGL002695
REFERENCES: None available.

ARCTOSTAPHYLOS PATULA SHRUBLAND
Greenleaf Manzanita Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle to moderate slopes of mesa tops and plateaus at elevations of 5700-7800 feet. Slopes are of all aspects. Soil texture is sand to sandy loam. Litter ground cover is limited to underneath the shrubs in each stand.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This shrubland association is dominated by *Arctostaphylos patula* with 5-80% foliar cover. *Quercus gambelii, Amelanchier utahensis, Yucca elata var. utahensis, Artemisia tridentata, Purshia tridentata, Ericameria nauseosa*, and *Tetradymia canescens* are shrubs that may be present, each with less than 5% cover, and combined with less than 10% cover. Lone *Pinus ponderosa* trees are occasionally present with cover less than 10%. Herbaceous species are variable in composition and contribute minimal cover. Common graminoids present in the understory of the sampled associations are *Poa fendleriana, Sporobolus cryptandrus, Elymus elymoides, Hesperostipa comata, Achnatherum hymenoides*, and *Carex rossii*. Common forbs sampled are *Arenaria fendleri, Arenaria macradenia, Comandra umbellata, Tragopogon dubius, Phlox austromontana, Hymenopappus filifolius, Packera multilobata, Vicia americana, Frasera speciosa, Machaeranthera canescens, Heterotheca villosa, Tradescantia occidentalis, Penstemon caespitosus*, and other *Penstemon* spp.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Arctostaphylos patula*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Arctostaphylos patula*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: Stands of *Arctostaphylos patula* shrubs are widespread across the high-elevation mesas. Associations were documented throughout the northern region of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH16, RH49, RH90, RH11, RH30, 32, 71, 125, 210, 262, 362, 8, 13, 35, 356, 509, 252, 251, 85, 204, 364
Classification Confidence: **Identifier:** CEGL002696
REFERENCES: None available.

III.A.2.N.c.36. ARCTOSTAPHYLOS PUNGENS SHRUBLAND ALLIANCE
Mexican Manzanita Shrubland Alliance

ARCTOSTAPHYLOS PUNGENS SHRUBLAND

Mexican Manzanita Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This chaparral association has been described from the Virgin Mountains in southern Nevada, Markagunt Plateau in southwestern Utah, the Mogollon Rim in Arizona south to the Animas Mountains in southwestern New Mexico. Sites include dry, gentle to moderate slopes of mountains and plateaus. Substrates are variable and range from rocky, coarse-textured soil to clay loam. The vegetation is characterized by a typically dense, tall-shrub layer dominated by *Arctostaphylos pungens* (50-70% cover) with sparse short-shrub or herbaceous layers. Associated shrubs vary geographically with *Arctostaphylos patula, Amelanchier utahensis, Ceanothus* spp., *Cercocarpus ledifolius, Ephedra viridis, Garrya flavescens, Mahonia fremontii, Quercus gambelii, Quercus turbinella*, or *Robinia neomexicana* present in the northern extant and *Arctostaphylos pringlei, Ceanothus* spp., *Garrya wrightii, Nolina microcarpa, Quercus hypoleucoides, Q. turbinella*, or scattered *Q. rugosa* or *Pinus discolor* trees present in the southern extent. The herbaceous layer, if present, consists of sparse cover of grasses or forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: The site where this association occurs is a moderately steep slope at 6800 feet with southwest aspect. Soil texture is clay loam.

Global Environment: This chaparral association has been described from the Virgin Mountains in southern Nevada, Markagunt Plateau in southwestern Utah, the Mogollon Rim in Arizona south to the Animas Mountains in southwestern New Mexico. Elevation ranges from 980-2470 m (3200-8100 feet). Sites include dry gentle to moderate slopes of mountains and plateaus. Substrates range from coarse textured, gravelly soils with rocks to clay loam. Parent material includes rhyolite, granite, quartzite and sandstone.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is uncommon in the park. Here, at the northern extent of its range, *Arctostaphylos pungens* is usually an insignificant component of montane shrub communities. At this site, it dominates with 10% cover. Other shrub species present with less cover include *A. patula, Amelanchier utahensis, Quercus gambelii*, and *Ceanothus fendleri*. Total shrub cover is 20%. Shrub interspaces are primarily exposed ashy clay soils and small gravelly rock. *Penstemon caespitosus* is the prominent herbaceous species at this site.

Global Vegetation: This association is characterized by a dense tall-shrub layer dominated by *Arctostaphylos pungens* with sparse short-shrub and herbaceous layers. Stands in Nevada include associated species such as *Cercocarpus ledifolius, Robinia neomexicana, Garrya flavescens, Ephedra viridis, Quercus turbinella, Amelanchier utahensis, Mahonia fremontii*, and *Ceanothus greggii*. In Utah the shrub layer was open (about 20% cover) with 10% cover of *Arctostaphylos pungens*. *Arctostaphylos patula, Amelanchier utahensis, Quercus gambelii*, and *Ceanothus fendleri* were present in small amounts. *Penstemon caespitosus* and other scattered forbs were present. In Arizona, stands averaged 86% shrub canopy cover and were dominated by *Arctostaphylos pungens* (55%), with 12% cover *Ceanothus* spp, 9% cover *Arctostaphylos pringlei*, and scattered *Quercus turbinella* and other shrub species. In New Mexico stands were less diverse. *Arctostaphylos pungens* canopy cover was 70% with less than 5% tree cover of *Quercus hypoleucoides, Quercus rugosa* and *Pinus discolor*. Other species were sparse and included less than 5% cover of *Nolina microcarpa* and *Garrya wrightii*. Introduced annual species are common in some stands.

Global Dynamics: *Arctostaphylos pungens* is a fire-adapted species that reproduces prolifically from heat-scarified seeds after fires (Carmichael et al. 1978). Armstrong (1969) considers these shrublands a fire disclimax. Prior to a fire, the *Arctostaphylos pungens* shrubland he described was a *Pinus monophylla / Juniperus osteosperma* woodland because of the numerous stumps present. He believed the lack of tree regeneration was caused by the low rainfall and re-occurring fires. Bourgeron et al. (1993b) suggest that this a seral phase of the *Pinus discolor / Quercus hypoleucoides* woodland. Most of the woody species associated with this association are fire-adapted and often replace burned-over conifer woodlands (Carmichael et al. 1978). This all would indicate that fire promotes/maintains this community.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Arctostaphylos pungens*

Global

Stratum	**Species**
TREE CANOPY	*Amelanchier utahensis*
TALL SHRUB	*Arctostaphylos pungens*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Arctostaphylos pungens, Quercus gambelii*
FORB	*Penstemon caespitosus*

Global

Stratum	**Species**
TALL SHRUB	*Arctostaphylos pungens*

GLOBAL SIMILAR ASSOCIATIONS:
- Quercus turbinella - Garrya flavescens - Arctostaphylos pungens Shrubland (CEGL000977)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled at Corral Hollow on the Horse Pasture Plateau of Zion National Park. It has also been observed in small stands in the Kolob Canyons region of the park.

Global Range: This association occurs from the Virgin Mountains in extreme southeastern Nevada and adjacent Utah to the Gray Ranch in extreme southwestern New Mexico. It likely occurs in adjacent Mexico.

Nations: US
States/Provinces: NM NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 98 (This site was burned in 1996.)
Classification Confidence: 2 **Identifier:** CEGL000958
REFERENCES: Armstrong 1969, Bourgeron and Engelking 1994, Bourgeron et al. 1993b, Carmichael et al. 1978, Driscoll et al. 1984

III.A.2.N.c.40. QUERCUS TURBINELLA SHRUBLAND ALLIANCE
Turbinella Live Oak Shrubland Alliance

QUERCUS TURBINELLA - (AMELANCHIER UTAHENSIS) COLLUVIAL SHRUBLAND
Turbinella Live Oak - (Utah Serviceberry) Colluvial Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation for this association ranges between 4500 and 6500 feet on moderate to steep colluvial slopes with sandy-textured soils.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association commonly occupies the steep colluvial slopes below towering sandstone walls in the park. *Quercus turbinella* is typically dominant with 10-70% cover. *Quercus turbinella* was absent in one plot sampled, but other characteristics were similar to this association's description. The mixture of other shrubs represented in the sampled sites includes *Amelanchier utahensis, Arctostaphylos pungens, Arctostaphylos patula, Shepherdia rotundifolia, Fraxinus anomala, Rhus trilobata*, and *Quercus gambelii*, which may be present to abundant. Common subshrubs include *Opuntia* spp., *Yucca* spp., and *Gutierrezia sarothrae*. Pinyon and juniper trees may be present, but have insignificant cover. Common herbaceous species are inconsistent in composition and have minimal cover.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Quercus turbinella*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Arctostaphylos pungens, Quercus turbinella*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs throughout Zion National Park on colluvial slopes below sandstone walls.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH70, 1, 106, 138, 144, 146, 513, 527, 18, 82
Classification Confidence: 3 **Identifier:** CEGL002950
REFERENCES: None available.

III.A.2.N.h. Seasonally flooded temperate broad-leaved evergreen shrubland

III.A.2.N.h.2. PLUCHEA SERICEA SEASONALLY FLOODED SHRUBLAND ALLIANCE

Arrow-weed Seasonally Flooded Shrubland Alliance

PLUCHEA SERICEA SEASONALLY FLOODED SHRUBLAND [PLACEHOLDER]

Arrow-weed Seasonally Flooded Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This evergreen shrubland is found in wetlands from southern Californiato the Sonoran Desert, and extends north into the Colorado Plateau in southwestern Utah. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil. The vegetation is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis, Atriplex* spp., *Baccharis* spp., *Prosopis* spp., *Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. The typically sparse herbaceous layer, if present, is typically composed of *Distichlis spicata, Scirpus americanus, Sporobolus airoides*, or *Typha angustifolia*. The presence of weedy species is common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: Stands of *Pluchea sericea* occur below 4000 feet on river floodplains with clay loam to sandy soils.

Global Environment: This evergreen shrubland is found in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southwestern Utah. Elevation ranges from sea level to 1220 m (4000 feet). Stands occur in canyon bottoms, irrigation ditches, streamsides, floodplains, and along the margins of springs. Sites are flat to gently sloping and are permanently or seasonally flooded with a high water table. Water chemistry may be fresh or saline/alkaline. Substrates are generally alluvial and vary from well-drained to poorly drained and coarse-textured to fine-textured soil.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pluchea sericea* dominates this association with 40% cover and heights of 1 m. Herbaceous cover is minimal, less than 10%, and usually composed of exotic species due to its frequent exposure to human and/or livestock disturbance.

Global Vegetation: This plant association is characterized by a moderately dense to dense short- to tall-shrub layer (1-5 m tall) that is dominated by *Pluchea sericea*, often forming pure stands. Stands generally form small patches within other wetland and riparian vegetation. Other species are present with low cover and vary regionally. Shrub associates may include *Allenrolfea occidentalis, Atriplex canescens, Atriplex torreyi, Baccharis emoryi, Baccharis sergiloides, Prosopis glandulosa, Prosopis pubescens, Salix exigua, Suaeda moquinii*, and introduced *Tamarix* spp. The typically sparse herbaceous layer, if present, is typically composed of *Distichlis spicata, Scirpus americanus, Sporobolus airoides*, or *Typha angustifolia*. Weedy species such as *Erodium cicutarium, Lactuca* spp., *Melilotus officinalis* are common in disturbed stands.

Global Dynamics: This riparian association grows in seasonally flooded, freshwater and brackish habitats with permanently saturated ground. Exotic tamarisk species have invaded many occurrences of this alliance.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Pluchea sericea*
SHORT SHRUB	*Gutierrezia sarothrae*
GRAMINOID	*Sporobolus cryptandrus*
FORB	*Melilotus officinalis*

Global

Stratum	**Species**
TALL SHRUB	*Pluchea sericea*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Pluchea sericea*
GRAMINOID	*Sporobolus cryptandrus*

Global

Stratum	**Species**
TALL SHRUB	*Pluchea sericea*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs near the confluence of the East Fork and North Fork of the Virgin River. Additional stands are found along the Virgin River at the southern boundary of the park. Another stand within the park occurs in Coal Pits Wash near the southern boundary.

Global Range: This wetland association occurs in wetlands in southern California, the Mojave, Colorado and Sonoran deserts, and extends north into the Colorado Plateau in southwestern Utah.

Nations: US
States/Provinces: CA UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 522
Classification Confidence: 2 **Identifier:** CEGL003080
REFERENCES: Barbour and Major 1977, Beatley 1976, Holland 1986b, Sawyer and Keeler-Wolf 1995

III.A.4.N.a. Lowland microphyllous evergreen shrubland

III.A.4.N.a.4. ARTEMISIA FILIFOLIA SHRUBLAND ALLIANCE
Sand Sagebrush Shrubland Alliance

ARTEMISIA FILIFOLIA COLORADO PLATEAU SHRUBLAND

Sand Sagebrush Colorado Plateau Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on floodplain terraces and alluvial fans with extremely sandy soils. Slopes are flat to moderately steep with southeastern to southwestern aspects.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is dominated by *Artemisia filifolia* with foliar cover ranging from 20-50%. *Psorothamnus fremontii* is present at some sites. *Sporobolus cryptandrus* and *Pleuraphis jamesii* occur in shrub interspaces averaging 10% cover. Other minimal herbaceous cover includes species adapted to dry sandy sites and often the invasive exotic *Bromus tectorum*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Artemisia filifolia*
GRAMINOID	*Bromus tectorum, Sporobolus cryptandrus*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Artemisia filifolia*
GRAMINOID	*Sporobolus cryptandrus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs only in the southernmost region of the park in the North and East Fork of the Virgin River corridors.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH41, 150, 508, 512, 518
Classification Confidence: 2 **Identifier:** CEGL002697
REFERENCES: None available.

III.A.4.N.a.17. ARTEMISIA TRIDENTATA SHRUBLAND ALLIANCE
Big Sagebrush Shrubland Alliance

ARTEMISIA TRIDENTATA - (ERICAMERIA NAUSEOSA) / BROMUS TECTORUM SEMI-NATURAL SHRUBLAND

Big Sagebrush - (Rubber Rabbitbrush) / Cheatgrass Semi-natural Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on alluvial flats and benches with sandy soils. It also occurs in clay soils found in association with Crater Hill and Coal Pits Wash. Elevation ranges between 3700 and 6400 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Composition of this association is somewhat variable. *Artemisia tridentata* is always present with cover ranging from 10-50% and averaging 1 m in height. *Ericameria nauseosa* is not always present, but is highly likely to be present at least in the vicinity. Its cover ranges from 0-20% in sampled stands. Other shrubs that may occur with minimal cover are *Chrysothamnus viscidiflorus, Tetradymia canescens, Opuntia* spp., and *Gutierrezia* spp. In the herbaceous layer, *Bromus tectorum* cover ranges from 1-15%. Other graminoids found in the sampled stands are *Sporobolus cryptandrus, Pleuraphis jamesii, Elymus elymoides, Poa fendleriana, Pascopyrum smithii*, and *Bromus diandrus*. Forb species are inconsistent in composition among the sites. Forbs that most commonly occur are *Senecio spartioides, Heterotheca villosa*, and *Tradescantia occidentalis*. Total herbaceous cover ranges from 1-30%.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Artemisia tridentata*
GRAMINOID	*Bromus tectorum*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Artemisia tridentata, Ericameria nauseosa*
GRAMINOID	*Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs throughout the park in lower elevation alluvial flats, specifically Kolob Visitor Center, Hop Valley, Coal Pits Wash, Crater Hill, Dalton Wash, Pine Creek, Shune's Hollow, and Stave Springs.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH24, RH36, RH38, RH65, 30, 46, 52, 506, 507
Classification Confidence: 3 **Identifier:** CEGL002699
REFERENCES: None available.

ARTEMISIA TRIDENTATA / BOUTELOUA GRACILIS SHRUBLAND

Big Sagebrush / Blue Grama Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This shrubland has only been described from the plateaus and mesas of Grand Canyon and Zion national parks in northwestern Arizona and southwestern Utah, but it is more widespread and likely occurs in New Mexico and Nevada. Sites range from valley bottoms and drainages to rolling hills, mesa tops and terraces. Substrates are alluvial soils derived from limestone or volcanic flows or sandy-textured soil derived from sandstone or sandy limestone. Stands have an open, short-shrub canopy (less than 1 m tall) that is dominated by the evergreen microphyllous shrub *Artemisia tridentata* usually with greater than 20% cover. Other common shrubs and dwarf-shrubs may include *Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Atriplex canescens, Krascheninnikovia lanata*, or *Ephedra viridis*. The sparse herbaceous layer is dominated by the short perennial bunchgrass *Bouteloua gracilis* with *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii*, or *Sporobolus cryptandrus* often present. Forbs are sparse. Scattered *Juniperus osteosperma* trees and succulents such as *Opuntia* spp. may also be present.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 6100 feet on gently sloping terrace above wash. Soils are sandy and rapidly drained.

Global Environment: This shrubland has only been described from the plateaus and mesas of Grand Canyon and Zion national parks in northwestern Arizona and southwestern Utah, but it is more widespread and likely occurs in New Mexico and Nevada. Elevations range from 1370-2040 m. Sites range from valley bottoms and drainages to rolling hills, mesa tops and terraces. Substrates include sandy-textured soils derived from sandstone or sandy limestone and moderately deep, fine-textured, alkaline, calcareous, alluvial soils derived from limestone or volcanic flows.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Artemisia tridentata* is dominant with 15% cover and heights of 1-2 m. *Tetradymia canescens* codominates with 10% cover. The herbaceous layer is significant. *Bouteloua gracilis* dominates with 10% cover, and *Sporobolus cryptandrus*, 5% cover. Forb species present are *Penstemon* spp., *Hymenopappus filifolius, Lupinus sericeus*, and *Castilleja applegatei ssp. martinii*. Total vegetation cover is 30%.

Global Vegetation: This shrubland is characterized by an open, short-shrub canopy (less than 2 m tall) that is dominated by the evergreen microphyllous shrub *Artemisia tridentata* usually with greater than 20% cover. Other common shrubs and dwarf-shrubs may include *Gutierrezia sarothrae, Chrysothamnus viscidiflorus, Atriplex canescens, Ephedra viridis, Krascheninnikovia lanata*, or *Tetradymia canescens*. The sparse herbaceous layer is dominated by the short perennial bunchgrass *Bouteloua gracilis* with *Achnatherum hymenoides (= Oryzopsis hymenoides), Pascopyrum smithii*, or *Sporobolus cryptandrus* often present. Forbs are sparse but may include species of *Castilleja, Eriogonum, Lupinus*, and *Penstemon*. Scattered *Juniperus osteosperma* trees and succulents such as *Opuntia* spp. may also be present.

Global Dynamics: *Artemisia tridentata* shrubs are readily killed by fire and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). However, this association has an open, short-shrub canopy and a relatively sparse herbaceous layer (low fine fuels to carry the fire), so it is unlikely that it would burn except under extreme conditions.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Tetradymia canescens*
GRAMINOID	*Bouteloua gracilis*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Gutierrezia sarothrae*
GRAMINOID	*Bouteloua gracilis*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Tetradymia canescens*
GRAMINOID	*Bouteloua gracilis, Sporobolus cryptandrus*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata*
GRAMINOID	*Bouteloua gracilis*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: On Fishtail Mesa, cover of *Artemisia bigelovii* was lumped with *Artemisia tridentata* in plot summary tables as "*Artemisia*" by Jameson et al. (1962) and Rowlands and Brian (1996). It is not clear if these shrub species co-occurred within the plot sites or not.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled in Terry Wash, east of Cougar Mountain, in the Guardian Angels Quadrangle. It has also been observed in Shunes Hollow in the southeast corner of the park.

Global Range: This association is described from Zion and Grand Canyon national parks in southwestern Utah and northwestern Arizona. It is likely widespread across the Colorado Plateau and also may occur in New Mexico and Nevada.

Nations: US
States/Provinces: AZ UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 206. It's rather unusual for *Bromus tectorum* to be absent from this vegetation type. This could be considered TECA - EPVI Shrubland.
Classification Confidence: 2 **Identifier:** CEGL000995
REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, Driscoll et al. 1984, Everett 1987, Jameson et al. 1962, Warren et al. 1982, Wright et al. 1979

III.A.4.N.a.18. ARTEMISIA TRIDENTATA SSP. TRIDENTATA SHRUBLAND ALLIANCE

Basin Big Sagebrush Shrubland Alliance

ARTEMISIA TRIDENTATA SSP. TRIDENTATA / PASCOPYRUM SMITHII - (ELYMUS LANCEOLATUS) SHRUBLAND

Basin Big Sagebrush / Western Wheatgrass - (Streamside Wild Rye) Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This sagebrush shrubland occurs on valley bottoms, stream terraces and other relatively mesic sites west of the Great Plains. Most stands grow on alluvial terraces in stream alluvium, although a few occur on upland swales. Soils generally are loamy or sandy. Water tables may be within 2 m of the soil surface. The stream channel often is dry and may be incised. The vegetation is characterized by a sparse to moderately dense short-shrub layer (up to about 35% canopy cover and to 1.5 m tall) that is dominated by *Artemisia tridentata ssp. tridentata*, with an herbaceous layer that usually dominated by *Pascopyrum smithii* or *Elymus lanceolatus*. Other shrubs may be present in small amounts, especially *Ericameria nauseosa (= Chrysothamnus nauseosus), Chrysothamnus viscidiflorus*, or *Quercus gambelii*. The sparse to dense herbaceous layer is dominated by graminoids and is poor in species richness relative to other sagebrush types. Other species that may be present in substantial amounts are *Elymus elymoides (= Sitanion hystrix)* in northern Colorado, *Poa secunda (= Poa nevadensis)* and *Muhlenbergia richardsonis*, in Nevada, and *Leymus cinereus* and *Poa pratensis* in Montana. Forbs contribute much less cover than do grasses. Mosses and lichens may be important ground cover.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 6200 feet on a gentle southeast-facing slope as a part of wide valley landscape. Soils texture is sandy loam.

Global Environment: This sagebrush shrubland occurs on valley bottoms, stream terraces and other relatively mesic sites west of the Great Plains. Stands occur over an elevational range of 1800-2400 m (5900-7875 feet). Most stands grow on alluvial terraces in stream alluvium, although a few occur on upland swales. Soils generally are loamy or sandy. Water tables may be within 2 m of the soil surface. The stream channel often is dry and incised.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is a part of a mosaic of oak islands and grasslands in the Lee Valley. *Artemisia tridentata ssp. tridentata* is 1 m high and has foliar cover of 10%. *Quercus gambelii* is present with insignificant cover. The herbaceous cover is dominated by *Elymus lanceolatus* with 30% cover. No other graminoids are present and forbs are nearly absent.

Global Vegetation: This association is characterized by a sparse to moderately dense short-shrub layer (up to about 35% canopy cover and to 1.5 m tall) that is dominated by *Artemisia tridentata ssp. tridentata*, with an herbaceous layer that usually dominated by *Pascopyrum smithii* or *Elymus lanceolatus*. Other shrubs may be present in small amounts, especially *Ericameria nauseosa (= Chrysothamnus nauseosus), Chrysothamnus viscidiflorus*, or *Quercus gambelii*. The sparse to dense herbaceous layer is dominated by graminoids and is poor in species richness relative to other sagebrush types. Other species that may be present in substantial amounts are *Elymus elymoides (= Sitanion hystrix)* in northern Colorado (Tiedemann et al. 1987), *Poa secunda (= Poa nevadensis)* and *Muhlenbergia richardsonis* in Nevada (Blackburn et al. 1971), and *Leymus cinereus* and *Poa pratensis* in Montana (Cooper et al. 1995). Forbs contribute much less cover than do grasses. Species that often occur are *Symphyotrichum ascendens (= Aster ascendens)* and *Collinsia parviflora* in Nevada (Blackburn et al. 1971), *Penstemon caespitosus* in north-central Colorado (Tiedemann et al. 1987), *Achillea millefolium, Erigeron compositus, Packera cana (= Senecio canus)*, and *Taraxacum officinale* in southwestern Montana (Cooper et al. 1995), and *Cordylanthus ramosus* in southwestern Wyoming (Jones and Fertig 1996). Mosses and lichens may be important ground cover.

Global Dynamics: *Artemisia tridentata* shrubs are killed by burns and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata ssp tridentata*
GRAMINOID	*Elymus lanceolatus*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata ssp tridentata*
GRAMINOID	*Elymus lanceolatus, Pascopyrum smithii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata ssp tridentata*
GRAMINOID	*Elymus lanceolatus, Pascopyrum smithii*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata ssp tridentata*
GRAMINOID	*Elymus lanceolatus, Pascopyrum smithii*

GLOBAL SIMILAR ASSOCIATIONS:

- Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus) Shrub Herbaceous Vegetation (CEGL001508)--occupies soils with more salts.
- Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii Shrubland (CEGL001047)--has a shrub layer dominated by that subspecies of big sagebrush and occupies drier sites.
- Artemisia tridentata ssp. tridentata / Pseudoroegneria spicata - Poa secunda Shrub Herbaceous Vegetation (CEGL001019)--generally has a more open shrub layer and an undergrowth dominated by *Pseudoroegneria spicata* rather than *Pascopyrum smithii* and grows on shallower soils.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3?.

Global Comments: *Elymus lanceolatus* has been confused with *Pascopyrum smithii* in field studies. This association may include either or both species. Similar associations such as *Sarcobatus vermiculatus / Pascopyrum smithii - (Elymus lanceolatus) Shrub Herbaceous Vegetation (CEGL001508)* occupies soils with more salts. Stands of *Artemisia tridentata ssp. wyomingensis / Pascopyrum smithii* Shrubland (CEGL001047) have a shrub layer dominated by that subspecies of big sagebrush and occupy drier sites. *Artemisia tridentata ssp. tridentata / Pseudoroegneria spicata - Poa secunda* Shrub Herbaceous Vegetation (CEGL001019) generally has a more open shrub layer and undergrowth dominated by *Pseudoroegneria spicata* rather than *Pascopyrum smithii*; stands of this type grow on shallower soils.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled southeast of Firepit Knoll in the Guardian Angels quadrangle.

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

Nations: US
States/Provinces: CO ID? MT NV OR? UT WA? WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH04
Classification Confidence: 1 **Identifier:** CEGL001017
REFERENCES: Beetle and Johnson 1982, Blackburn et al. 1971, Bourgeron and Engelking 1994, Bunting 1987, Cooper et al. 1995, Driscoll et al. 1984, Everett 1987, Francis 1983, Johnston 1987, Jones and Fertig 1996, Keammerer 1977, Strong 1980, Tiedemann et al. 1987, Wright et al. 1979

III.A.4.N.a.19. ARTEMISIA TRIDENTATA SSP. VASEYANA SHRUBLAND ALLIANCE

Mountain Big Sagebrush Shrubland Alliance

ARTEMISIA TRIDENTATA SSP. VASEYANA / HESPEROSTIPA COMATA SHRUBLAND

Mountain Big Sagebrush / Needle-and-Thread Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations ranging from 6100-7100 feet on flat to gently easterly sloping terrain. Soil texture is loamy sand.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association occurs in openings of *Pinus edulis / Juniperus osteosperma* woodlands or in a mosaic with *Quercus gambelii* shrubland islands. *Artemisia tridentata ssp. vaseyana* is dominant with 10-40% cover and less than 1 m in height. Other shrubs that may be present in the stand are *Purshia tridentata, Symphoricarpos oreophilus, Chrysothamnus viscidiflorus, Amelanchier utahensis*, and *Cercocarpus montanus*, all of minimal cover. The herbaceous layer can be significant and usually a combination of codominant graminoids, such as *Hesperostipa comata, Bouteloua gracilis, Poa fendleriana*, and *Muhlenbergia* spp. Total graminoid cover is 5-50%. Forbs are sparse and are inconsistent in composition among sites.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata ssp vaseyana*
GRAMINOID	*Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* spp., *Poa fendleriana*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata ssp vaseyana, Chrysothamnus viscidiflorus, Purshia tridentata, Symphoricarpos oreophilus*
GRAMINOID	*Bouteloua gracilis, Hesperostipa comata, Muhlenbergia* spp., *Poa fendleriana*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Of all the references for this association, only Hironaka et al. (1983) clearly reference an *Artemisia tridentata ssp. vaseyana / Stipa comata* vegetation type. All the others (Blackburn 1967, Blackburn et al. 1968c, 1971, Tueller et al. 1966, 1974, Mclean 1970, Poulton 1955, DeVelice and Lesica 1993) do not provide information as to the subspecies of *Artemisia tridentata*. Further clarification of which published materials relate to this association is needed. Based on habitat information and photos available for the study areas in Nevada, these could reference *Artemisia tridentata ssp. tridentata / Stipa comata* vegetation types.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled in the northeastern region of the park, the mesa east of The Bishopric, and Deertrap Mountain.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 124, 259, 261, 370, 375
Classification Confidence: 3 **Identifier:** CEGL002931
REFERENCES: Blackburn 1967, Blackburn et al. 1968c, Blackburn et al. 1971, DeVelice and Lesica 1993, Hironaka et al. 1983, McLean 1970, Poulton 1955, Tueller and Blackburn 1974, Tueller et al. 1966

III.A.4.N.a.23. ERICAMERIA NAUSEOSA SHRUBLAND ALLIANCE

Rubber Rabbitbrush Shrubland Alliance

ERICAMERIA NAUSEOSA / BROMUS TECTORUM SEMI-NATURAL SHRUBLAND

Rubber Rabbitbrush / Cheatgrass Semi-natural Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation ranges from 4000-5500 feet for this association on both steep and gentle slopes. Slopes are north-facing and have deep sandy soils.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Ericameria nauseosa* is the dominant shrub in this association with cover of 20-40%. *Rhus trilobata* and/or *Artemisia tridentata* are occasionally present. *Yucca elata var. utahensis* and *Opuntia macrorhiza* are present to abundant. The herbaceous layer has sparse to high cover of the exotic *Bromus tectorum*, and *Sporobolus cryptandrus* is present, but with minimal cover. Few other herbaceous species are present.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Ericameria nauseosa, Opuntia macrorhiza*
GRAMINOID	*Bromus tectorum*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Ericameria nauseosa, Opuntia macrorhiza, Rhus trilobata, Yucca elata var utahensis*
GRAMINOID	*Bromus tectorum, Sporobolus cryptandrus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs below the Watchman near the west entrance of Zion National Park and in the drainage basin above the Watchman. It has also been observed in Shune's Creek and scattered throughout the park in disturbed areas.

Global Range: This association has currently only been described from Zion NP in southwestern Utah, but is likely more widespread throughout the western U.S. in disturbed areas.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 109, 385
Classification Confidence: 3 **Identifier:** CEGL002937
REFERENCES: None available.

III.A.4.N.a.21. PURSHIA (STANSBURIANA, MEXICANA) SHRUBLAND ALLIANCE
(Stansbury Cliff-rose, Mexican Cliff-rose) Shrubland Alliance

PURSHIA STANSBURIANA - ARCTOSTAPHYLOS PATULA SHRUBLAND [PROVISIONAL]

Stansbury Cliff-rose - Greenleaf Manzanita Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations of approximately 7000 feet on the Twin Brothers mesa top and the steeply sloped mesa rim of Towers of the Virgin. Soils are sandy.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of *Purshia mexicana / Arctostaphylos patula* are not widespread in Zion National Park and are likely confined to the vicinity where they were sampled. Stands with *Pinus edulis* in the tree canopy occur at lower elevations. *Purshia stansburiana (= Purshia mexicana ssp. stansburiana)* is the dominant tall shrub in this association with cover of 20-30%. *Amelanchier utahensis* and *Quercus gambelii* are present to abundant in the tall-shrub layer. *Arctostaphylos patula* occurs in the short-shrub layer with 50% cover. Subshrubs present are often *Gutierrezia sarothrae* and *Opuntia* spp. *Poa fendleriana* and *Phlox austromontana* are commonly present in the herbaceous layer.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Purshia stansburiana*
SHORT SHRUB	*Arctostaphylos patula*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Amelanchier utahensis, Purshia stansburiana, Quercus gambelii*
SHORT SHRUB	*Arctostaphylos patula*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on Towers of the Virgin and Twin Brothers Mesa, both located in the Springdale East quadrangle in Zion National Park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 269, AA317. AA plot 142 does not have ARPA, but still resembles this association.

Classification Confidence: **Identifier:** CEGL002948

REFERENCES: None available.

III.A.4.N.c. Temporarily flooded microphyllous shrubland

III.A.4.N.c.1. TAMARIX SPP. SEMI-NATURAL TEMPORARILY FLOODED SHRUBLAND ALLIANCE

Salt-cedar species Semi-natural Temporarily Flooded Shrubland Alliance

TAMARIX SPP. TEMPORARILY FLOODED SHRUBLAND

Salt-cedar species Temporarily Flooded Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This broadly defined association is composed of shrublands which form moderately dense to dense thickets on banks of larger streams across the western Great Plains, interior and southwestern U.S. and northern Mexico. Stands are dominated by introduced species of *Tamarix*, including *Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. *Tamarix* spp. were introduced from the Mediterranean and have become naturalized in various sites, including salt flats and other saline habitats, springs, and especially along streams and regulated rivers, where it replaces the native vegetation, such as shrublands dominated by species of *Salix* or *Prosopis*. A remnant herbaceous layer may be present, depending on the age and density of the shrub layer. *Tamarix* species have become a critical nuisance along most large rivers in the semi-arid West and, because of the difficulty to remove, may have irreversibly changed the vegetation on many sites.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Palustrine

Zion National Park Environment: This association was not sampled at Zion NP, but occurred in the environs and was mapped.

Global Environment: These widespread shrublands are common along larger streams, rivers, and around playas in the western U.S. and Mexico. Elevation ranges from 75 m below sea level to 1860 m. *Tamarix* spp. have become naturalized in various sites including riverbanks, floodplains, basins, sandbars, side channels, springs, salt flats, and other saline habitats. Stands grow especially well along regulated rivers where flood-regenerated native species like *Populus* are declining. Substrates are commonly thin sandy loam soil over alluvial deposits of sand, gravel or cobbles.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association was not sampled at Zion NP, but occurred in the environs and was mapped.

Global Vegetation: This semi-natural shrubland occurs along streams, rivers and playas where it forms a moderate to dense tall-shrub layer that is solely or strongly dominated by species of *Tamarix* including *Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*. Other shrubs may include species of *Salix* (especially *Salix exigua*) and *Prosopis, Rhus trilobata*, and *Sarcobatus vermiculatus* but with low cover (if shrub species are codominant then stand is classified as a natural shrubland). Scattered *Acer negundo, Salix amygdaloides, Populus* spp., or *Elaeagnus angustifolia* trees may also be present. Depending on stand age and density of the shrub layer, an herbaceous layer may be present. Associated species include *Distichlis spicata, Sporobolus airoides*, and introduced forage species such as *Agrostis gigantea, Agrostis stolonifera*, and *Poa pratensis*. Introduced herbaceous species such as *Polypogon monspeliensis, Conyza canadensis, Lepidium latifolium*, and others have been reported from shrublands in this association.

Global Dynamics: *Tamarix* spp. are highly competitive shrubs that have invaded many riparian and wetland environments in the western U.S. Hansen et al. (1995) report that these shrubs are extremely drought- and salt-tolerant, produce prolific wind-dispersed seeds over much of the growing season, can resprout after burning or cutting, and if kept moist, buried or broken branches will develop adventitious roots and grow. Stands seem to favor disturbed and flow-regulated rivers, but establish well in pristine areas, too. Under optimum conditions riparian areas can be converted to a dense thicket in less than 10 years (Hansen et al. 1995). Once established, stands are extremely difficult to eradicate, requiring cutting with herbicide application on stumps to prevent resprouting (Smith 1989).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*
GRAMINOID	*Bromus rigidus, Poa fendleriana, Poa pratensis*

Global

Stratum	**Species**
TALL SHRUB	*Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*
SHORT SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Distichlis spicata, Poa fendleriana, Sporobolus airoides*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*

Global

Stratum	**Species**
TALL SHRUB	*Tamarix ramosissima, Tamarix chinensis, Tamarix gallica*, and *Tamarix parviflora*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Bromus tectorum*

GLOBAL SIMILAR ASSOCIATIONS:

- Tamarix spp. - (Baccharis halimifolia) Shrubland (CEGL004918)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: *Tamarix* spp. Temporarily Flooded Shrubland (CEGL003114) is a broadly defined plant association that is composed of many diverse *Tamarix* spp.-dominated vegetation communities from a wide variety of environments. Muldavin et al. (2000a) described 8 community types that will be reviewed as possible USNVC associations.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was not sampled at Zion NP, but occurred in the environs and was mapped. It likely occurs in lowlands along stream channels and in disturbed riparian forest in canyons.

Global Range: This semi-natural shrubland is found along drainages in the semi-arid western Great Plains, interior and southwestern U.S. and northern Mexico, from central and eastern Montana, south to Colorado, western Oklahoma and Texas, west to California.

Nations: MX US
States/Provinces: AZ CA CO MT MXCH MXCO MXSO NM NV OK TX UT WY?

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: None
Classification Confidence: 2 **Identifier:** CEGL003114
References: Baalman 1965, Cowardin et al. 1979, Hansen et al. 1995, Hoagland 2000, Holland 1986b, Muldavin et al. 2000a, Nachlinger and Reese 1996, Ortenberger and Bird 1933, Paysen et al. 1980, Sawyer and Keeler-Wolf 1995, Smith 1989, Stevens and Shannon 1917, Szaro 1989, Ungar 1968, Von Loh et al. 2002, Ware and Penfound 1949

III.A.5.N.a. Broad-leaved and microphyllous evergreen extremely xeromorphic subdesert shrubland

III.A.5.N.a.11. EPHEDRA NEVADENSIS SHRUBLAND ALLIANCE

Nevada Joint-fir Shrubland Alliance

EPHEDRA NEVADENSIS BASALT SHRUBLAND [PROVISIONAL]

Nevada Joint-fir Basalt Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This stand of *Ephedra nevadensis* occurs on a basalt outcrop at 4100 feet. The slope is gentle with a southerly aspect. Exposed soils are minimal and have clay loam texture. Most of soil is covered with small and large lava rocks.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Ephedra nevadensis* dominates this association with cover of 30%. *Gutierrezia sarothrae, Atriplex canescens*, and *Echinocereus engelmannii* are present but contribute minimal cover. The herbaceous layer is normally very sparse.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Ephedra nevadensis*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Atriplex canescens, Ephedra nevadensis, Gutierrezia sarothrae*
GRAMINOID	*Achnatherum hymenoides, Bromus tectorum, Hesperostipa comata, Sporobolus cryptandrus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the Rockville Bench at the southern boundary of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 516
Classification Confidence: **Identifier:** CEGL002936
REFERENCES: None available.

III.A.5.N.a.12. EPHEDRA VIRIDIS SHRUBLAND ALLIANCE

Mormon-tea Shrubland Alliance

TETRADYMIA CANESCENS - EPHEDRA VIRIDIS SHRUBLAND [PROVISIONAL]

Gray Horsebrush - Mormon-tea Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs in sandy soils of slickrock basins on flat to moderate slopes with variable aspects. Elevation ranges 5600 to 6000 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Tetradymia canescens* is the dominant shrub with 10-40% cover. *Ephedra* viridis and *Artemisia tridentata* are almost always present, sometimes with as much cover as *T. canescens*. The shrub layer is usually diverse with combinations of *Ephedra viridis, Artemisia tridentata, Ericameria nauseosa, Quercus gambelii, Amelanchier utahensis, Purshia tridentata*, and *Purshia stansburiana*. Combined shrub cover is approximately 50%. Herbaceous cover is minimal and may consist of *Bromus tectorum, Bouteloua gracilis, Muhlenbergia pungens*, and *Sporobolus cryptandrus*. This association was observed during the Accuracy Assessment phase of project and needs more data collected to fully describe it.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Tetradymia canescens,Ephedra viridis, Ericameria nauseosa, Quercus gambelii*
GRAMINOID	*Bouteloua gracilis, Bromus tectorum*

Global

Stratum **Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHORT SHRUB	*Ephedra viridis, Tetradymia canescens*

Global

Stratum **Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:

Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in the slickrock region of the park that exists predominantly east of the tunnel and both north and south of Highway 9.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 47, 510. AA plots: 21, 40, 129
Classification Confidence: 3 **Identifier:** CEGL002973
REFERENCES: None available.

III.A.5.N.b. Facultatively deciduous extremely xeromorphic subdesert shrubland

III.A.5.N.b.6. ATRIPLEX CANESCENS SHRUBLAND ALLIANCE
Fourwing Saltbush Shrubland Alliance

ATRIPLEX CANESCENS - ARTEMISIA TRIDENTATA SHRUBLAND

Fourwing Saltbush - Big Sagebrush Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This shrubland is found in the Colorado Plateau, Great Basin, and Mojave Desert. Stands occur on level plains, valley bottoms, stream terraces, low and mid-slopes. Slopes are typically less than 25% and it is found on all aspects. Substrates are well-drained, silty loam and clay fine-textured soils. Some stands may be subject to periodic flooding. Evidence of erosion such as rills and gullies is common. The vegetation is characterized by a sparse to moderately dense short-shrub layer (15-35% cover) that is codominated by *Atriplex canescens* and *Artemisia tridentata*. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia* spp., *Krascheninnikovia lanata, Lycium* spp., and *Opuntia* spp. The sparse to moderately dense 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 species of *Cirsium, Eriogonum, Penstemon*, or *Sphaeralcea*. Introduced species such as *Agropyron cristatum, Bromus rubens*, and *Bromus tectorum* are common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 3800-4500 feet on alluvial flats or benches with southerly aspects. Soil texture is loamy sand.

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

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Atriplex canescens* and *Artemisia tridentata* codominate this association, each with 5-10% cover. Other shrubs present at the sampled sites are *Ephedra nevadensis, Ericameria nauseosa, Chrysothamnus viscidiflorus*, and *Gutierrezia microcephala*. Total shrub cover is 10-15%. Herbaceous cover is very sparse and variable. *Bromus tectorum* is often present and may have 10% cover. Forbs present at the sampled sites are *Sphaeralcea coccinea, Lactuca serriola, Euphorbia* spp., and *Eriogonum inflatum*.

Global Vegetation: This association is characterized by a sparse to moderately dense short-shrub layer (10-35% cover) that is codominate by *Atriplex canescens* and *Artemisia tridentata*. Associated shrubs include *Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia microcephala, Gutierrezia sarothrae, Krascheninnikovia lanata, Lycium* spp., and *Opuntia* spp (Roberts et al. 1992, Warren et al. 1982). The sparse to moderately dense 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 such as *Agropyron cristatum, Bromus rubens*, *Bromus tectorum,* and *Lactuca serriola* are common in disturbed stands.

Global Dynamics: *Atriplex canescens* is tolerant of fire and generally sprouts vigorously from the root crown after burning (Wright 1980). It often recovers fully within 2 or 3 years after a burn (Wright 1980). However, *Artemisia tridentata* shrubs are readily killed by fire and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Atriplex canescens*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Atriplex canescens*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ericameria nauseosa*
GRAMINOID	*Bromus tectorum*
FORB	*Sphaeralcea coccinea*

Global

Stratum	**Species**
SHORT SHRUB	*Artemisia tridentata, Atriplex canescens*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: Stands of *Atriplex canescens - Artemisia tridentata* occur at the southern boundary of the park and are likely to extend to the south outside the boundary. This association was sampled at Dalton Wash and near Coal Pits Wash.

Global Range: This shrubland occurs in the Colorado Plateau, Great Basin, and Mojave Desert.

Nations: US
States/Provinces: AZ CA? NV? UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH35, RH44. This association was never seen during Accuracy Assesments.
Classification Confidence: 2 **Identifier:** CEGL001282
REFERENCES: Bourgeron and Engelking 1994, Bunting 1987, Driscoll et al. 1984, Everett 1987, Roberts et al. 1992, Warren et al. 1982, Wright 1980, Wright et al. 1979

ATRIPLEX CANESCENS SHRUBLAND

Fourwing Saltbush Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This shrubland association is known from the Great Basin north into southern Columbia Basin and east into Wyoming and the Colorado Plateau. It is common on middle elevation bajadas in deep, sandy soils , but will occur at lower elevations along alluvial benches where soils are often finer-textured and possibly saline/alkaline. Parent material includes volcanic tuff, shale and sandstone. The vegetation 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. Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum kearneyi, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum*, or *Psorothamnus* spp. *Ephedra viridis* may be present but is not a codominant. The typically sparse herbaceous layer includes low cover of species 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*. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus diandrus*, and *Salsola kali* are common on disturbed sites.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 3800-4000 feet on an alluvial flat and eroded bench, with clay loam and sandy soils.

Global Environment: This shrubland association is known from the Great Basin north into southern Columbia Basin and east into Wyoming and Colorado Plateau. It is common on deep, sandy soils on middle elevation bajadas (1370-1680 m, 4500-5500 feet), 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). Parent materials include volcanic tuff, shale and sandstone. At lower elevations, it often occurs as a mosaic with *Lycium pallidum - Grayia spinosa*- or *Atriplex confertifolia*-dominated shrublands.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Atriplex canescens* has 5-30% cover. Other shrubs present with usually less than 5% cover are *Coleogyne ramosissima, Lycium pallidum, Psorothamnus fremontii, Ephedra nevadensis*, and *Gutierrezia sarothrae*. The herbaceous layer has 10-90% cover. Herbaceous species present in the sampled stands and observations are *Bromus tectorum, Bromus diandrus, Achnatherum hymenoides, Aristida purpurea, Sporobolus cryptandrus, Pleuraphis jamesii*, and *Elymus elymoides*. Near the visitor's center, this association's herbaceous layer is dominated by *Bromus diandrus*. Forbs are very sparse and inconsistent in composition among sampled sites.

Global Vegetation: This 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. Notable codominants in the shrub layer include *Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra nevadensis, Eriogonum kearneyi, Grayia spinosa, Gutierrezia sarothrae, Lycium pallidum, Psorothamnus fremontii*, or *Psorothamnus polydenius*. *Ephedra viridis* may be present but is not a codominant. The typically sparse herbaceous layer includes low cover of species such as *Achnatherum hymenoides (= Oryzopsis hymenoides)*, *Aristida purpurea, Elymus elymoides, Pleuraphis jamesii (= Hilaria jamesii),* and *Sporobolus cryptandrus*. Common forb species on sandy sites include *Cymopterus ripleyi, Dalea searlsiae,. Lesquerella ludoviciana*, and *Oenothera pallida*. Winter annual forb cover is variable depending on annual precipitation. Introduced species such as *Bromus tectorum, Bromus diandrus*, and *Salsola kali* are common on disturbed sites.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Atriplex canescens*
GRAMINOID	*Bromus diandrus, Bromus tectorum*

Global

Stratum	**Species**
SHORT SHRUB	*Atriplex canescens*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Atriplex canescens*
GRAMINOID	*Bromus diandrus, Bromus tectorum*

Global

Stratum	**Species**
SHORT SHRUB	*Atriplex canescens*

GLOBAL SIMILAR ASSOCIATIONS:
- Atriplex canescens - Artemisia tridentata Shrubland (CEGL001282)
- Atriplex canescens / Calycoseris parryi Shrubland (CEGL001284)
- Atriplex canescens - Krascheninnikovia lanata Shrubland (CEGL001285)
- Atriplex canescens / Purshia stansburiana Shrubland (CEGL001286)
- Atriplex canescens - Ephedra viridis Shrubland (CEGL001287)
- Atriplex canescens / Pleuraphis jamesii Shrubland (CEGL001288)
- Atriplex canescens / Achnatherum hymenoides Shrubland (CEGL001289)
- Atriplex canescens / Sporobolus airoides Shrubland (CEGL001291)
- Artemisia tridentata - Atriplex canescens - Sarcobatus vermiculatus / (Achnatherum hymenoides) Shrubland (CEGL001355)
- Prosopis glandulosa / Atriplex canescens Shrubland (CEGL001382)
- Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda Shrub Herbaceous Vegetation (CEGL001733)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in Parunaweep Canyon, Huber Wash and lower sections of the Virgin River corridor. It occurs infrequently in small stands on alluvial flats or benches near the southern boundary of the park.

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

Nations: US
States/Provinces: CA NV UT WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 39, 517. AA plots: 225, 119, 118, 108
Classification Confidence: 2 **Identifier:** CEGL001281
REFERENCES: Beatley 1976, Bourgeron and Engelking 1994, Driscoll et al. 1984, Ostler et al. 2000

III.A.5.N.b.11. COLEOGYNE RAMOSISSIMA SHRUBLAND ALLIANCE
Blackbrush Shrubland Alliance

COLEOGYNE RAMOSISSIMA / PLEURAPHIS JAMESII SHRUBLAND

Blackbrush / James' Galleta Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. Sites are gently sloping to flat. Substrates are variable and range from deep, well-drained, sandy soils derived from sandstone to rocky, clayey soils. The vegetation is characterized by an open (10-30% cover) short-shrub layer that is dominated by the deciduous, microphyllous shrub *Coleogyne ramosissima* with a sparse to moderately dense perennial graminoid layer that is dominated or codominated by *Pleuraphis jamesii*. Shrub associates may be present including *Atriplex canescens, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. *Achnatherum hymenoides, Calochortus nuttallii*, and several annuals may be present to abundant in the herbaceous layer, especially during wet years. Cover of introduced annual *Bromus* species may be high in disturbed stands. Occasional *Juniperus osteosperma* or *Pinus edulis* trees are present in some stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was documented on flat terrain with sandy or clayey, rocky soils at elevations of 4000 feet.

Global Environment: This shrubland association occurs in the Colorado Plateau and Mojave Desert in areas with hot summers and cold winters. Elevation ranges from 1200-1525 m (3950-5000 feet). Sites are gently sloping to flat. Substrates are variable and range from deep, well-drained, sandy soils derived from sandstone to rocky clayey soils (Utah Environmental and Agricultural Consultants 1973).

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Coleogyne ramosissima* is the dominant species in this association, though cover is a sparse 10-20%. *Ephedra nevadensis* and *Gutierrezia sarothrae* are usually present. *Pleuraphis jamesii* is well represented in the shrub interspaces at 10% foliar cover. Presence of other herbaceous species is minimal to absent.

Global Vegetation: The vegetation is characterized by an open (10-30% cover) short-shrub layer that is dominated by the deciduous, microphyllous shrub *Coleogyne ramosissima* with a sparse to moderately dense perennial graminoid layer that is dominated or codominated by *Pleuraphis jamesii*. Shrub associates may be present including *Atriplex canescens, Ephedra nevadensis, Ericameria nauseosa, Gutierrezia sarothrae*, and *Opuntia* spp. *Achnatherum hymenoides, Calochortus nuttallii*, and several annuals such as *Astragalus* sp. *Eriogonum nutans, Ipomopsis polycladon*, and *Phacelia ivesiana* may be present to abundant in the herbaceous layer, especially during wet years. Cover of introduced annual *Bromus* species may be high in disturbed stands. Occasional *Juniperus osteosperma* or *Pinus edulis* trees are present in some stands.

Global Dynamics: *Coleogyne ramosissima* is very sensitive to fire because it does not resprout after burning, and seeds in the seed bank are short-lived and destroyed by fire (Bowns and West 1976, Wright 1980). It is slow to recolonize burns, often requiring over 60 years to re-establish (Wright 1980). Burned-over areas often convert to *Gutierrezia microcephala*- or *Artemisia tridentata*-dominated shrublands (Bowns and West 1976). Invasion of introduced annual *Bromus* spp. creates a fire hazard and increases fire frequency (Warren et al. 1982).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima, Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima, Ephedra nevadensis, Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima, Ephedra nevadensis, Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima, Ephedra nevadensis, Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

GLOBAL SIMILAR ASSOCIATIONS:
- Coleogyne ramosissima Shrubland (CEGL001332)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This association is similar to the broadly-defined *Coleogyne ramosissima* Shrubland (CEGL001332). This association is separated only by the presence of a *Pleuraphis jamesii*- dominated herbaceous layer. More classification work in needed to fully describe each association.

ELEMENT DISTRIBUTION

Zion National Park Range: Stands of *Coleogyne ramosissima / Pleuraphis jamesii* occur in the foothills near the southern boundary of Zion National Park. Stands were documented in the Springdale West quadrangle and are expected to be uncommon within the park boundaries.

Global Range: This shrubland association occurs in the Colorado Plateau and Mojave Desert.

Nations: US
States/Provinces: AZ? CA? CO UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 502, 514
Classification Confidence: 2 **Identifier:** CEGL001334
REFERENCES: Bourgeron and Engelking 1994, Bowns and West 1976, Driscoll et al. 1984, Utah Environmental and Agricultural Consultants 1973, Warren et al. 1982, Wright 1980

COLEOGYNE RAMOSISSIMA SHRUBLAND

Blackbrush Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This broadly defined shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills in areas with hot summers and cold winters. Sites are gently sloping to flat. In Nevada, stands occur on lower foothills and upper bajadas often with cooler northern and eastern aspects. Substrates tend to be shallow, calcareous, sandy- or loamy-textured soils, often with a caliche subhorizon. Gravel, boulders and rock outcrops are common in many stands. The vegetation has an open to moderately dense short-shrub layer (10-50% cover) that is dominated by *Coleogyne ramosissima*. It can occur in almost pure stands. Other shrubs and dwarf-shrubs may be present with low cover including *Ambrosia dumosa, Atriplex* spp., *Chrysothamnus viscidiflorus, Ephedra* spp., *Ericameria* spp., *Gutierrezia* spp., *Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., and *Yucca baccata*. Occasional *Juniperus* spp., *Pinus edulis*, or *P. monophylla* trees may be present. The herbaceous layer is usually sparse, except during wet years when cover of annuals may be high. Introduced annual *Bromus* spp. may have high cover in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Stands of blackbrush are positioned on lowslopes, ridgetops, or interfluves at elevations of 3500-4000 feet. The terrain naturally decreases in elevation in a southerly and westerly direction from the higher plateaus and mesas of the park, and this association occurs on the lower foothills on eastern, southern, and western aspects. Soils that support these shrublands are for the most part fine, well-drained loamy sands.

Global Environment: This broadly defined shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills in areas with hot summers and cold winters. Elevations range from 1190-2133 m (3900-7000). Sites are gently sloping to flat. In Nevada, stands occur on lower foothills and upper bajadas often with cooler northern and eastern aspects. The upper elevation ecotones are generally narrow and *Coleogyne ramosissima* may mix with *Artemisia* spp., but the lower elevation ecotones tend to be broader and *Coleogyne ramosissima* may mix with communities dominated by *Larrea tridentata, Ambrosia dumosa, Atriplex* spp., or *Grayia spinosa* (Beatley 1976). Stands described from the Colorado Plateau often occur in a mosaic with pinyon-juniper woodlands (Warren et al. 1982). Substrates tend to be shallow, calcareous, sandy- or loamy-textured soils, often with a caliche subhorizon. Gravel, boulders and rock outcrops are common in many stands.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Coleogyne ramosissima* ranges from 10-40% foliar cover in this shrubland association. Other shrubs and subshrubs, such as *Ephedra nevadensis, Ephedra viridis, Gutierrezia sarothrae, Gutierrezia microcephala*, and *Atriplex canescens*, are commonly associated with blackbrush stands in the park and contribute from 5-20% cover. Total foliar cover is usually less than 40%. Though generally sparse, *Bromus tectorum* is commonly found scattered throughout under the shrubs and in the interspaces. Bunch grasses *Sporobolus cryptandrus* and *Pleuraphis jamesii* may also be present in some stands. *Juniperus osteosperma* trees or seedlings occur occasionally in this shrubland association, as well as subshrubs *Yucca baccata* and *Opuntia macrorhiza*.

Global Vegetation: This association has an open to moderately dense (10-50% cover) short-shrub layer that is dominated by the deciduous, microphyllous shrub *Coleogyne ramosissima*. It can occur in almost pure stands. Other shrub and dwarf-shrub species may be present with low cover including *Ambrosia dumosa, Atriplex canescens, A. confertifolia, Chrysothamnus viscidiflorus, Ephedra funerea, E. nevadensis, E. viridis, Ericameria linearifolia, E. teretifolia, Gutierrezia sarothrae, G. microcephala, Krascheninnikovia lanata, Lycium* spp., *Menodora spinescens, Opuntia* spp., and *Yucca baccata*. Occasional *Juniperus* spp., *Pinus edulis*, or *Pinus monophylla* trees are present in some stands. The herbaceous layer generally includes sparse cover of graminoids and forbs, except during wet years when cover of annuals may be high. Cover of introduced annual *Bromus* spp. may be high in disturbed stands.

Global Dynamics: *Coleogyne ramosissima* is very sensitive to fire because it does not resprout after burning, and seeds in the seed bank are short-lived and destroyed by fire (Bowns and West 1976, Wright 1980). It is slow to recolonize burns often requiring over 60 years to re-establish (Wright 1980). Burned-over areas convert to *Gutierrezia microcephala*- or *Artemisia tridentata*-dominated shrublands (Bowns and West 1976). Invasion of introduced annual *Bromus* spp. creates a fire hazard and increases fire frequency (Warren et al. 1982).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Atriplex canescens, Coleogyne ramosissima, Ephedra nevadensis, Gutierrezia microcephala, Gutierrezia sarothrae*
GRAMINOID	*Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Global

Stratum	**Species**
SHORT SHRUB	*Atriplex canescens, Coleogyne ramosissima, Ephedra nevadensis, Gutierrezia microcephala*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima*
GRAMINOID	*Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Global

Stratum	**Species**
SHORT SHRUB	*Coleogyne ramosissima*

GLOBAL SIMILAR ASSOCIATIONS:
- Pinus edulis - Juniperus osteosperma / Coleogyne ramosissima Woodland (CEGL000781)
- Quercus turbinella - Coleogyne ramosissima Shrubland (CEGL000982)
- Coleogyne ramosissima - Eriogonum fasciculatum Shrubland (CEGL001333)
- Coleogyne ramosissima / Pleuraphis jamesii Shrubland (CEGL001334)
- Larrea tridentata - Coleogyne ramosissima Shrubland (CEGL002717)
- Coleogyne ramosissima - Thamnosma montana Shrubland (CEGL002718)
- Coleogyne ramosissima - Purshia stansburiana Shrubland (CEGL002720)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4G5.

Global Comments: This widespread plant association is broadly defined by the strong dominance of *Coleogyne ramosissima* without diagnostic codominate shrub or herbaceous species. It is similar to the broadly defined *Coleogyne ramosissima / Pleuraphis jamesii* Shrubland (CEGL001334) and is separated only by the lack of a *Pleuraphis jamesii*- dominated herbaceous layer. More classification work is needed to fully describe each association.

ELEMENT DISTRIBUTION

Zion National Park Range: These shrublands occur on the southwest edge of the Springdale West quadrangle and the Zion National Park boundary. Extensive contiguous stands cover the low-elevation hills, ridges and alluvial terraces of Coalpits and Huber Wash and extend southward to uplands or benches of the Virgin River corridor.

Global Range: This widespread desert shrubland association occurs in the Colorado Plateau, southern Great Basin, Mojave Desert, and Sierra Nevada foothills.

Nations: US
States/Provinces: AZ CA NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH47, RH82, RH83, 501
Classification Confidence: 2 **Identifier:** CEGL001332
REFERENCES: Annable 1985, Armstrong 1969, BIA 1979, Beatley 1976, Bourgeron and Engelking 1994, Bowns and West 1976, Bradley 1964, Callison et al. 1985, Driscoll et al. 1984, Ostler et al. 2000, Peterson 1984, Schultz et al. 1987, Shields et al. 1959, Warren et al. 1982, Wells 1960, West 1983d, Wright 1980

III.B.2.N.a. Temperate cold-deciduous shrubland

III.B.2.N.a.23. AMELANCHIER UTAHENSIS SHRUBLAND ALLIANCE
Utah Serviceberry Shrubland Alliance

AMELANCHIER UTAHENSIS SHRUBLAND

Utah Serviceberry Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This mountain shrubland association occurs in the foothills, mountains and mesas in north-central Utah, the Colorado Plateau and Great Basin of the western U.S. Stands occur on moderate slopes on all aspects. It is found on relatively warm southern aspects in the Wasatch Mountains, but also occurs on northern aspects at lower elevations and at more southern latitudes. Substrates are moderately deep, rocky loams and clays. The vegetation is characterized by a sparse to moderately dense tall-shrub layer (15-60% cover) dominated by the cold-deciduous shrub, *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer other shrub associates may include low cover of *Acer grandidentatum, Chrysothamnus viscidiflorus, Mahonia repens, Purshia tridentata*, and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5%). The sparse to moderately dense herbaceous layer is a mixture of perennial graminoids and forbs. Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation ranges between 6500-8000 feet for this association. Slopes are gentle or steep with various aspects. Soil texture is clayey or fine-grained on cinder cone formations, such as Firepit Knoll. The *Amelanchier utahensis* stands on the northern boundary of the park has rich loamy soils.

Global Environment: This montane shrubland association occurs in the foothills, mountains and mesas in north-central Utah, the Colorado Plateau and Great Basin of the western U.S. Elevation ranges from 1980-2440 m (6500-8000 feet). Stands occur on moderate slopes on all aspects. It is found on relatively warm southern aspects in the Wasatch Mountains (Yake and Brotherson 1979), but also occurs on northern aspects at lower elevations and more southern latitudes. Substrates are moderately deep, rocky loams and clays.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Amelanchier utahensis* dominates the shrub layer with 15-40% cover. Other shrubs are absent or insignificant in sampled plots. The high-elevation stand on the northern boundary of the park is more mesic, and shrubs are nearly 5 m in height. *Acer grandidentatum* is present as well as other mesic herbaceous species, such as *Mertensia arizonica* and *Poa pratensis*. This area is also subject to historical and current livestock grazing. The other documented sites have drier conditions. *Amelanchier utahensis* has a shorter stature and is more widely spaced. *Bromus tectorum* is abundant in the understory, and few other species are present. In observed locations in Cave Valley and Lee Valley, *Artemisia tridentata* is a component of this association.

Global Vegetation: This vegetation has a sparse to moderately dense (15-60% cover) tall-shrub layer dominated by *Amelanchier utahensis*. *Symphoricarpos oreophilus* often forms a short-shrub layer. Other shrubs may include *Acer grandidentatum, Chrysothamnus viscidiflorus, Mahonia repens, Purshia tridentata*, and *Rosa woodsii*. *Quercus gambelii* may also be present, but it is always poorly represented (<5% cover). The sparse to moderate herbaceous layer is a mixture of perennial graminoids and forbs. Herbaceous species include *Bromus carinatus, Koeleria macrantha, Achnatherum nelsonii ssp. dorei), Balsamorhiza sagittata, Chenopodium fremontii, Machaeranthera canescens*, and species of *Astragalus, Eriogonum, Mertensia*, and *Penstemon* (Yake and Brotherson 1979). Introduced species such as *Agropyron cristatum* and *Bromus tectorum* are common in disturbed stands.

Global Dynamics: Fire is important in maintaining the montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees and other less fire-tolerant species. *Amelanchier utahensis* will sprout from the root crown after above-ground parts of the plant are killed by fire (Carmichael et al. 1978). It may be slightly harmed by fire, depending on moisture conditions, but is considered to be fire-tolerant and will persist or increase after burning (Carmichael et al. 1978, Crane 1982).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis*

Global

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis*
SHORT SHRUB	*Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Artemisia tridentata*

Global

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: This association is not well known. More survey work and classification work are needed to further define this type.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in two documented sites on the western side of Firepit Knoll and ridge north of Camp Creek and was observed in Cave Valley and Lee Valley.

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

Nations: US
States/Provinces: NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH51, 65, 117. In Pine Springs Wash, there was a *Quercus turbinella* and *Amelanchier utahensis* mixture (not colluvial). AMUT was found in small stands in Lee Valley and Cave Valley. It was in a mosaic with *Artemisia tridentata*.
Classification Confidence: 2 **Identifier:** CEGL001067
REFERENCES: Bourgeron and Engelking 1994, Carmichael et al. 1978, Crane 1982, Driscoll et al. 1984, Eddleman and Jaindl 1994, Yake and Brotherson 1979

III.B.2.N.a.27. QUERCUS GAMBELII SHRUBLAND ALLIANCE
Gambel Oak Shrubland Alliance

QUERCUS GAMBELII - CERCOCARPUS MONTANUS / (CAREX GEYERI) SHRUBLAND
Gambel Oak - Mountain-mahogany / (Geyer's Sedge) Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This mixed montane shrubland association is reported from foothills, mountains and mesa tops in western Colorado and Utah. Stands occur on moderate to steep slopes. Aspect varies with elevation with low elevation stands restricted to more mesic northern and eastern aspects, and higher elevation stands occurring on southern and western aspects. Substrates are typically shallow and rocky, derived from sandstone and shale parent materials, and range from sandy- to clayey-textured soil. The vegetation is characterized by a moderately dense to dense thicket of tall deciduous shrubs 2-5 m tall (on unstable, eroding or talus slopes the shrub canopy may be open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula, Arctostaphylos pungens, Artemisia tridentata, Fendlera rupicola, Fraxinus anomala, Peraphyllum ramosissimum, Physocarpus monogynus, Purshia tridentata, Rhus trilobata, Rosa woodsii, Quercus turbinella, Symphoricarpos oreophilus*, and *Yucca* spp. may be present depending on geography. Occasional *Juniperus osteosperma* and *Pinus edulis* trees may be present also. The herbaceous layer is generally sparse because of dense overstory.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation ranges 5600-7200 feet for this association. Stands at lower elevations occur on northerly aspects. Slope gradient tends to be moderately steep to steep with northerly and easterly aspects. Stands may occur on mesa tops, but are generally indicative of mountain slopes in the northwest region of Zion National Park. Soil texture is clayey or loamy.

Global Environment: This mixed montane shrubland association is reported from foothills, mountains and mesa tops in western Colorado and Utah. Elevation ranges from 1700-2500 m (5600-8200 feet). Stands occur on moderate to steep slopes. Aspect varies with elevation with low elevation stands restricted to more mesic northern and eastern aspects, and higher elevation stands occurring on southern and western aspects. Substrates are typically shallow and rocky, derived from sandstone and shale parent materials, and range from sandy- to clayey-textured soil.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association depicts a true mixed montane shrubland. Total shrub cover is usually over 50%. Few pinyon and juniper trees exist in the stands or are often absent. *Cercocarpus montanus* is always present with cover from 10-50%. *Quercus turbinella* and *Amelanchier utahensis* are codominants or at least present in the stand. Other shrubs that may be present in this mountain shrub complex, but always contribute minimal cover, are *Symphoricarpos oreophilus, Arctostaphylos patula, Arctostaphylos pungens, Peraphyllum ramosissimum, Quercus turbinella, Fraxinus anomala*, and *Purshia tridentata*. Herbaceous species commonly present are *Poa fendleriana, Achnatherum hymenoides*, and *Vicia americana*.

Global Vegetation: This association is characterized by a moderately dense to dense thicket of tall deciduous shrubs 2-5 m tall (on unstable, eroding or talus slopes the shrub canopy may be open). Codominance of *Quercus gambelii* and *Cercocarpus montanus* (at least 10% cover of each) is diagnostic of this plant association, but *Amelanchier utahensis* is often also abundant to codominant. Low cover of other mixed shrub associates is common. *Arctostaphylos patula, Arctostaphylos pungens, Artemisia tridentata, Fendlera rupicola, Fraxinus anomala, Peraphyllum ramosissimum, Physocarpus monogynus, Purshia tridentata, Rhus trilobata, Rosa woodsii, Quercus turbinella, Symphoricarpos oreophilus*, and *Yucca* spp. may be present depending on geography. Occasional *Juniperus osteosperma* and *Pinus edulis* trees may be present also. The herbaceous layer is generally sparse because of dense overstory. It is typically composed of scattered graminoids such as *Carex geyeri, Poa fendleriana, Achnatherum hymenoides*, and forbs like *Vicia americana, Lupinus* spp., and *Lathyrus* spp.

Global Dynamics: Fire is important in maintaining the montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system used to draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). Muldavin et al. (1998b) reported that, in the Organ Mountains in southwestern New Mexico after a severe fire, *Quercus gambelii* resprouted into a dense thicket that excluded both herbaceous understory and conifer species. *Cercocarpus montanus* is also fire-adapted. Although its branches are usually killed by fire, it burns less readily than many other shrubs and sprouts vigorously from the root crown after most fires (Bradley et al. 1992, Pase and Lindenmuth 1971).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*

Global

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Cercocarpus montanus, Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Juniperus scopulorum, Pinus edulis, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Arctostaphylos pungens, Cercocarpus montanus, Peraphyllum ramosissimum, Quercus gambelii, Symphoricarpos oreophilus*
GRAMINOID	*Achnatherum hymenoides, Poa fendleriana*
FORB	*Vicia americana*

Global

Stratum	**Species**
TALL SHRUB	*Cercocarpus montanus, Quercus gambelii*
GRAMINOID	*Carex geyeri*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3.

Global Comments: This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Cercocarpus montanus* (10% cover or more). Other shrubs species may be present to codominant.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is abundant on the mountain slopes west of the Kolob Canyons. It has also been documented on the eastern side of the park in the Temple of Sinawava quadrangle.

Global Range: This montane shrubland association occurs in the foothills, mountains and mesa tops of western Colorado and Utah.

Nations: US
States/Provinces: CO UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH78, 79, 80, 111, 139, 201, 275
Classification Confidence: 2 **Identifier:** CEGL001113
REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, Bradley et al. 1992, Clary 1992, Dillinger 1970, Driscoll et al. 1984, Ellis and Hackney 1981, Erdman 1962, Ferchau 1973, Hanson and Ball 1928, Keammerer and Peterson 1981, Muldavin et al. 1998b, Pase and Lindenmuth 1971, Schmoll 1935, Vories 1974

QUERCUS GAMBELII / AMELANCHIER UTAHENSIS SHRUBLAND

Gambel Oak / Utah Serviceberry Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This montane shrubland occurs in Utah and likely western Colorado. Stands occur on mesas, higher benches, ridges, foothills and mountains. Slopes are gentle to steep and aspects are easterly, southerly, and westerly. Soil are generally deep and well-developed. Vegetation is characterized by a sparse to moderately dense (20-70% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* with a short-shrub layer codominated by *Amelanchier utahensis* and *Artemisia tridentata*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Ephedra viridis, Gutierrezia sarothrae, Opuntia* spp., *Prunus virginiana*, and *Symphoricarpos* spp. Perennial graminoids such as *Pascopyrum smithii* or *Poa fendleriana* typically dominate the sparse herbaceous layer (<10% total cover). Common forbs may include *Achillea millefolium, Artemisia ludoviciana, Balsamorhiza sagittata, Phlox austromontana, Thalictrum fendleri*, or *Vicia americana*. Occasionally, tree species such as *Pinus edulis* or *Juniperus osteosperma* are present in the overstory.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on mountain slopes, ridges, and mesa tops at elevations of 5000-7500 feet. Slopes are gentle to steep and aspects are easterly, southerly, and westerly. Soil texture is variable.

Global Environment: This mountain shrubland occurs in Utah and likely western Colorado. Elevation ranges from 1525-2300 m (5000-7500 feet). Stands occur on mesas, higher benches, ridges, foothills and mountains Slopes are gentle to steep and aspects are easterly, southerly, and westerly. Soil are generally deep and well-developed.

VEGETATION DESCRIPTION

Zion National Park Vegetation: The tree layer is absent or minimal in this association. *Quercus gambelii* is the dominant shrub with cover over 10%. *Amelanchier utahensis* codominates or has less cover than *Quercus gambelii*. Other shrubs commonly present with minimal cover are *Symphoricarpos oreophilus, Cercocarpus montanus, Gutierrezia sarothrae*, and *Opuntia macrorhiza*. Total shrub cover ranges from 20-70%. The herbaceous layer is sparse, but commonly represented by *Poa fendleriana, Packera multilobata, Vicia americana*, and *Artemisia ludoviciana*.

Global Vegetation: This association is characterized by a sparse to moderately dense (20-70% cover) tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* with a short-shrub layer codominated by *Amelanchier utahensis* and *Artemisia tridentata*. *Cercocarpus montanus* is absent or poorly represented (<5% cover). Other shrubs and dwarf-shrubs present with low cover may include *Ephedra viridis, Gutierrezia sarothrae, Opuntia* spp., *Prunus virginiana*, and *Symphoricarpos* spp. Graminoids such as *Pascopyrum smithii* or *Poa fendleriana* dominate the sparse herbaceous layer (<10% total cover). Common forbs include *Achillea millefolium, Artemisia ludoviciana, Balsamorhiza sagittata, Packera multilobata, Phlox austromontana, Thalictrum fendleri*, or *Vicia americana*. Occasionally, tree species are present in the overstory including *Pinus edulis* or *Juniperus osteosperma*.

Global Dynamics: Fire is important in maintaining montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system used to draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). Muldavin et al. (1998b) reported that, in the Organ Mountains in southwestern New Mexico after a severe fire, *Quercus gambelii* resprouted into a dense thicket that excluded both herbaceous understory and conifer species. *Amelanchier utahensis* also sprouts from the root crown after above-ground parts of the plant are killed by fire (Carmichael et al. 1978). It may be slightly harmed by fire, depending on moisture conditions, but is considered to be fire-tolerant and will persist or increase after burning (Carmichael et al. 1978, Crane 1982).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Quercus gambelii*

Global

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Quercus gambelii*
SHORT SHRUB	*Symphoricarpos oreophilus*
FORB	*Artemisia ludoviciana, Vicia americana*

Global

Stratum	**Species**
TALL SHRUB	*Amelanchier utahensis, Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3G5.

Global Comments: This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Amelanchier utahensis* with only minor amounts (<10% cover) of *Artemisia tridentata* or *Cercocarpus montanus*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs abundantly scattered throughout the northwestern region of Zion National Park, on Kolob Arch, Guardian Angels and Springdale West quadrangles.

Global Range: This montane shrubland occurs in Utah and likely western Colorado.

Nations: US
States/Provinces: CO? UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH3, RH25, RH73, 19, 64, 73, 255, 360
Classification Confidence: 2 **Identifier:** CEGL001110
REFERENCES: Bourgeron and Engelking 1994, Carmichael et al. 1978, Cedar Creek Associates Inc. 1987, Clary 1992, Crane 1982, Driscoll et al. 1984, Muldavin et al. 1998b

QUERCUS GAMBELII / ARTEMISIA TRIDENTATA SHRUBLAND

Gambel Oak / Big Sagebrush Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This shrubland association is described from mountains and plateaus of Utah. Sites are on nearly level mesas to steep hillslopes (to 40%). Soils are gravelly loams. The vegetation is characterized by a moderately dense to dense tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* (10-60% cover) with a sparse to moderately dense short-shrub layer dominated by *Artemisia tridentata* often forming a mosaic of oak and sagebrush. If present, *Amelanchier* spp. and *Cercocarpus montanus* occur in minor amounts (<10% cover). Other shrubs that may be present include *Chrysothamnus viscidiflorus, Purshia tridentata, Opuntia* spp, *Rosa* spp., *Symphoricarpos* spp., and *Tetradymia canescens*. The relatively sparse herbaceous layer is a mixture of grasses and forbs.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at 6000-7000 feet, on flat to moderate sloping terrain, and on sandy soils.

Global Environment: This shrubland association has been described from mountains and plateaus of Utah. Elevation ranges from 1830-2135 m (6000-7000 feet). Sites are on nearly level mesas to steep hillslopes (to 40%). Soils are gravelly loams.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Quercus gambelii* dominates this association with cover of 10-40%. *Artemisia tridentata* is a significant component of the shrubland averaging 10% cover. Other shrub species inconsistently present with less cover are *Tetradymia canescens, Chrysothamnus* spp., *Purshia tridentata*, and *Opuntia* spp. Herbaceous species are of variable composition and minimal cover. Graminoids commonly present are *Poa fendleriana* and *Sporobolus cryptandrus*.

Global Vegetation: This association is characterized by a moderately dense to dense tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii* (10-60% cover) with a sparse to moderately dense short-shrub layer dominated by *Artemisia tridentata* often forming a mosaic of oak and sagebrush. If present, *Amelanchier* spp. and *Cercocarpus montanus* occur in minor amounts (<10% cover). Other shrubs that may be present include *Chrysothamnus viscidiflorus, Purshia tridentata, Opuntia* spp, *Rosa* spp., *Symphoricarpos* spp., and *Tetradymia canescens*. The relatively sparse herbaceous layer is a mixture of grasses and forbs. Graminoids commonly present are *Carex rossii, Poa fendleriana , Pseudoroegneria spicata*, and *Sporobolus cryptandrus*. Common forbs include *Achillea millefolium, Artemisia ludoviciana, Thalictrum fendleri*, or *Vicia americana*.

Global Dynamics: Fire is important in maintaining the montane shrublands, as burning eliminates *Juniperus osteosperma* and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with a well-developed root system used to draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). However, *Artemisia tridentata* shrubs are killed by burns and do not resprout (Wright et al. 1979). *Artemisia tridentata* will re-establish relatively quickly (about 10-20 years) if a seed source is nearby (Bunting 1987). If fire-return intervals are more frequent than 10 years, then *Artemisia tridentata* has difficulty recovering (Bunting 1987, Everett 1987). *Artemisia tridentata* may be able to persist in this community where an open shrub canopy and a sparse herbaceous layer limit fire movement and make it unlikely that it would burn except under extreme conditions.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata, Quercus gambelii*

Global

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata, Quercus gambelii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata, Quercus gambelii*

Global

Stratum	**Species**
TALL SHRUB	*Artemisia tridentata, Quercus gambelii*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4G5.

Global Comments: This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Artemisia tridentata* with only minor amounts (<10% cover) of *Amelanchier utahensis* or *Cercocarpus montanus*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs throughout Zion National Park, specifically on Kolob Canyons, Firepit Knoll, and Deer Trap Mountain.

Global Range: This shrubland association occurs in mountains and plateaus of Utah and possibly occurs in western Colorado.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH6, RH 72, 126
Classification Confidence: 2 **Identifier:** CEGL001111
REFERENCES: Blackhawk Coal Company 1981, Boucek 1986, Bourgeron and Engelking 1994, Bunting 1987, Christensen 1955, Clary 1992, Driscoll et al. 1984, Everett 1987, Wright et al. 1979

QUERCUS GAMBELII / POA FENDLERIANA SHRUBLAND [PROVISIONAL]

Gambel Oak / Muttongrass Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation ranges 5800-7600 feet for this association. Slopes are gentle to moderate and northeast-facing. Soil texture is sand and sandy loam.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Quercus gambelii* clearly dominates this association with foliar cover ranging from 20-90%. Other shrubs present have insignificant cover and inconsistent representation. *Symphoricarpos oreophilus*, if present, has less than 5% cover. The tree canopy layer is absent. The herbaceous layer is fairly significant with cover of 5-30%. *Poa fendleriana* is usually dominant and occurs consistently. Other graminoid species that may be present to abundant are *Bouteloua gracilis, Poa pratensis, Achnatherum hymenoides*, and *Hesperostipa comata*. Forb species present are inconsistent and of minimal cover.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Quercus gambelii*
GRAMINOID	*Bouteloua gracilis, Poa fendleriana*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Quercus gambelii*
GRAMINOID	*Poa fendleriana*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is mostly found in the northern latitudes of the park at high elevations and some north-facing slopes of lower elevations.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH91, 76, 268, 350
Classification Confidence: **Identifier:** CEGL002949
REFERENCES: None available.

QUERCUS GAMBELII / SYMPHORICARPOS OREOPHILUS SHRUBLAND
Gambel Oak / Mountain Snowberry Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This plant association is found in the foothills, plateaus and mountains from western Texas to southern and western Colorado and northern Utah, and likely occurs in northern Arizona. It is a mesic upland and a non-obligate riparian community that appears to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained sandy loam to clay loam derived from alluvium or colluvium. The vegetation is characterized by an open to closed, typically tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present including *Amelanchier* spp., *Prunus virginiana, Robinia neomexicana*, and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands the oak is mostly under 2 m tall, forming a short-shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids such as species of *Achnatherum, Bromus, Elymus, Poa*, and *Koeleria*. Common forbs include *Vicia americana, Thalictrum fendleri*, and *Achillea millefolium*. Occasionally, tree species are present in the overstory.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on high slopes, ridges, and mesas, with elevations ranging from 6500-7800 feet, various aspects, and gentle to moderate gradients. Soil texture is most commonly clay loam.

Global Environment: This plant association is found in the foothills, plateaus and mountains from western Texas to southern and western Colorado and northern Utah, and likely occurs in northern Arizona. Elevation ranges from 1830-2625 m (6000-8600 feet). It is a mesic upland and a non-obligate riparian community that appears to be transitional between riparian areas and drier upland communities such as *Artemisia* spp. It occurs on cool, moist sites, such as along drainages in canyons and steep draws in more xeric areas, and as a mesic upland shrubland forming extensive stands on cooler northern slopes. Substrates are typically deep, well-drained sandy loam to clay loam derived from alluvium or colluvium.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Quercus gambelii* is dominant in this association either in tree, tall-shrub, or short-shrub form with cover of 10-60%. *Symphoricarpos oreophilus* is in the understory with cover of 5-20%. On the east side of the park, shrubs that may be present to well-represented are *Purshia tridentata* and *Peraphyllum ramosissimum*. Graminoids are often abundant in the understory, and the stand may appear as a wooded grassland. Some graminoid species that occur are *Hesperostipa comata, Poa pratensis, Poa fendleriana, Achnatherum lettermanii, Bouteloua gracilis, Bromus inermis, Elymus repens, Achnatherum hymenoides*, and *Elymus elymoides*. *Vicia americana* is commonly present. Surrounding vegetation is commonly grassland meadows and shrublands.

Global Vegetation: The vegetation is characterized by an open to closed, tall-shrub layer (2-5 m tall) that is dominated by *Quercus gambelii*. The understory is composed of a short-shrub layer that is dominated by *Symphoricarpos oreophilus* or a closely related local *Symphoricarpos* species such as *Symphoricarpos rotundifolius* or *Symphoricarpos palmeri*. Other mesic shrubs may be present including *Amelanchier* spp., *Prunus virginiana, Robinia neomexicana*, and *Brickellia* sp. In some stands, the *Quercus gambelii* develop into small trees that form a tree canopy. These "woodlands" are included in this association because their floristic composition is identical to the tall shrublands. In other stands the oak is mostly under 2 m tall forming a short shrub layer. The herbaceous layer is sparse to moderately dense, depending on density of woody canopy, and is often dominated by graminoids such as species of *Achnatherum, Bromus, Elymus, Poa*, and *Koeleria macrantha*. Common forbs include *Vicia americana, Thalictrum fendleri*, and *Achillea millefolium*. Occasionally, tree species are present in the overstory including *Pinus ponderosa, Juniperus scopulorum*, and *Pseudotsuga menziesii*. Introduced graminoids such as *Bromus inermis* and *Poa pratensis* are often common in stands that have been disturbed by heavy livestock grazing.

Global Dynamics: Fire is important in maintaining montane shrublands, as burning eliminates *Juniperus osteosperma, Juniperus scopulorum*, and *Pinus edulis* trees, but not the more fire-adapted shrub species. *Quercus gambelii* is a fire-adapted species with well-developed root systems that draw moisture from a large volume of soil allowing for rapid resprouting after fire (Clary 1992). Muldavin et al. (1998b) reported that, in the Organ Mountains in southwestern New Mexico after a severe fire, *Quercus gambelii* resprouted into a dense thicket that excluded both herbaceous understory and conifer species. *Symphoricarpos oreophilus* is tolerant of fire, is usually undamaged by low-severity fire, and will sprout if the above-ground parts are burned. It is considered a weak sprouter and may take longer to recover from a burn than *Quercus gambelii* (up to 15 years after a severe fire) (Crane 1982, Wright et al. 1979).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*
GRAMINOID	*Achnatherum lettermanii, Hesperostipa comata, Poa pratensis*

Global

Stratum	Species
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*

Global

Stratum	Species
TALL SHRUB	*Quercus gambelii, Symphoricarpos oreophilus*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This plant association is similar to other montane Gambel oak shrublands except for the codominance of *Symphoricarpos oreophilus* with only minor amounts (<10% cover) of *Amelanchier utahensis, Artemisia tridentata*, or *Cercocarpus montanus*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs at high-elevation sites in Kolob Arch, Guardian Angels, and Temple of Sinawava quadrangles.

Global Range: This shrubland association is reported from foothills, plateaus and mountains of western Texas to southern and western Colorado and Utah, and likely occurs in Arizona.

Nations: US
States/Provinces: AZ? CO NM TX UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH05, RH50, 86, 91, 94, 103, 122, 133, 256, 84
Classification Confidence: 2 **Identifier:** CEGL001117
REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, Clary 1992, Crane 1982, Driscoll et al. 1984, Erdman 1962, Hess and Wasser 1982, Hoffman and Alexander 1980, Johnston 1987, Kittel et al. 1994, Kittel et al. 1999, Kittel et al. 1999b, Komarkova et al. 1988a, Muldavin 1994, Muldavin and Mehlhop 1992, Muldavin et al. 1994a, Muldavin et al. 1998b, Muldavin et al. 2000b, Soil Conservation Service 1978, Wright et al. 1979

III.B.2.N.a.200. SYMPHORICARPOS OREOPHILUS SHRUBLAND ALLIANCE
Mountain Snowberry Shrubland Alliance

SYMPHORICARPOS OREOPHILUS / POA PRATENSIS SEMI-NATURAL SHRUBLAND [PROVISIONAL]
Mountain Snowberry / Kentucky Bluegrass Semi-natural Shrubland

ELEMENT CONCEPT
GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION
USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs in depressions or gentle drainages of the undulating plateau at 7800 feet. Soil texture is clay loam. Low-intensity prescribed fire in the spring of 1999 impacted this area.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION
Zion National Park Vegetation: *Symphoricarpos oreophilus* is widespread in Oak Valley and Lower Kolob Plateau as an understory species. Here, it is the dominant species in the short-shrub layer with 30% cover. Charred stems of *Artemisia nova* are abundant at the site due to the recent prescribed fire. No live *Artemisia nova* shrubs are present in the plot sampled, but they are present in unburned areas nearby. Total herbaceous cover is 30%. *Poa pratensis* dominates with 20% cover. Other graminoids present are *Pascopyrum smithii, Elymus repens*, and *Achnatherum lettermanii*. Forbs present include *Lathyrus brachycalyx, Lupinus argenteus, Artemisia campestris, Mentha X piperita, Penstemon* spp., *Mertensia arizonica, Eriogonum racemosum, Tragopogon dubius*, and *Achillea millefolium*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES
Zion National Park

Stratum	Species
SHORT SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Poa pratensis*
FORB	*Lathyrus brachycalyx*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES
Zion National Park

Stratum	Species
SHORT SHRUB	*Symphoricarpos oreophilus*
GRAMINOID	*Pascopyrum smithii, Poa pratensis*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled in Oak Spring Valley in the Guardian Angels quadrangle of Zion National Park and has been observed scattered infrequently across the Lower Kolob Plateau.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 90
Classification Confidence: 3 **Identifier:** CEGL002951
REFERENCES: None available.

III.B.2.N.d. Temporarily flooded cold-deciduous shrubland

III.B.2.N.d.26. BETULA OCCIDENTALIS TEMPORARILY FLOODED SHRUBLAND ALLIANCE

Water Birch Temporarily Flooded Shrubland Alliance

POPULUS FREMONTII / BETULA OCCIDENTALIS WOODED SHRUBLAND

Fremont Cottonwood / Water Birch Wooded Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This riparian shrubland association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: Elevation for this association is 5500 to 6000 feet, but it does occur at lower elevations if the site is shaded and north-facing. It occurs on flat to gentle sloping streambanks and benches on sandy loam soils.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Vegetation structure and cover in this association are variable. *Populus fremontii* may be present as young trees contributing to the tall-shrub layer, codominated by riparian shrubs *Betula occidentalis* and *Salix* spp. In some cases, *Populus fremontii* or *Juniperus scopulorum* may occur as mature trees with a canopy cover of 5-20%. *Betula occidentalis* dominates the shrub layer (10-40% cover) accompanied by various shrubs of inconsistent frequency depending on the adjacent upland vegetation. Most frequently occurring or characteristic shrubs of this association are *Salix* spp. and *Rosa woodsii*. The herbaceous layer has variable composition, with average cover of 30% and relatively tall structure. This may not be true where recreational trails intersect streambanks and the vegetation is trampled. Common herbaceous species include *Agrostis stolonifera, Poa pratensis,* and *Maianthemum stellatum.*

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Populus angustifolia, Populus fremontii*
SHRUB	*Betula occidentalis, Rosa woodsii*
GRAMINOID	*Agrostis stolonifera, Poa pratensis*
FORB	*Maianthemum stellatum*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Populus fremontii*
SHRUB	*Betula occidentalis*

Global

Stratum	**Species**

Information not available.

OTHER NOTEWORTHY SPECIES

Zion National Park
Salix spp. are also dominant shrubs and *Equisetum* spp. are also dominant forbs.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in mid-elevation, cool drainages of the Kolob Canyons, specifically Taylor Creek and its tributaries. It has also been documented in Left Fork of North Creek and Shune's Creek.

Global Range: This riparian association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 23, 38, 69, 524
Classification Confidence: 3 **Identifier:** CEGL002981
REFERENCES: None available.

III.B.2.N.d.6. SALIX (EXIGUA, INTERIOR) TEMPORARILY FLOODED SHRUBLAND ALLIANCE

(Coyote Willow, Sandbar Willow) Temporarily Flooded Shrubland Alliance

SALIX EXIGUA / BARREN SHRUBLAND

Coyote Willow / Barren Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and Great Basin. It is composed of nearly pure stands of *Salix exigua*, with few other species. Exposed gravel, cobbles or sand characterize the ground cover, but an undergrowth of a few, scattered forbs and grasses is usually present. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and streambanks.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: *Salix exigua* / Barren Shrublands occur on deep alluvial sands of washes and sandbars at elevations from 4000 to 7000 feet.

Global Environment: This riparian shrubland is common in the Rocky Mountains, Colorado Plateau and Great Basin. Elevation ranges from 780-2600 m. This association occurs within the annual flood zone of rivers on point bars, islands, sand or cobble bars, and on streambanks occurring along a wide variety of stream reaches, from moderately sinuous and moderate-gradient reaches. It can form large, wide stands on mid-channel islands in larger rivers or narrow stringer bands on small, rocky tributaries. Substrates are typically coarse alluvial deposits of sand, silt and cobbles that are highly stratified vertically from flooding scour and deposition, often consisting of alternating layers of finer textured soil with organic material over coarser alluvium. Occasionally, this association occurs on deep pockets of sand. The lack of soil development and high ground cover of coarse alluvial material are key indicators for this association.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Salix exigua* dominates this association though its foliar cover is sparse, 10-30%. The herbaceous vegetation layer cover is 10%. These riparian sites usually are subject to human disturbance and readily invaded by exotic grasses and forbs. *Populus fremontii* seedlings are also abundant in this vegetation, suggesting succession will occur to a *Populus fremontii* forest or woodland.

Global Vegetation: This riparian association is characterized by a sparse to dense, tall-shrub (1.5-3 m) canopy composed of *Salix exigua* with ground cover of exposed gravel, cobbles or sand. Relatively low cover of several other shrubs and trees may be present including *Alnus incana, Salix monticola, Salix ligulifolia (= Salix eriocephala var. ligulifolia), Salix irrorata, Salix lucida, Acer negundo, Abies lasiocarpa, Populus angustifolia, Populus deltoides*, and *Populus fremontii*. A sparse herbaceous layer may be present among the bare soil, gravel, cobbles, or boulders consisting of a wide variety of forbs and graminoids. *Mentha arvensis*, and species of *Carex, Eleocharis, Juncus, Schoenoplectus*, and *Equisetum* are often present. Introduced species, such as *Elaeagnus angustifolia, Tamarix* spp., *Bromus tectorum, Bromus inermis, Elymus repens (= Elytrigia repens), Poa pratensis, Agrostis stolonifera* (and other exotic forage species), *Taraxacum officinale, Conyza canadensis*, and *Lepidium latifolium*, have been reported from some stands.

Global Dynamics: This association is an early-seral type that colonizes newly created point bars and other recent alluvial deposits formed in rivers and streams (Kittel et al. 1999b).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Salix exigua*
GRAMINOID	*Agrostis stolonifera, Bromus tectorum, Juncus longistylis*
FORB	*Artemisia campestris, Rumex acetosella, Senecio spartioides*

Global

Stratum	**Species**
TALL SHRUB	*Salix exigua*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Salix exigua*

Global

Stratum	**Species**
TALL SHRUB	*Salix exigua*

GLOBAL SIMILAR ASSOCIATIONS:

- Salix exigua / Mesic Graminoids Shrubland (CEGL001203)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: In the western Great Plains this association includes stands composed of intermediates between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* (Dorn 1997, G. Kittel pers. comm. 2001). Until recently these taxa where combined at the species level (Kartesz 1999). More information on the distribution of introgression between *Salix interior (= Salix exigua ssp. interior)* and *Salix exigua (= Salix exigua ssp. exigua)* is needed to fully understand the ranges of these two species.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented in Hop Valley and Lee Valley in Zion National Park. It likely occurs in other similar washes or river sandbars throughout the park.

Global Range: This riparian shrubland association is common at lower to middle elevations in the Great Basin, Colorado Plateau and Rocky Mountains extending out into the western Great Plains along major rivers.

Nations: US
States/Provinces: CO ID? UT WA

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 74
Classification Confidence: 1 **Identifier:** CEGL001200
REFERENCES: Bourgeron and Engelking 1994, Christy 1973, Dorn 1997, Driscoll et al. 1984, Hall and Hansen 1997, Hansen et al. 1995, Johnston 1987, Jones and Walford 1995, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999, Kittel et al. 1999b, Muldavin et al. 2000a, Padgett et al. 1988b, Padgett et al. 1989, Tuhy and Jensen 1982

SALIX EXIGUA / MESIC GRAMINOIDS SHRUBLAND

Coyote Willow / Mesic Graminoids Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This riparian association is found primarily in the central Great Plains, but also occurs in parts of the Rocky Mountains and Intermountain semi-desert regions. It generally occurs along backwater channels and other perennially wet, but less scoured sites such as floodplain swales and irrigation ditches. In Nebraska, this community is found on sandbars, islands, and shorelines of stream channels and braided rivers. The vegetation is characterized by the dominance of *Salix exigua* in a moderately dense tall-shrub canopy with a dense herbaceous layer dominated by graminoids. Other common shrubs include saplings of *Populus deltoides* or *Salix amygdaloides, Salix eriocephala, Salix lutea*, and *Amorpha fruticosa*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Panicum virgatum* or other tall grasses are present. Other mesic graminoids, such as *Carex* spp., *Eleocharis* spp., *Juncus* spp., *Pascopyrum smithii, Schoenoplectus pungens (= Scirpus pungens)*, and *Sphenopholis obtusata*, may be present. Common forb species include *Bidens* spp., *Lobelia siphilitica, Lycopus americanus, Lythrum alatum, Polygonum* spp., and *Xanthium strumarium*. Diagnostic features include nearly pure stands of *Salix exigua* shrubs, with a dense herbaceous layer of at least 30% cover of mesic graminoids.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs infrequently on sandy creek bottoms that are seasonally flooded. Stream gradient is flat to gentle and soils are deep sands.

Global Environment: This riparian association is found primarily in the central Great Plains, but also occurs in parts of the Rocky Mountains and Intermountain semi-desert regions. Elevation ranges from 1750-2700 m (5700-9100 feet). It generally occurs along alluvial terraces of backwater channels and other perennially wet, but less scoured sites such as floodplain swales and irrigation ditches. This community is found on sandbars, islands, and shorelines of stream channels and braided rivers in Nebraska (Steinauer and Rolfsmeier 2000). Stands usually occur within 1 m vertical distance of the stream channel on point bars, low floodplains, terraces and along overflow channels. It can also occur away from the stream channel in mesic swales or along the margins of beaver ponds and seeps. Soils are derived from alluvium and are quite variable in development, ranging from thin (<1 m) and skeletal with depth (10-50% cobbles) to well-developed Mollisols (Kittel et al. 1999). Textures are typically loamy sands interspersed with layers of silty clays and alternating with coarse sands. Upper layers (10-30 cm) often have 25-30% organic matter (Kittel et al. 1999).

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is dominated by *Salix exigua* and a diverse array of mesic graminoids in sandy bottoms of intermittent streams. *Salix exigua* may be present to abundant. Graminoids dominate the understory on the rocky sand substrate and include *Juncus longistylis, Juncus tenuis, Juncus torreyi, Luzula parviflora, Schoenoplectus americanus, Typha angustifolia, Sorghastrum nutans, Elymus canadensis, Pascopyrum smithii*, and *Agrostis stolonifera*.

Global Vegetation: This association is characterized by the dominance of *Salix exigua* in a moderately dense, tall-shrub canopy with a dense herbaceous layer dominated by mesic graminoids. Others common shrubs may include saplings of *Populus deltoides, Salix amygdaloides, Salix bebbiana, Salix eriocephala, Salix geyeriana, Salix lucida ssp. lasiandra (= Salix lasiandra), Salix lutea, Salix monticola, Salix planifolia, Amorpha fruticosa*, or *Rosa woodsii*. Tall perennial grasses can appear to codominate the stand when *Spartina pectinata, Sorghastrum nutans, Panicum virgatum*, or other tall grasses are present. Mesic graminoids dominate the diverse understory and include *Carex pellita (= Carex lanuginosa), Carex nebrascensis, Carex rostrata, Deschampsia caespitosa, Eleocharis palustris, Elymus canadensis, Equisetum* spp., *Glyceria* spp., *Juncus balticus, Juncus longistylis, Juncus tenuis, Juncus torreyi, Luzula parviflora, Pascopyrum smithii, Schoenoplectus americanus, Schoenoplectus pungens (= Scirpus pungens), Sphenopholis obtusata*, and others. The sparse forb cover may include *Lobelia siphilitica, Bidens* spp., *Geum macrophyllum, Lycopus americanus, Lythrum alatum, Mentha arvensis, Polygonum* spp., *Typha angustifolia, Veronica americana*, and *Xanthium strumarium*. *Agrostis stolonifera, Bromus inermis, Melilotus* spp., *Poa pratensis*, *Phleum pratense*, and other introduced forage species may be present to abundant in disturbed stands of this community. Diagnostic features of this association include the nearly pure stands of *Salix exigua* shrubs, with a dense herbaceous layer of at least 30% cover of mesic graminoids.

Global Dynamics: Flooding and scouring during spring periods is common. This plant association is considered early-seral typical of recent floodplains and highly disturbed, low, wet areas . The presence of *Populus* sp. seedlings within this association indicates succession to a cottonwood stand. Overgrazing by livestock will reduce the vigor of *Salix exigua* and may eventually eliminate it from the site allowing invasion of introduced and non-palatable native species. However, reducing stocking rate will allow *Salix exigua* to re-establish itself, provided it has not been completely eliminated from the site. (Hansen et al. 1995).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Salix exigua*
GRAMINOID	*Schoenoplectus americanus, Sorghastrum nutans, Spartina pectinata*

Global

Stratum	**Species**
TALL SHRUB	*Salix exigua*
GRAMINOID	*Pascopyrum smithii, Poa pratensis, Schoenoplectus americanus, Sorghastrum nutans*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Salix exigua*
GRAMINOID	*Juncus* spp., *Schoenoplectus* spp.

Global

Stratum	**Species**
TALL SHRUB	*Salix exigua*
GRAMINOID	*Carex nebrascensis, Elymus canadensis, Juncus balticus, Schoenoplectus americanus, Sorghastrum nutans*

GLOBAL SIMILAR ASSOCIATIONS:

- Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049)
- Salix exigua Temporarily Flooded Shrubland (CEGL001197)
- Salix exigua / Barren Shrubland (CEGL001200)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This broadly defined plant association occupies a rather large range and currently includes *Salix exigua* shrublands with herbaceous layers dominated by the introduced mesic, perennial, sod-grass *Poa pratensis*. Classification review of descriptions from the western part of its range need further review to determine if the type should be split. In addition, western stands may all belong to *Salix exigua sensu stricto*, and Great Plains stands may belong to either *Salix exigua* or *Salix interior* (or intermediates). *Salix interior* is an entirely Great Plains and eastward species (Kartesz 1999). In Nebraska, this community intergrades and is a successional stage that appears after both Riverine Sand Flats - Bars Sparse Vegetation (CEGL002049) and *Salix exigua* Temporarily Flooded Shrubland (CEGL001197), which is more frequently disturbed and lacks many of the more mesic herbaceous species.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented at sites along Pine Creek and the Right Fork of North Creek. It also has been observed along several small creeks of the western side of Zion National Park.

Global Range: This association is found primarily in the central Great Plains, but also parts of the Rocky Mountains and Intermountain Semi-desert regions, ranging from Wyoming west to possibly Idaho, south to Utah, and east to Oklahoma.

Nations: US
States/Provinces: CO ID? KS NE OK UT WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 66, 143
Classification Confidence: 1 **Identifier:** CEGL001203
REFERENCES: Bourgeron and Engelking 1994, Cooper and Cottrell 1990, Driscoll et al. 1984, Hansen et al. 1995, Hoagland 1998c, Hoagland 2000, Jones and Walford 1995, Kittel 1994, Kittel and Lederer 1993, Kittel et al. 1996, Kittel et al. 1999, Lauver et al. 1999, Padgett et al. 1988b, Padgett et al. 1989, Steinauer and Rolfsmeier 2000, Walford et al. 2001

III.B.2.N.d.37. SALIX LIGULIFOLIA TEMPORARILY FLOODED SHRUBLAND ALLIANCE

Strapleaf Willow Temporarily Flooded Shrubland Alliance

SALIX LIGULIFOLIA / CAREX UTRICULATA SHRUBLAND [PROVISIONAL]

Strapleaf Willow / Beaked Sedge Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This stand occurs above 7500 feet. The meadow is positioned in a gently sloping basin with a northern aspect. Soils are moist clay loam with 100% herbaceous vegetation litter cover. Small stream channels meander through the meadow.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Salix ligulifolia* is the only shrub occurring in this willow carr with over 50% cover. Diverse herbaceous vegetation composes a lush, dense herbaceous vegetation layer and surrounding meadow. Some herbaceous species present are *Carex rostrata* (30% cover), *Poa pratensis* (10%), *Agrostis stolonifera, Phleum pratense, Carex microptera, Maianthemum stellatum* (20%), *Mentha arvensis*, and *Mertensia arizonica*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Salix ligulifolia*
GRAMINOID	*Carex utriculata, Poa pratensis*
FORB	*Maianthemum stellatum*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
TALL SHRUB	*Salix ligulifolia*
GRAMINOID	*Carex utriculata*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was documented on Horse Ranch Mountain of Zion National Park. *Salix ligulifolia* occurs naturally at higher elevations. Consequently, this association is not likely to be found elsewhere in the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah, but may occur elsewhere on the Markagunt Plateau.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 121
Classification Confidence: 3 **Identifier:** CEGL002975
REFERENCES: None available.

III.B.3.N.a. Extremely xeromorphic deciduous subdesert shrubland without succulents

III.B.3.N.a.4. PROSOPIS GLANDULOSA SHRUBLAND ALLIANCE
Honey Mesquite Shrubland Alliance

[NO ASSOCIATION]

ALLIANCE CONCEPT
GLOBAL SUMMARY: This alliance includes shrublands dominated by *Prosopis glandulosa*. Shrublands in this alliance can cover extensive areas, invading open grasslands and often forming thickets. The shrublands extend up to 4500 feet elevation. Associated species can include *Atriplex canescens, Bouteloua curtipendula, Bouteloua gracilis, Muhlenbergia porteri, Sporobolus airoides, Sporobolus flexuosus*, and *Buchloe dactyloides*.

ENVIRONMENTAL DESCRIPTION
USFWS Wetland System: Not Applicable

Zion National Park Environment: This alliance was not sampled at Zion NP, but occurred in the environs and was mapped. Sampling is needed to determine association level environmental information.

Global Environment: Shrublands included in this alliance occur from southwestern Oklahoma to the coast of southern Texas, and west to southern Nevada. Elevation ranges from 1-1600 m. Climate is arid to semi-arid, with hot summers and freezing temperatures not uncommon during the winter. Precipitation varies with geography. At the Jornada Experimental Range in southwestern New Mexico, annual precipitation ranged from 7-45 cm with mean annual precipitation of about 23 cm (Herbel et al. 1972). The precipitation has a bimodal distribution with about two-thirds of the precipitation falling during July to October and a third falling during the winter months. Farther west the proportion of summer precipitation decreases and winter precipitation dominates (Barbour and Major 1977). Sites include sandy plains, gypsum hills, coppice dunes, terraces along intermittent drainages, and moderately saline soils just above tidal flats. They are generally flat or gently sloping, and this vegetation occurs on all aspects. Substrate is usually sandy or gravelly alluvium, but may be composed of eolian sands and deltaic clays. Parent materials include andesite and rhyolite. Soils are generally coarse-textured, but may include gravelly clay loams. Some sites are moderately saline. These shrublands may grade into grasslands dominated by *Bouteloua gracilis, Sporobolus airoides, Pleuraphis mutica (= Hilaria mutica)* or may be surrounded by a matrix of desertscrub dominated by *Larrea tridentata* or *Ambrosia* spp.

VEGETATION DESCRIPTION
Zion National Park Vegetation: This alliance was not sampled at Zion NP, but occurred in the environs and was mapped. Sampling is needed to determine association level vegetation information.

Global Vegetation: Shrublands included in this alliance cover extensive areas of sandy plains and valleys, gypsum hills and dunes from southwestern Oklahoma to the coast of south Texas and across southern New Mexico and southeastern Arizona, invading open grasslands and often forming thickets. In western Arizona and other dry portions of its range, the vegetation occurs as arroyo riparian and dune vegetation types. Stands have moderate to dense cover dominated by the xeromorphic deciduous shrub *Prosopis glandulosa*. The diversity of other species can vary greatly with geography and substrate, with dune communities the most depauperate and riparian arroyos the most diverse. Other characteristic shrubs include *Acacia greggii, Artemisia filifolia, Atriplex canescens, Chilopsis linearis, Ericameria laricifolia, Gutierrezia sarothrae, Krascheninnikovia lanata, Larrea tridentata, Lycium berlandieri*, and *Ziziphus obtusifolia*. Succulents may include *Opuntia acanthocarpa, Opuntia leptocaulis, Opuntia imbricata, Opuntia phaeacantha, Yucca baccata, Yucca elata*, and *Yucca glauca*. Depending on geography, substrate and land-use history, the graminoid layer can be moderately dense to insignificant. Characteristic perennial grasses include *Aristida* spp., *Bouteloua curtipendula, Bouteloua eriopoda, Bouteloua gracilis, Buchloe dactyloides, Pleuraphis jamesii (= Hilaria jamesii), Pleuraphis mutica (= Hilaria mutica), Muhlenbergia porteri, Sporobolus flexuosus*, and *Sporobolus wrightii*. Sparse annual grasses such as *Aristida adscensionis, Bouteloua barbata*, and *Dasyochloa pulchella (= Erioneuron pulchellum)* may be present. Forb cover is also sparse, but it can be relatively diverse. Common forbs include species of *Chenopodium, Croton, Eriogonum, Euphorbia, Solanum*, and *Zinnia*. In more saline areas, shrubs are sparser and grasses and forbs are more common and may include *Spartina spartinae, Borrichia frutescens, Sporobolus airoides, Distichlis spicata*, and *Sesuvium verrucosum*. Bourgeron et al. (1993b) described several stands at the Gray Ranch with canopy cover for *Prosopis glandulosa* and perennial grasses (dominated by *Bouteloua* spp.) ranging from 10-30% and 3-55%, respectively..

Global Dynamics: Shrublands dominated by *Prosopis glandulosa* have replaced large areas of desert grasslands, especially those formerly dominated by *Bouteloua eriopoda*, in Trans-Pecos Texas, southern New Mexico and southeastern Arizona (Hennessy et al. 1983, York and Dick-Peddie 1969). Studies on the Jornada Experimental Range suggest that combinations of drought, overgrazing by livestock, wind and water erosion, seed dispersal by livestock, fire suppression, shifting dunes, and changes in the seasonal distribution of precipitation have caused this recent, dramatic shift in vegetation physiognomy (Buffington and Herbel 1965, Gibbens et al. 1983, Herbel et al. 1972, Hennessy et al. 1983, Humphrey 1974, McLaughlin and Bowers 1982, McPherson 1995, Schlesinger et al. 1990).

Prosopis spp. have extensive root systems that allow them to exploit deep soil water that is unavailable to shallower rooted grasses and cacti (Burgess 1995). This strategy works well, except on sites that have well-developed argillic or calcic soil horizons that limit infiltration and storage of winter moisture in the deeper soil layers (McAuliffe 1995). McAuliffe (1995) found *Prosopis* spp. invasion on these sites to be limited to a few, small individuals. This has implications in plant geography and grassland revegetation work in the southwestern United States..

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Prosopis glandulosa*

Global

Stratum	**Species**
TALL SHRUB	*Prosopis glandulosa*
SHORT SHRUB	*Acacia greggii, Artemisia filifolia, Atriplex canescens, Chilopsis linearis, Ericameria laricifolia, Gutierrezia sarothrae, Krascheninnikovia lanata, Larrea tridentata, Lycium berlandieri*, and *Ziziphus obtusifolia*
GRAMINOID	*Spartina spartinae, Sporobolus airoides, Distichlis spicata*,

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TALL SHRUB	*Prosopis glandulosa*

Global

Stratum	**Species**
TREE CANOPY	*Prosopis glandulosa*

OTHER NOTEWORTHY SPECIES

Global

Stratum	**Species**
GRAMINOID	*Bromus rigidus, Bromus tectorum*

GLOBAL SIMILAR ALLIANCES:
- PROSOPIS GLANDULOSA WOODLAND ALLIANCE (A.611)
- PROSOPIS GLANDULOSA TEMPORARILY FLOODED WOODLAND ALLIANCE (A.637)
- PROSOPIS (GLANDULOSA, VELUTINA) WOODLAND ALLIANCE (A.661)
- PROSOPIS GLANDULOSA SHRUB HERBACEOUS ALLIANCE (A.1550)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: Not Applied to alliances.

Global Comments: Although stand structure is different, all the similar alliances include stands that are dominated or codominated by *Prosopis glandulosa*. Some arroyo riparian stands in Arizona are similar to stands in the *Baccharis sarothroides, Acacia greggii*, and *Parkinsonia* spp.-dominated alliances.

Classification of *Prosopis glandulosa*-dominated stands needs clarification. Because *Prosopis glandulosa* can have both shrub and tree growth forms, there may be confusion classifying a given stand. For example, what characteristic separates a *Prosopis* arroyo riparian woodland from a shrubland? Currently, mesquite coppice dunes, which may be better classified in a sparsely vegetated alliance, are included in this alliance. Also, the formation in which this alliance is classified does not allow succulents. However, many stands in this alliance have a fairly consistent presence of succulents, usually species of *Opuntia* and *Yucca*.

ELEMENT DISTRIBUTION

Zion National Park Range: This alliance was not sampled at Zion NP, but occurred in the environs and was mapped. It likely occurs in lowlands and disturbed riparian forest in canyon.

Global Range: Shrublands included in this alliance are found in southwestern Oklahoma, western and southern Texas, west across the Chihuahuan and Sonoran deserts and into southern Nevada. The alliance likely occurs in adjacent northern Mexico.

Nations: MX US
States/Provinces: AZ MXNU MXTM NM NV OK UT TX

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: None
Classification Confidence: 2 **Identifier:** A.1031
REFERENCES: Barbour and Major 1977, Beatley 1976, Bourgeron et al. 1993b, Bourgeron et al. 1995, Bowers 1984, Brown 1982, Brown et al. 1977a, Buffington and Herbel 1965, Burgess 1995, Diamond 1993, Dick-Peddie 1993, Donart et al. 1978a, Eyre 1980, Gardner 1951, Gibbens et al. 1983, Hennessy et al. 1983, Herbel et al. 1972, Hoagland 1998a, Humphrey 1974, McAuliffe 1995, McLaughlin and Bowers 1982, McPherson 1995, Muldavin and Mehlhop 1992, Schlesinger et al. 1990, Smith and Douglas 1989, Stromberg 1995a, Warren and Anderson 1985, Warren and Treadwell 1980, Warren et al. 1981, York and Dick-Peddie 1969

IV. Dwarf-shrubland

IV.A.2.N.a. Extremely xeromorphic evergreen subdesert dwarf-shrubland

IV.A.2.N.a.9. ARTEMISIA NOVA DWARF-SHRUBLAND ALLIANCE
Black Sagebrush Dwarf-shrubland Alliance

ARTEMISIA NOVA / ELYMUS ELYMOIDES DWARF-SHRUBLAND

Black Sagebrush / Bottlebrush Dwarf-shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association is found in the foothills, plateaus and mountains of Nevada and Utah. Stands occur on well-drained slopes, knolls and ridges. Substrates are typically shallow, gravelly or stony soils derived from calcareous parent materials such as limestone. These soils are frequently coarse-textured, but subsoil argillic horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. *Artemisia nova* plants often grow in adjacent *Artemisia tridentata* shrublands that are found on deeper soils in basins. Combined ground cover of bare ground, rock and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies. The vegetation is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Artemisia nova* and a sparse herbaceous layer dominated by the perennial graminoid *Elymus elymoides* with scattered forbs. *Atriplex confertifolia, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ephedra viridis*, and *Grayia spinosa* are common shrub associates that may be present in smaller amounts. The herbaceous layer includes low cover of species of *Comandra, Cryptantha, Erigeron, Eriogonum, Machaeranthera, Phlox, Penstemon*, and *Poa secunda*. Introduced annual graminoids such as *Bromus rubens* and *Bromus tectorum* are common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations of 6000 and 7200 feet on gentle easterly and southerly slopes. Soil texture is described as sandy loam or clay.

Global Environment: This association is found in the foothills, plateaus and mountains of Nevada and Utah. Elevation ranges from 1525-2200 m (5000-7200 feet). Stands occur on well-drained slopes, knolls and ridges. Substrates are typically shallow, gravelly or stony soils often derived from calcareous parent materials such as limestone. These soils are frequentlycoarse-textured, but subsoil argillic horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. *Artemisia nova* plants often grow in adjacent *Artemisia tridentata* shrublands that are found on deeper soils in basins. Combined ground cover of bareground, rock and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Artemisia nova* is dominant with 30% cover and less than 0.5 m in height. *Elymus elymoides* has 5-20% cover, and codominates with *Poa secunda*. At one site *Ipomopsis congesta* was present with 10% cover, and at the other site, *Astragalus flavus* was present. Bare soil and basalt rockaccounted for significant ground cover between shrubs.

Global Vegetation: This association is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Artemisia nova* and a sparse herbaceous layer dominated by the perennial graminoid *Elymus elymoides* with scattered forbs. *Atriplex confertifolia, Artemisia tridentata, Chrysothamnus viscidiflorus, Ephedra nevadensis, Ephedra viridis*, and *Grayia spinosa* are common shrub associates that may be present in smaller amounts. Other herbaceous species include *Comandra umbellata ssp. pallida (= Comandra pallida), Cryptantha* spp., *Erigeron* spp., *Eriogonum microthecum, Machaeranthera canescens, Phlox longifolia, Penstemon* spp., and *Poa secunda*. Introduced annual graminoids such as *Bromus rubens* and *Bromus tectorum* are common in disturbed stands.

Global Dynamics: *Artemisia nova* is readily killed by all fire intensities, does not sprout after burning, and is slow to re-invade by seed from off-site sources (Tisdale and Hironaka 1981, Wright et al. 1997). Generally, fire is not a significant ecological process of *Artemisia nova*-dominated communities because the sparse vegetation precludes the occurrence of fire (Wright et al. 1997). Fire frequency may increase because invasion of introduced annual grasses, such as *Bromus tectorum* or *Bromus rubens*, provides fine fuel that allows fires to spread.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Elymus elymoides*

Global

Stratum	**Species**
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Elymus elymoides*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Elymus elymoides, Poa secunda*

Global

Stratum	**Species**
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Elymus elymoides*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4G5.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled near Pace Knoll in Kolob Arch quadrangle and in Pine Valley in Guardian Angels quadrangle of Zion National Park.

Global Range: This dwarf-shrubland association occurs in the foothills, plateaus and mountains of Nevada and Utah at elevations above 1525 m (5000 feet).

Nations: US
States/Provinces: NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 53, 57
Classification Confidence: 2 **Identifier:** CEGL001418
REFERENCES: Bourgeron and Engelking 1994, Driscoll et al. 1984, Jensen et al. 1988a, Lewis 1975, Ostler et al. 2000, Rickard and Beatley 1965, Tisdale and Hironaka 1981, Wright et al. 1979

ARTEMISIA NOVA / HESPEROSTIPA COMATA DWARF-SHRUBLAND

Black Sagebrush / Needle-and-Thread Dwarf-shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association is found in the foothills, plateaus and mountains of Nevada and Utah. Stands occur on flat mesa tops, benches and plains or on steep pediment slopes, knolls and ridges. Aspects are often southern. Substrates are typically shallow, stony soils often derived from calcareous parent materials such as limestone. Soil textures are variable and range from sandy, loamy, fine-textured or skeletal; argillic subsoil horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. Combined ground cover of bare ground, rock and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies. The vegetation is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Artemisia nova* and a sparse herbaceous layer dominated by the perennial graminoid *Hesperostipa comata* with scattered forbs. Scattered *Chrysothamnus viscidiflorus, Ericameria parryi, Grayia spinosa, Krascheninnikovia lanata*, and *Tetradymia canescens* are common shrub associates that may be present in smaller amounts. *Achnatherum hymenoides, Elymus elymoides, Koeleria macrantha, Pleuraphis jamesii, Poa fendleriana*, or *Poa secunda* may be present in the herbaceous layer, but have sparse cover. Forbs include species of *Astragalus, Erigeron, Eriogonum, Packera, Phlox*, and *Penstemon*. Introduced annual graminoids such as *Bromus rubens* and *Bromus tectorum* are common in disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was sampled at 8300 feet on a gentle northeast-facing slope, or bluff backslope. Soil texture is clay loam. Small rock fragments contribute 70% to ground cover.

Global Environment: This association is found in the foothills, plateaus and mountains of Nevada and Utah. Elevation ranges from 1890-2530 m (6200-8300 feet). Stands occur on flat mesa tops, benches and plains or on steep pediment slopes, knolls and ridges. Aspects are often southern. Substrates are typically shallow, stony soils often derived from calcareous parent materials such as limestone. Soil textures are variable and range from sandy, loamy, fine-textured or skeletal; argillic subsoil horizons are common. There is often an impenetrable subsurface layer from a duripan, caliche, or bedrock. Combined grounds cover of bare ground, rock and gravel is often high (about 70% cover). Litter is concentrated under the shrub canopies. *Artemisia nova* plants often grow in adjacent *Artemisia tridentata* shrublands that are found on deeper soils in basins.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Artemisia nova* is distributed evenly across the bluff, with 20% cover and height less than 0.5 m. *Gutierrezia sarothrae, Eriogonum microthecum*, and *Opuntia macrorhiza* contribute sparse cover in the dwarf-shrub layer. Perennial grasses, including *Hesperostipa comata* (10%cover), *Poa secunda, Elymus elymoides, Pseudoroegneria spicata*, and *Poa fendleriana*, totaling 25% cover, emerge above the shrub layer. Forb species present are *Penstemon eatonii, Petradoria pumila*, and *Hymenopappus filifolius*.

Global Vegetation: This association is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Artemisia nova* and a sparse to moderately dense herbaceous layer dominated by the perennial graminoid *Hesperostipa comata* with scattered forbs. Scattered *Chrysothamnus viscidiflorus, Ericameria parryi, Eriogonum microthecum, Grayia spinosa, Gutierrezia sarothrae, Krascheninnikovia lanata*, and *Tetradymia canescens* are common shrub associates that may be present in smaller amounts. *Achnatherum hymenoides, Elymus elymoides, Koeleria macrantha, Pleuraphis jamesii, Poa fendleriana*, or *Poa secunda* may be present in the herbaceous layer, but have sparse cover. Other herbaceous species include *Astragalus* spp., *Erigeron* spp., *Eriogonum racemosum, Hymenopappus filifolius, Leptodactylon pungens, Packera multilobata, Phlox longifolia*, and *Penstemon* spp. Introduced annual graminoids such as *Bromus rubens* and *Bromus tectorum* are common in disturbed stands.

Global Dynamics: *Artemisia nova* is readily killed by all fire intensities, does not sprout after burning, and is slow to re-invade by seed from off-site sources (Tisdale and Hironaka 1981, Wright et al. 1997). Generally, fire is not a significant ecological process of *Artemisia nova*-dominated communities because the sparse vegetation precludes the occurrence of fire (Wright et al. 1997). Fire frequency may increase by invasion of introduced annual grasses, such as *Bromus tectorum* or *Bromus rubens*, providing fine fuels that allow fires to spread. The common associate *Chrysothamnus viscidiflorus* does sprout after fire and may replace *Artemisia nova* where fires are more frequent (Roberts et al. 1992).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Hesperostipa comata, Elymus elymoides, Poa fendleriana*

Global

Stratum	Species
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Hesperostipa comata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Hesperostipa comata*

Global

Stratum	Species
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Hesperostipa comata*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G3?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on the western side of Horse Ranch Mountain in Zion National Park and may occur infrequently in the northern region.

Global Range: This dwarf-shrubland association occurs in the foothills, plateaus and mountains of Nevada and Utah at elevations above 1890 m (6200 feet).

Nations: US
States/Provinces: CO ID NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 116
Classification Confidence: 1 **Identifier:** CEGL001425
REFERENCES: Baker and Kennedy 1985, Blackburn et al. 1968c, Bourgeron and Engelking 1994, Driscoll et al. 1984, Roberts et al. 1992, Tisdale and Hironaka 1981, Wright et al. 1979, Zamora and Tueller 1973

ARTEMISIA NOVA / POA FENDLERIANA DWARF-SHRUBLAND [PROVISIONAL]

Black Sagebrush / Muttongrass Dwarf-shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs between 6000 and 8000 feet. The sites sampled had clay loam soils on level terrain between two ridges.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: In this association, *Artemisia nova* has 10-25% cover and height of less than 0.5 m. *Amelanchier utahensis* is generally present and of short stature, but does not contribute significant cover. *Poa fendleriana* is the dominant graminoid, with cover of 10-20%. Other associated grasses are *Elymus elymoides, Bouteloua gracilis*, and *Koeleria macrantha*. Forb species present are *Calochortus nuttallii, Lotus utahensis, Eriogonum* spp., *Arenaria fendleri*, and *Astragalus* spp.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
DWARF SHRUB	*Amelanchier utahensis, Artemisia nova*
GRAMINOID	*Elymus elymoides,Poa fendleriana*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
DWARF SHRUB	*Artemisia nova*
GRAMINOID	*Poa fendleriana*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on the backside of the ridge west of Scenic Drive Overlook in the Kolob Arch quadrangle and near Lava Point Road in the Kolob Reservoir quadrangle. This association is not widespread in the park, but may occur again in the vicinity of the above-named areas.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH17, 21
Classification Confidence: **Identifier:** CEGL002698
REFERENCES: None available.

IV.B.2.N.a. Caespitose cold-deciduous dwarf-shrubland

IV.B.2.N.a.200. GUTIERREZIA SAROTHRAE DWARF-SHRUBLAND ALLIANCE
Snakeweed Dwarf-shrubland Alliance

GUTIERREZIA SAROTHRAE - (OPUNTIA SPP.) / PLEURAPHIS JAMESII DWARF-SHRUBLAND

Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This dwarf-shrubland was described from Utah and northern Arizona where it occurs on level to gently sloping hillslopes, plateaus and bluffs. Aspects are reported from the southeast, south and southwest. Soils are variable, but tend to be fine-textured and may occur over gravel and cobbles. Disturbance may be important in maintaining this vegetation community as some stands have been created by chaining of trees and improper grazing by livestock. This broadly defined association is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Gutierrezia sarothrae*, frequently with *Opuntia* spp. and an herbaceous layer with *Pleuraphis jamesii* present to abundant (1-30% cover). Some stands have a diverse woody layer that includes low cover of several shrub species and occasional *Pinus edulis* or *Juniperus osteosperma* trees. The herbaceous layer is typically dominated by graminoids with several species present including *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata*, or *Pascopyrum smithii*. There is usually only sparse cover of native forbs like *Chamaesyce* spp. or *Sphaeralcea coccinea.* Introduced species such as *Bromus tectorum* or *Salsola kali* may dominate the herbaceous layer of some disturbed stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations around 4000 feet on gently sloping hillsides with a southeastern aspect. Soils are clayey in comparison to most of the very sandy soils throughout the park. One sample documents this association at 7400 feet with different herbaceous components.

Global Environment: This association is described from Utah and northern Arizona where it occurs on level to gently sloping hillslopes, plateaus and bluffs. Elevations range from 1350-2260 m. Aspects are reported from the southeast, south and southwest. Soils are variable, but tend to be fine-textured and may occur over gravel and cobbles. Disturbance may be important in maintaining this vegetation community as some stands have been created by chaining of trees and improper grazing by livestock.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Average foliar cover of *Gutierrezia sarothrae* is 10%, and *Opuntia* spp. are present to abundant in this association. *Pleuraphis jamesii* ranges from absent to abundant. Other species that occur at the sampled sites are *Psorothamnus fremontii, Coleogyne ramosissima, Juniperus osteosperma, Elymus elymoides*, and *Bromus tectorum*. At the high-elevation site, *Poa fendleriana, Bouteloua gracilis, Arenaria fendleri*, and *Eriogonum umbellatum* dominate the herbaceous layer.

Global Vegetation: This broadly defined association is characterized by an open dwarf-shrub canopy (10-30% cover) that is dominated by *Gutierrezia sarothrae*, frequently with *Opuntia* spp. and an herbaceous layer with *Pleuraphis jamesii* present to abundant (1-30% cover). Some stands have a diverse woody layer that includes low cover of *Artemisia nova, Atriplex canescens, Atriplex confertifolia, Chrysothamnus viscidiflorus, Coleogyne ramosissima, Ephedra* spp., *Eriogonum* spp., *Grayia spinosa, Lycium pallidum, Purshia tridentata*, or occasional *Pinus edulis* or *Juniperus osteosperma* trees. The herbaceous layer is typically dominated by graminoids with several species present including *Pleuraphis jamesii, Achnatherum hymenoides, Aristida purpurea, Bouteloua gracilis, Elymus elymoides, Hesperostipa comata*, or *Pascopyrum smithii*. There is usually only sparse cover of native forbs like *Chamaesyce* spp. or *Sphaeralcea coccinea.* Introduced species such as *Bromus tectorum, Erodium cicutarium, Sisymbrium altissimum*, or *Salsola kali* may dominate the herbaceous layer of some disturbed stands.

Global Dynamics: *Gutierrezia sarothrae* occurs in many natural grassland and steppe communities in the western U.S. and is known to increase when these communities are disturbed mechanically or by over-grazing (Stubbendieck et al. 1992, USFS 1937). The role of disturbance in this association needs further study to understand its successional nature.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Gutierrezia sarothrae, Opuntia* spp.
GRAMINOID	*Bromus tectorum, Elymus elymoides,Pleuraphis jamesii*

Global

Stratum	**Species**
DWARF SHRUB	*Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Gutierrezia sarothrae, Opuntia* spp.
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	**Species**
DWARF SHRUB	*Gutierrezia sarothrae*
GRAMINOID	*Pleuraphis jamesii*

GLOBAL SIMILAR ASSOCIATIONS:

- Gutierrezia sarothrae / Pleuraphis rigida Shrub Herbaceous Vegetation (CEGL001543)--possibly an anthropogenicly disturbed *Pleuraphis rigida* grassland.
- Gutierrezia sarothrae - Krascheninnikovia lanata - Atriplex canescens / Bouteloua eriopoda Shrub Herbaceous Vegetation (CEGL001733)--rare grassland endemic to Grand Canyon National Park.
- Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii Shrub Herbaceous Vegetation (CEGL001776)--described from northwestern New Mexico.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: This broadly defined dwarf-shrubland includes stands that could also be classified as a dwarf-shrub herbaceous association.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is commonly found in the southwestern region of the park where elevation is low and the climate is very dry.

Global Range: This association is described from Utah and northern Arizona, but is likely more widespread throughout the semi-arid western U.S.

Nations: US
States/Provinces: AZ UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH37, 39, 40, 41, 56, 266, 505
Classification Confidence: 3 **Identifier:** CEGL002690
REFERENCES: Stubbendieck et al. 1992, USFS 1937, Von Loh et al. 2002

V. HERBACEOUS VEGETATION

V.A.5.N.c. Medium-tall sod temperate or subpolar grassland

V.A.5.N.c.201. THINOPYRUM INTERMEDIUM SEMI-NATURAL HERBACEOUS ALLIANCE

Intermediate Wheatgrass Semi-natural Herbaceous Alliance

THINOPYRUM INTERMEDIUM SEMI-NATURAL HERBACEOUS VEGETATION

Intermediate Wheatgrass Semi-natural Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This *Thinopyrum intermedium* type occurs widely throughout the northern Great Plains of the United States, and perhaps more widely in the Midwest and Canada. Stands can occur in a wide variety of human-disturbed habitats, and *Thinopyrum intermedium (= Agropyron intermedium)* is widely planted as pasture and hayland along road ditches for Conservation Reserve Program lands, and in dense-nesting-cover mixes. It is commonly found on reseeded cultivated lands planted with legumes such as sweet clover and alfalfa and may also have escaped into surrounding habitats. It is most abundant on dry, medium-textured soils, but has adapted to a broad range of soil textures and moisture conditions. Vegetation is primarily medium-tall (0.5-1 m) graminoids and dominated by *Thinopyrum intermedium*, a naturalized, cool-season grass species from eastern Europe. Other weedy species such as *Bromus inermis* may occur as well, but native species are generally less than 20% cover. Native grass species will rarely, if ever, reestablish in sites dominated by *Thinopyrum intermedium*.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on a dry meadow site on a gently sloping, northeast-facing ridge. Soils are clay loam and may be seasonally saturated.

Global Environment: The *Thinopyrum intermedium* type occurs widely throughout the northern Great Plains of the United States, and perhaps more widely in the Midwest and Canada. It also is reported from Utah and likely occurs elsewhere in the western U.S. Stands can occur in a wide variety of human-disturbed habitats, and is widely planted as pasture and hayland along road ditches for Conservation Reserve Program lands, and in dense-nesting-cover mixes (D. Ode pers. comm.). It is commonly found on reseeded cultivated lands planted with legumes such as sweet clover and alfalfa and may also have escaped into surrounding habitats (D. Ode pers. comm.). It is most abundant on dry, medium-textured soils, but has adapted to a broad range of soil textures and moisture conditions. Vegetation is primarily medium-tall (0.5-1 m) graminoids and dominated by *Thinopyrum intermedium (= Agropyron intermedium)*, a naturalized, cool-season grass species from eastern Europe. Other weedy species such as *Bromus inermis* may occur as well, but native species are generally less than 20% cover. Native grass species will rarely, if ever, reestablish in sites dominated by *Thinopyrum intermedium*.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is dominated by intermediate wheatgrass with 60-70% cover. Herbaceous vegetation of *Bromus inermis, Achnatherum lettermanii, Artemisia ludoviciana, Vicia americana, Mertensia arizonica*, and *Lupinus* spp. together contribute less than 10% cover. Evidence of recent livestock grazing is apparent, and grazing has probably occurred at this site occasionally since the park was established. Historically, the site was probably subjected to moderate to heavy grazing.

Global Vegetation: *Thinopyrum intermedium (= Agropyron intermedium, = Elytrigia intermedia)* often contributes 90% of the cover for this community; however, other exotics such as *Bromus inermis* can invade into these areas. Native species almost never reestablish in areas dominated by *Thinopyrum intermedium* and contribute less than 20% cover.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Thinopyrum intermedium, Bromus inermis*
FORB	*Artemisia ludoviciana, Vicia americana, Lupinus spp.*

Global

Stratum	**Species**
GRAMINOID	*Thinopyrum intermedium*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Thinopyrum intermedium*
FORB	*Artemisia ludoviciana*

Global

Stratum	**Species**
GRAMINOID	*Thinopyrum intermedium*

GLOBAL SIMILAR ASSOCIATIONS:

- Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation (CEGL005264)--*Bromus inermis* will often invade into *Thinopyrum intermedium* communities.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: This type was first proposed based on work at Zion National Park. It is futher developed based on data from Lacreek National Wildlife Refuge and comments by Dave Ode.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on a ridge north of Camp Creek, the most northern region of the park.

Global Range: The *Thinopyrum intermedium* type occurs widely throughout the northern Great Plains of the United States, and perhaps more widely in the Midwest and Canada. It also is reported from Utah and likely occurs elsewhere in the western U.S. where it has been seeded or escaped from plantings.

Nations: US
States/Provinces: MN? ND? NE SD UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 118
Classification Confidence: 3 **Identifier:** CEGL002935
REFERENCES: Ode pers. comm.

V.A.5.N.d. Medium-tall bunch temperate or subpolar grassland

V.A.5.N.d.400. BROMUS INERMIS SEMI-NATURAL HERBACEOUS ALLIANCE
Smooth Brome Semi-natural Herbaceous Alliance

BROMUS INERMIS - (PASCOPYRUM SMITHII) SEMI-NATURAL HERBACEOUS VEGETATION

Smooth Brome - (Western Wheatgrass) Semi-natural Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This smooth brome grassland type occurs widely throughout the northern Great Plains and on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture, and hay fields, and has escaped into a variety of habitats including prairie, riparian grasslands, and mesic mountain meadows. In Montana, the best examples occur on mesic alluvial terraces. This grass grows best on moist, well-drained, finer-textured loam and clay loams and does not tolerate prolonged flooding. The vegetation is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia, that forms moderately dense to dense stands that often develop into monocultures. Other weedy species such as *Cirsium arvense* may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Pascopyrum smithii, Deschampsia caespitosa*, and *Hesperostipa comata (= Stipa comata)* and sparse, scattered mesic shrubs such as *Symphoricarpos* spp. as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site or the stand would be typed as such.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle, 0- to 5-degree slopes in moderate- to high-elevation meadows where slow drainage or spring snowmelt creates moist or seasonally saturated soils. Documented stands occurred on south to southwest aspects. Disturbances such as prior water development construction and/or livestock grazing may have impacted these sites.

Global Environment: This smooth brome grassland type occurs widely throughout the northern Great Plains and on relatively mesic sites in the semi-arid interior western United States, and perhaps more widely in the midwestern U.S. and Canada. Stands can occur in a wide variety of human-disturbed habitats, including highway rights-of-way, jeep trails, etc. The type is also widely planted for revegetating disturbed land, pasture, and hay fields, and has escaped into a variety of habitats including prairie, riparian grasslands, and mesic mountain meadows. In Montana, this community is found on elevation ranges from 1100-2050 m (3590-6700 feet) with best examples occurring on mesic alluvial terraces (Hansen et al. 1995). This grass grows best on moist, well-drained, finer-textured loam and clay loams, not heavy clays or sand, and does not tolerate prolonged flooding (Hansen et al. 1995).

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Bromus inermis* dominates this association with 50-90% cover. *Pascopyrum smithii* contributes an additional 5% cover on the margin of the sampled stands. Other herbaceous species may contribute minor cover. *Symphoricarpos oreophilus* may be present and sparsely distributed in the stand as it invades from adjacent drier upland vegetation.

Global Vegetation: This association is dominated by medium-tall (0.5-1 m) graminoids. The dominant grass is *Bromus inermis*, a naturalized species from Eurasia, that forms moderately dense to dense stands that often develop into monocultures. Other weedy species such as *Cirsium arvense* may occur as well, but native species are generally less than 10% cover. Native species may include mixed-grass prairie and montane meadow grasses, such as *Pascopyrum smithii, Deschampsia caespitosa*, and *Hesperostipa comata (= Stipa comata)* and sparse, scattered mesic shrubs such as *Symphoricarpos* spp. as well as many others. However, the native species are not conspicuous enough to identify the native plant association that could occupy the site or the stand would be typed as such.

Global Dynamics: *Bromus inermis* is a strongly rhizomatous, cool-season grass that grows 0.5-1 (1.5) m tall (Cronquist et al. 1977). It is a highly competitive, sod-forming grass with a dense fibrous root and rhizome system.

The extensive rhizome system allows it to rapidly spread and makes it able to tolerate heavy grazing by livestock (Hansen et al 1995). Although this grass grows best on moist alluvial sites, it does not tolerate prolonged flooding (Hansen et al. 1995). It also has good drought resistance, which allows it to persist in semi-arid regions (Cronquist et al. 1977). Flooding of infested riparian areas has been used to restore native riparian or wetland species in degraded (de-watered) sites (Hansen et al. 1995). *Bromus inermis* is also fire-adapted and will vigorously sprout after most burns (Hansen et al. 1995). However, this cool-season grass is not tolerant of hot, late-spring burns, which is during its active growing period (Hansen et al. 1995). This may be an effective control measure where native vegetation is dominated by warm-season grasses.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus inermis, Pascopyrum smithii*

Global

Stratum	**Species**
GRAMINOID	*Bromus inermis, Pascopyrum smithii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus inermis*

Global

Stratum	**Species**
GRAMINOID	*Bromus inermis*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: Where native species are conspicuous enough to identify the native plant association that could occupy the site, the stand should be typed as such. *Bromus inermis* occurs widely throughout the midwestern and western U.S., and perhaps this association should be broadened to include almost any stand dominated almost exclusively by *Bromus inermis*.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on Horse Pasture Plateau and the East Rim Mesa and may occur in other gently sloping meadows or drainages on plateaus throughout Zion National Park.

Global Range: This type occurs widely throughout the northern Great Plains and in relatively mesic sites in Utah and Wyoming, and perhaps more widely in the midwestern U.S. and Canada as well as the western United States where *Bromus inermis* has escaped from revegetation and forage plantings.

Nations: US
States/Provinces: MT ND SD UT WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 49, 83. *Bromus inermis - (Pascopyrum smithii)* Semi-natural Herbaceous Vegetation (CEGL005264) may be associated with disturbance such as past cattle grazing or water developments. The site documented on the East Mesa drainage appears to have been created by a water development or flood control project. Cattle grazing at one time likely disturbed the site at Sawmill Springs.
Classification Confidence: 3 **Identifier:** CEGL005264
REFERENCES: Cronquist et al. 1977, Hansen et al. 1995

V.A.5.N.d.27. HESPEROSTIPA COMATA BUNCH HERBACEOUS ALLIANCE

Needle-and-Thread Bunch Herbaceous Alliance

HESPEROSTIPA COMATA GREAT BASIN HERBACEOUS VEGETATION

Needle-and-Thread Great Basin Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This grassland occurs on the Colorado Plateau and Great Basin. Stands are found on plains, gentle hillslopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, cobbles, clay loams and silty clay. This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata*. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Poa fendleriana*, or *Sporobolus cryptandrus*, may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species may be diverse and include species of *Artemisia, Balsamorhiza, Cirsium, Gilia, Hymenopappus, Lappula, Machaeranthera*, and *Vicia*. Scattered shrubs and dwarf-shrubs may be present with less than 5% total cover. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Some stands have high cover of cryptogams on the soil.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on flat terrain or slight depressions of mesa tops and, at one site, the depression of a cinder cone. Elevations range 6400-7600 feet, and soil texture is sandy or clay loam.

Global Environment: This grassland occurs in the Colorado Plateau and Great Basin. Elevation ranges from 1450-2320 m. Stands are found on plains, gentle hillslopes, knolls and bluffs, mesa tops, and plateau parks. Substrates are variable and include sand, cobbles, clay loams and silty clay. Fires may be important in maintaining these grasslands by reducing woody cover, but burning during the growing season could also damage the *Hesperostipa comata* plants.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Hesperostipa comata* dominates this association with 10-40% cover and heights of 0.5 m. Other graminoids present in the sampled associations are *Achnatherum lettermanii, Poa fendleriana, Elymus elymoides*, and *Poa pratensis*. Some shrubs that may be present with less than 5% cover are *Chrysothamnus viscidiflorus, Symphoricarpos oreophilus*, and *Artemisia tridentata ssp. vaseyana*. Forbs contribute another 20-30% herbaceous cover. Forbs present among the three sites sampled are *Machaeranthera canescens, Tragopogon dubius, Cirsium arizonicum, Artemisia ludoviciana, Artemisia dracunculus, Artemisia campestris, Vicia americana, Lotus utahensis, Penstemon* spp., *Aster* spp., *Eriogonum racemosum, Balsamorhiza sagittata, Comandra umbellata, Ericameria linearifolia, Hymenopappus filifolius, Antennaria* sp., and *Epilobium brachycarpum*.

Global Vegetation: This association is characterized by a relatively sparse to moderate herbaceous layer (10-40% cover) that is strongly dominated by the cool-season bunchgrass *Hesperostipa comata*. Low cover of other grasses, such as *Achnatherum hymenoides, Achnatherum lettermanii, Aristida purpurea, Elymus elymoides, Pleuraphis jamesii, Poa fendleriana*, or *Sporobolus cryptandrus*, may be present. However, *Bouteloua eriopoda* is not present. Forb cover ranges from sparse to moderate and may be diverse. Associated species include *Artemisia campestris, Artemisia dracunculus, Artemisia ludoviciana, Balsamorhiza sagittata, Cirsium arizonicum, Hymenopappus filifolius, Machaeranthera canescens, Vicia americana*, and species of *Antennaria, Eriogonum, Gilia*, and *Lappula*. Scattered shrubs and dwarf-shrubs may present with less than 5% total cover. *Artemisia tridentata ssp. vaseyana, Chrysothamnus viscidiflorus, Ericameria nauseosa, Opuntia polyacantha, Gutierrezia sarothrae*, and *Symphoricarpos oreophilus* have been reported from this grassland. The widespread introduced annual grass *Bromus tectorum* often contributes significant cover in disturbed stands. Several other exotic species like *Salsola kali, Bassia scoparia (= Kochia scoparia)*, *Poa pratensis,* and *Sisymbrium altissimum* may be present to abundant. Some stands have high cover of cryptogams on the soil including *Collema tenax, Tortula ruralis, Bellia papillata*, and *Fulgensia bracteata* (Kleiner and Harper 1977).

Global Dynamics: These grasslands are dominated by relatively deep-rooted grasses that use soil moisture below 0.5 m during the typically dry summers. The coarse-textured soils allow for rapid infiltration and storage of winter and summer precipitation (Daubenmire 1970, Kleiner 1968, Kleiner and Harper 1977, Thilenius et al. 1995). Fires during dormancy may be important in maintaining these grasslands by reducing woody cover. However, burning during the growing season generally kills or severely damages *Hesperostipa comata* plants. After fire, regeneration of this non-rhizomatous bunchgrass is by seed and may take many years to reach prefire densities (FEIS 1998).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
GRAMINOID	*Achnatherum lettermanii, Hesperostipa comata*

Global

Stratum	Species
GRAMINOID	*Hesperostipa comata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
GRAMINOID	*Hesperostipa comata*

Global

Stratum	Species
GRAMINOID	*Hesperostipa comata*

GLOBAL SIMILAR ASSOCIATIONS:

- Muhlenbergia montana - Hesperostipa comata Herbaceous Vegetation (CEGL001647)
- Pseudoroegneria spicata - Hesperostipa comata Herbaceous Vegetation (CEGL001679)
- Hesperostipa comata - Carex filifolia Herbaceous Vegetation (CEGL001700)
- Hesperostipa comata - Achnatherum hymenoides Herbaceous Vegetation (CEGL001703)
- Hesperostipa comata - Poa secunda Herbaceous Vegetation (CEGL001704)
- Elymus lanceolatus - Hesperostipa comata Herbaceous Vegetation (CEGL001746)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G2G4.

Global Comments: This association is composed of relatively pure *Hesperostipa comata* grasslands in the Intermountain West. The similar associations are distinguished by the codominance of other grass species or a shrub layer.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on a mesa overlooking Beartrap Canyon, an unnamed mesa north of Wynopits Mesa, and in the cinder cone depression of Firepit Knoll. All these sites occur in the northern region of Zion National Park. This association was observed in stands less than 0.5 hectare in size scattered on mesas on the eastern side of the park.

Global Range: This grassland is found in the Colorado Plateau and Great Basin in Colorado and Utah and will probably occur in adjacent states.

Nations: US
States/Provinces: CO UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 63, 271, 352
Classification Confidence: 2 **Identifier:** CEGL001705
REFERENCES: Bourgeron and Engelking 1994, Daubenmire 1970, Driscoll et al. 1984, FEIS 1998, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1977, Thilenius et al. 1995

V.A.5.N.d.17. MUHLENBERGIA MONTANA HERBACEOUS ALLIANCE
Mountain Muhly Herbaceous Alliance

MUHLENBERGIA (PUNGENS, MONTANA) - HETEROTHECA VILLOSA HERBACEOUS VEGETATION [PROVISIONAL]

(Sandhill Muhly, Mountain Muhly) - Hairy Goldenaster Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at elevations of 6500 and 7100 feet on flat mesa tops with sandy soils. The ground surface has 20-30% cover of lichens and cryptograms and 50-70% bare soil.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: The herbaceous layer is prominent in this association with 20% cover. *Muhlenbergia pungens* is more commonly found in this association than *Muhlenbergia montana*, though the latter has been sampled in this study, and the former only observed. *Heterotheca villosa* is present to abundant. Other associated herbaceous species include *Achillea millefolium, Machaeranthera canescens, Phlox austromontana, Poa fendleriana,* and *Sporobolus cryptandrus.* Scattered shrubs may be present including *Arctostaphylos patula, Quercus gambelii, Symphoricarpos oreophilus, Yucca elata var. utahensis, Opuntia macrorhiza*, and *Gutierrezia* spp. with low cover (<10% cover total). Dominance of *Muhlenbergia pungens* and/or *Muhlenbergia montana* is diagnostic of this grassland association.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Muhlenbergia montana, Muhlenbergia pungens, Poa fendleriana, Sporobolus cryptandrus*
FORB	*Heterotheca villosa*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Muhlenbergia montana, Muhlenbergia pungens*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on the Incline Temple and Great White Throne mesas of Zion National Park and has been observed in basins below mesas on the eastern side.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 355, 382
Classification Confidence: 3 **Identifier:** CEGL002938
REFERENCES: None available.

V.A.5.N.d.9. SPOROBOLUS CRYPTANDRUS HERBACEOUS ALLIANCE
Sand Dropseed Herbaceous Alliance

SPOROBOLUS CRYPTANDRUS GREAT BASIN HERBACEOUS VEGETATION

Sand Dropseed Great Basin Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This plant association is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of major rivers and on sand deposits on mesas and plains. Soils are loamy sands and sandy loams derived from alluvium, aeolian deposits or sandstone residuum. Sites have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation. The vegetation is dominated by the warm-season perennial graminoid *Sporobolus cryptandrus*. *Pleuraphis jamesii, Hesperostipa comata (= Stipa comata)*,or *Equisetum variegatum* frequently occur in low abundance. Low cover of native forbs such as *Sphaeralcea grossulariifolia* or *Chamaesyce fendleri* may be present. The introduced annual grass *Bromus tectorum* and several other exotic species like *Bromus rigidus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. Occasional *Brickellia* spp. or other shrubs may occur, but they are not dense enough to form a shrub layer.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association is documented at elevations less than 4500 feet, but may occur in small stands of less than 0.5 hectare on mesa tops and flat benches where deep, sandy loam soils develop. Larger than 0.5-hectare stands occur on sandy alluvial benches adjacent to river floodplains.

Global Environment: This grassland is described from the Uinta Basin and Colorado Plateau where it occurs on alluvial terraces of large rivers and on sand deposits on mesas and plains. Elevation ranges from 1243-1450 m. Sites are flat to gently sloping valley bottoms, plains or plateaus. Soils are loamy sands and sandy loams derived from alluvium, aeolian deposits or sandstone residuum. Stands have generally been disturbed by flooding, shifting sands, livestock grazing, or human recreation.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Stands of *Sporobolus cryptandrus* have low cover of 10-30%. Additional herbaceous cover is minimal and frequently represented by exotic grasses, such as *Bromus tectorum* and *Bromus diandrus*, and various weedy forbs. *Pleuraphis jamesii* may occur with foliar cover of less than 10%.

Global Vegetation: This plant association is found on alluvial terraces of large rivers and on sand deposits on mesas and plains. The sparse to moderately dense (10-30% cover) herbaceous layer is characterized by the dominance of the warm-season perennial graminoid *Sporobolus cryptandrus*. *Pleuraphis jamesii, Hesperostipa comata (= Stipa comata)*,or *Equisetum variegatum* frequently occur in low abundance. Low cover of native forbs such as *Sphaeralcea grossulariifolia* or *Chamaesyce fendleri* may be present. The widespread introduced annual grass *Bromus tectorum* and several other exotic species like *Bromus rigidus, Salsola kali, Helianthus annuus, Sisymbrium altissimum*, or *Tribulus terrestris* may be present to abundant, especially on disturbed riparian stands. An occasional *Brickellia* spp or other shrubs may occur, but they are not dense enough to form a shrub layer. Moss is important in some stands.

Global Dynamics: Disturbance is present and appears to be important in the maintenance of this vegetation. *Sporobolus cryptandrus* occurs throughout the western U.S. as a minor species, occasionally becoming locally dominant in disturbed or sandy sites in the midgrass prairie (Weaver and Albertson 1956). This perennial grass produces prolific seeds that are long-lived in the soil (20 years), and is observed to increase in abundance on disturbed and grazing-depleted ranges (USFS 1937).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus tectorum, Pleuraphis jamesii, Sporobolus cryptandrus*

Global

Stratum	**Species**
GRAMINOID	*Bromus tectorum, Sporobolus cryptandrus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Sporobolus cryptandrus*

Global

Stratum	**Species**
GRAMINOID	*Sporobolus cryptandrus*

GLOBAL SIMILAR ASSOCIATIONS:

- Sporobolus cryptandrus Shrub Herbaceous Vegetation (CEGL001514)--similar vegetation except with significant shrub component.
- Aristida purpurea var. longiseta - Sporobolus cryptandrus Herbaceous Vegetation (CEGL001515)--similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta*.
- Sporobolus cryptandrus - Poa secunda Herbaceous Vegetation (CEGL001516)--similar vegetation and environmental conditions except codominated by *Poa secunda*.
- Artemisia tridentata / Sporobolus cryptandrus - Achnatherum hymenoides Shrub Herbaceous Vegetation (CEGL001545)
- Aristida purpurea var. longiseta - Pseudoroegneria spicata - Sporobolus cryptandrus Herbaceous Vegetation (CEGL001589)--similar vegetation and environmental conditions except codominated by *Aristida purpurea var. longiseta - Pseudoroegneria spicata*.
- Ephedra viridis / Achnatherum hymenoides - Sporobolus cryptandrus Shrub Herbaceous Vegetation (CEGL001649)--sandy site grasslands with shrub layer.
- Bouteloua gracilis - Sporobolus cryptandrus Herbaceous Vegetation (CEGL001761)
- Schizachyrium scoparium - Aristida basiramea - Sporobolus cryptandrus - Eragrostis trichodes Herbaceous Vegetation (CEGL005221)--central Great Plains type.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: The association is broadly defined to include *Sporobolus cryptandrus*-dominated stands from both riparian and sandy upland sites. This plant association is similar to the threatened, regionally endemic *Sporobolus cryptandrus* plant associations from the Columbia Basin and lower Snake River that have declined significantly due to loss of habitat from hydroelectric dam construction and conversion of land to cultivation. Many of the riparian stands in these associations are in poor condition because of past management and invasion of introduced species.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is scattered throughout the park from alluvial canyon bottoms to mesa tops. Larger, more homogeneous stands of *Sporobolus cryptandrus* are located in sandy alluvial terraces along the North Fork of the Virgin River and in Cave Valley.

Global Range: The association is found on terraces of large rivers in the Colorado Plateau and likely occurs elsewhere in the southwestern U.S.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH 20, 16, 515. This association is in most cases heavily disturbed by humans and livestock due to its close proximity to the main river systems in the park.
Classification Confidence: 1 **Identifier:** CEGL002691
REFERENCES: USFS 1937, Von Loh et al. 2002

V.A.5.N.e. Short sod temperate or subpolar grassland

V.A.5.N.e.9. BOUTELOUA GRACILIS HERBACEOUS ALLIANCE
Blue Grama Herbaceous Alliance

BOUTELOUA GRACILIS - HESPEROSTIPA COMATA HERBACEOUS VEGETATION [PROVISIONAL]
Blue Grama - Needle-and-Thread Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gently sloping mesa tops with elevations ranging from 5900-7400 feet. Soil texture is loamy sand.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This plant association has an open to moderately dense herbaceous layer that is dominated by grasses with scattered shrubs that form a mosaic. The graminoid layer is codominated by *Bouteloua gracilis* and *Hesperostipa comata* with variable amounts of cover ranging from 5-20% combined. *Poa fendleriana* was present with 10% cover in most stands. Other grasses that occurred were *Muhlenbergia montana* and *Sporobolus cryptandrus*. Shrubs are less consistent in composition among sites sampled and contribute less than 10% cover. Shrub species that are likely to occur in the stand and in nearby shrublands are *Tetradymia canescens, Ericameria nauseosa, Arctostaphylos patula, Artemisia tridentata, Quercus gambelii*, and *Yucca elata var. utahensis*. *Pinus edulis* was present in two sampled sites, but with minimal cover. Pinyon-juniper woodlands are a part of the shrubland/grassland mosaic on a landscape scale.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bouteloua gracilis, Hesperostipa comata, Poa fendleriana*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bouteloua gracilis, Hesperostipa comata, Poa fendleriana*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on Cougar Mountain, Mount Majestic, and Pocket Mesa.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 132, 305, 359
Classification Confidence: 3 **Identifier:** CEGL002932
REFERENCES: None available.

V.A.5.N.e.14. PLEURAPHIS JAMESII HERBACEOUS ALLIANCE
James' Galleta Herbaceous Alliance

PLEURAPHIS JAMESII HERBACEOUS VEGETATION
James' Galleta Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Topography varies from mesa tops, slopes, and 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 sandy loams. Vegetation is characterized by a relatively sparse to moderately dense (10-60% cover) herbaceous layer that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses, such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides*, or *Sporobolus cryptandrus*, may be present. Forb cover is usually sparse and includes species of *Plantago, Gilia, Lappula*, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present; however, they are not dense enough to form a shrub layer. Some stands have high cover of cryptogams on the soil.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs at approximately 4000 feet, on level terrain of plateaus. Soil texture is sandy loam.

Global Environment: This widespread grassland association is found on alluvial flats, plateau parks and plains in the Colorado Plateau and elsewhere in the southwestern U.S. Elevation ranges from 1220-1660 m. Topography varies from mesa tops, slopes, and basin floors. Stands may be small woodland parks or more extensive on the plains. Soils in bottomland stands tend to be fine-textured; however, stands also occur on sandy loams.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Pleuraphis jamesii* is dominant in this association with 10-30% cover at the sampled sites. *Opuntia* spp., *Gutierrezia microcephala*, and *Bromus tectorum* are present with minimal cover. This association occurs in parks amongst *Pinus monophylla - Juniperus osteosperma* woodlands with *Pleuraphis jamesii* in the understory.

Global Vegetation: This association is characterized by a relatively sparse to moderately dense herbaceous layer (10-60% cover) that is strongly dominated by the warm-season bunchgrass *Pleuraphis jamesii*. Low cover of other grasses such as *Achnatherum hymenoides, Bouteloua eriopoda, Bouteloua gracilis, Hesperostipa comata, Muhlenbergia porteri, Sporobolus airoides*, or *Sporobolus cryptandrus* may be present. Forb cover is usually sparse and includes species of *Plantago, Gilia, Lappula*, and prickly pear cacti (*Opuntia* spp.). Many species of shrubs and dwarf-shrubs may be present, but they are not abundant enough to form a shrub layer. Woody species may include *Artemisia filifolia, Atriplex canescens, Atriplex confertifolia, Ephedra torreyana, Ericameria nauseosa, Gutierrezia* spp., *Tetradymia* spp., and occasional *Juniperus monosperma* trees. The widespread introduced annual grass *Bromus tectorum* and several other exotic species like *Salsola kali, Bassia scoparia (= Kochia scoparia), 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, Bellia papillata*, and *Fulgensia bracteata*.

Global Dynamics: *Pleuraphis jamesii* is both drought- and grazing-resistant (USFS 1937, Weaver and Albertson 1956, West et al. 1972). This grass is favored in mixedgrass stands because it is only moderately palatable to livestock; however, it decreases when heavily grazed during drought and in the more arid portions of its range where it is the dominant grass (West et al. 1972). This grass reproduces extensively from scaly rhizomes. These rhizomes make the plant resistant to trampling by livestock and have good soil binding properties (USFS 1937, Weaver and Albertson 1956, West et al. 1972).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	**Species**
GRAMINOID	*Pleuraphis jamesii*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Pleuraphis jamesii*

Global

Stratum	**Species**
GRAMINOID	*Pleuraphis jamesii*

GLOBAL SIMILAR ASSOCIATIONS:

- Atriplex canescens / Pleuraphis jamesii Shrubland (CEGL001288)
- Atriplex confertifolia / Pleuraphis jamesii Shrubland (CEGL001304)
- Krascheninnikovia lanata / Pleuraphis jamesii Dwarf-shrubland (CEGL001322)
- Coleogyne ramosissima / Pleuraphis jamesii Shrubland (CEGL001334)
- Artemisia nova / Pleuraphis jamesii Dwarf-shrubland (CEGL001420)
- Atriplex gardneri / Pleuraphis jamesii Dwarf-shrubland (CEGL001441)
- Bouteloua eriopoda - Pleuraphis jamesii Herbaceous Vegetation (CEGL001751)
- Bouteloua gracilis - Pleuraphis jamesii Herbaceous Vegetation (CEGL001759)
- Atriplex obovata / Pleuraphis jamesii - Sporobolus airoides Dwarf-shrub Herbaceous Vegetation (CEGL001775)
- Gutierrezia sarothrae / Sporobolus airoides - Pleuraphis jamesii Shrub Herbaceous Vegetation (CEGL001776)
- Pleuraphis jamesii - Sporobolus airoides Herbaceous Vegetation (CEGL001778)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G2G4.

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

ELEMENT DISTRIBUTION

Zion National Park Range: This association is found only in small stands near the southern boundary of the park, on Springdale West quadrangle.

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

Nations: US
States/Provinces: AZ CA CO NV UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH33, RH34
Classification Confidence: 2 **Identifier:** CEGL001777
REFERENCES: Bourgeron and Engelking 1994, Cannon 1960, Collins 1984, Driscoll et al. 1984, Francis 1986, Francis and Aldon 1983, Helm 1981, Kleiner 1968, Kleiner 1983, Kleiner and Harper 1972, Kleiner and Harper 1977, Marr et al. 1973a, Nichol 1937, Stewart et al. 1940, USFS 1937, Utah Environmental and Agricultural Consultants 1973, Weaver and Albertson 1956, West et al. 1972

V.A.5.N.k. Seasonally flooded temperate or subpolar grassland

V.A.5.N.k.42. CAREX (ROSTRATA, UTRICULATA) SEASONALLY FLOODED HERBACEOUS ALLIANCE

(Swollen-beak Sedge, Beaked Sedge) Seasonally Flooded Herbaceous Alliance

CAREX UTRICULATA HERBACEOUS VEGETATION

Beaked Sedge Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This wetland association is found throughout much of the western U.S. Stands occur in montane and subalpine areas around the edges of lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains. Sites are flat to undulating, often with a hummocky microtopography. The water table is usually near the surface for most of the growing season. There are a wide variety of soil types for this association. The vegetation is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex utriculata* (20-99% cover). Stands often appear to be nearly pure *Carex utriculata*, but a variety of other graminoid species may be present as well. Other graminoid species include *Carex lenticularis*, *Carex microptera*, *Calamagrostis canadensis, Glyceria striata*, and *Juncus balticus,* but usually with low cover. The sparse forb cover can include *Geum macrophyllum, Mentha arvensis*, and *Mimulus guttatus*. Scattered *Salix* spp. shrubs may be present because these riparian shrublands are often adjacent. *Salix* species vary depending on elevation and geography.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: *Carex utriculata* Herbaceous Vegetation (CEGL001562) occurs on wide, gently sloping terrain of middle- to high-elevation plateaus. The soils of open meadow drainages that support this association are seasonally to permanently saturated.

Global Environment: This wetland association is found throughout much of the western U.S. Elevation ranges from 1060-2950 m (3500-9680 feet). Stands occur in montane and subalpine areas around the edges of lakes and beaver ponds, along the margins of slow-moving reaches of streams and rivers, and in marshy swales and overflow channels on broad floodplains (Kittel et al. 1999b). Sites are flat to undulating, often with a hummocky microtopography (Kovalchik 1993). The water table is usually near the surface for most of the growing season. There are a wide variety of soil types for this association ranging from saturated organics or fine silty clays to clays over cobbles and alluvium to fine-loamy and sandy-skeletal. Mottling and gleying often occur near the surface because of the high water table.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Carex utriculata* dominates in this association with 90% cover in Potato Hollow. *Poa pratensis* and *Pascopyrum smithii* are present on the margins of the stand.

Global Vegetation: This plant association is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex utriculata* (20-99% cover). Stands often appear to be nearly pure *Carex utriculata*, but a variety of other graminoid species may be present as well. Other *Carex* species present include *Carex lenticularis, Carex microptera, Carex nebrascensis*, and *Carex scopulorum*, but usually with low cover. Other graminoid species that may be present include *Calamagrostis canadensis, Deschampsia caespitosa, Glyceria striata*, and *Juncus balticus*. Sparse forb cover may include *Epilobium* spp., *Geum macrophyllum, Mentha arvensis, Mimulus guttatus*, and *Polemonium occidentale*. Scattered *Salix* spp. shrubs may be present because these riparian shrublands are often adjacent. *Salix* species vary depending on elevation and geography. *Salix monticola, Salix drummondiana, Salix geyeriana, Salix planifolia*, and *Salix exigua* are common species.

Global Dynamics: *Carex utriculata* is a widespread species that colonizes recently formed pond edges and seasonally flooded areas near streams. Once established it is long-lived and will dominate sites unless disturbed with changes in site hydrology. Soil development (over time) may decrease soil moisture and allow other species to replace it (Manning and Padgett 1995).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Carex utriculata*

Global

Stratum	**Species**
GRAMINOID	*Carex utriculata*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Carex utriculata*

Global

Stratum	**Species**
GRAMINOID	*Carex utriculata, Juncus spp.*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: *Carex rostrata var. utriculata* (Boott) Bailey was recognized as a distinct species from *Carex rostrata* Stokes and named *Carex utriculata* Boott (Kartesz 1999). This taxonomic change has led to confusion in some of the earlier vegetation classification literature where no distinction was made between the subspecies. *Carex utriculata* Herbaceous Vegetation (CEGL001562) is known only from the western U.S., and for now, *Carex rostrata* communities are known only from the midwestern U.S. and Canada. According to Kartesz (1999), *Carex rostrata* is reported from most of Canada, some Great Lakes states and Montana, Idaho, and Washington in the western U.S. There is significant overlap in the species ranges, and additional survey work is needed to help clarify this.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled in Potato Hollow of the Horse Pasture Plateau.

Global Range: This wetland association in found at montane and subalpine elevations throughout much of the western U.S.

Nations: US
States/Provinces: AZ? CA CO ID MT NM NV OR UT WA WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 96. *Carex utriculata* has not been documented in Washington County according to the Utah Flora (Welsh et al. 1987).
Classification Confidence: 1 **Identifier:** CEGL001562
REFERENCES: Andrews 1983, Baker 1983a, Benedict 1983, Bourgeron and Engelking 1994, Driscoll et al. 1984, Franklin and Dyrness 1973, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Hess and Wasser 1982, Kartesz 1999, Kerr and Henderson 1979, Kettler and McMullen 1996, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1995, Kittel et al. 1996, Kittel et al. 1999b, Kovalchik 1987, Kovalchik 1993, Looman 1982, Mattson 1984, Mutel 1973, Mutel 1976, Mutel and Marr 1973, Mutz and Graham 1982, Mutz and Queiroz 1983, Nachlinger 1985, Norton et al. 1981, Padgett 1982, Padgett et al. 1988b, Padgett et al. 1989, Ramaley 1919a, Ramaley and Robbins 1909, Schlatterer 1972, Seyer 1979, Tuhy 1981, Tuhy and Jensen 1982, Youngblood et al. 1985a, Youngblood et al. 1985b

V.A.5.N.k.56. CAREX NEBRASCENSIS SEASONALLY FLOODED HERBACEOUS ALLIANCE

Nebraska Sedge Seasonally Flooded Herbaceous Alliance

CAREX NEBRASCENSIS HERBACEOUS VEGETATION

Nebraska Sedge Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: These minor wetlands occur on the western Great Plains and throughout much of the western U.S. Stands form open meadows that occur along the margins of streambanks, saturated floodplains, and lakes often forming a band along the alluvial terrace. Stands have also been sampled from marshy areas surrounding springs and below seeps on lower hillslopes. This association is often found on well-developed soil, but occurs on a wide variety of soil types. Soils tend to be fine-textured alluvium, ranging from sandy, silty loam, clay loam, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season. The vegetation is characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis* (25-99% cover), that generally forms small- to medium-sized meadows. Stands often are nearly pure *Carex nebrascensis*, but a variety of other graminoid species may be present such as *Carex praegracilis, Calamagrostis stricta, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Common forbs include *Eurybia integrifolia (= Aster integrifolius), Geum macrophyllum, Mentha arvensis, Mimulus glabratus*, and *Ranunculus cymbalaria*. Introduced species *Poa pratensis, Poa palustris*, and *Melilotus officinalis* may also be common.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This vegetation association occurs on gently sloping drainages on the park's high-elevation plateaus. Slopes are less than 5% and have south and southeast aspects. Clay soils impede rapid moisture infiltration and are seasonally to permanently saturated.

Global Environment: This wetland plant association occurs on the western Great Plains and throughout much of the western U.S. Elevation ranges from 1000-2800 m (3300-9200 feet). Stands form open meadows that occur along the margins of streambanks, flat floodplains, and lakes often forming a band along the alluvial terrace. Stands have also been sampled from marshy areas surrounding springs and below seeps on lower hillslopes. This association is often found on well-developed soil, but occurs on a wide variety of soil types ranging from saturated organics to Mollisols to Entisols. Soils tend to be fine-textured alluvium, ranging from sandy, silty loam, clay loam, or clay to organic and are typically gleyed and mottled near the surface because of the high water table most of the growing season.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Carex nebrascensis* Herbaceous Vegetation (CEGL001813) forms nearly homogeneous stands of 80% foliar cover. Wetland species *Juncus balticus* and *Poa pratensis* contribute to the dense, nearly 100%, total foliar cover. Heterogeneous stands of *Carex nebrascensis* occur around springs and ponds in the park, maintaining dominance at 20% cover. *Agrostis stolonifera, Equisetum arvense*, and *Trifolium longipes* are major contributors to the dense foliar cover of this wetland association. *Carex microptera, Typha angustifolia, Juncus ensifolius, Juncus tenuis, Eleocharis* spp., *Juncus longistylis, Achillea millefolium, Rumex acetosella*, and *Mentha arvensis* are also present in the sampled stand.

Global Vegetation: These wetlands are characterized by a moderately dense to dense perennial graminoid layer dominated or codominated by *Carex nebrascensis* (25-99% cover), that generally forms small- to medium-sized meadows. Stands often are nearly pure *Carex nebrascensis*, but a variety of other graminoid species may be present such as *Carex praegracilis, Calamagrostis stricta, Deschampsia caespitosa, Eleocharis palustris, Glyceria striata, Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, or *Triglochin maritima*. Forb cover is generally low, but can be high in moist locations. Common forbs include *Eurybia integrifolia (= Aster integrifolius), Geum macrophyllum, Mentha arvensis, Mimulus glabratus*, and *Ranunculus cymbalaria*. Introduced species *Poa pratensis, Poa palustris*, and *Melilotus officinalis* may also be common.

In Nebraska, common species include *Agrostis stolonifera, Carex hystericina, Carex pellita (= Carex lanuginosa), Eleocharis erythropoda, Equisetum* spp., *Juncus balticus, Schoenoplectus pungens (= Scirpus pungens)*, and *Triglochin* spp. (Steinauer and Rolfsmeier 2000).

Global Dynamics: In Montana, the *Carex nebrascensis* Community Type is considered a grazing-disclimax. Under season-long grazing, *Carex nebrascensis* increases in abundance, replacing former dominant species (Hansen et al. 1995). However, under extreme grazing conditions and a resulting drop in the water table, *Juncus balticus* or *Poa pratensis* can eventually replace *Carex nebrascensis*. In Nevada (and probably Colorado), sites dominated by *C. nebrascensis* are considered a Potential Natural Community (Manning and Padgett 1995).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Agrostis stolonifera, Carex microptera, Carex nebrascensis, Juncus balticus, Juncus ensifolius Juncus longistylis , Typha angustifolia*
FORB	*Equisetum arvense, Trifolium longipes*

Global

Stratum	**Species**
GRAMINOID	*Agrostis stolonifera, Carex nebrascensis, Juncus balticus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Agrostis stolonifera, Carex nebrascensis, Juncus balticus*
FORB	*Equisetum arvense*

Global

Stratum	**Species**
GRAMINOID	*Agrostis stolonifera, Carex nebrascensis, Juncus balticus*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G4.

Global Comments: In the Black Hills, classification of stands was problematic due to identification problems with *Carex nebrascensis* and *Carex aquatilis*. The two are difficult to distinguish based on available keys and written descriptions (Marriott and Faber-Langendoen 2000).

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on Horse Ranch Mountain and the Upper Kolob Plateau in Zion National Park.

Global Range: This sedge meadow type is widely distributed from the western Great Plains into the western mountains of the United States, ranging from South Dakota and Montana to possibly as far west as Washington, south to California and east to New Mexico.

Nations: US
States/Provinces: AZ CA CO ID MT NE NM? NV OR SD UT WA? WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 113, 134
Classification Confidence: 1 **Identifier:** CEGL001813

REFERENCES: Baker 1982b, Bourgeron and Engelking 1994, Cooper and Cottrell 1990, Driscoll et al. 1984, Hall 1973, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Jones 1992b, Jones and Walford 1995, Kittel et al. 1994, Kittel et al. 1996, Kittel et al. 1999, Kittel et al. 1999b, Kovalchik 1987, Manning and Padgett 1995, Marriott and Faber-Langendoen 2000, Mutz and Queiroz 1983, Padgett et al. 1988b, Padgett et al. 1989, Steinauer and Rolfsmeier 2000, Youngblood et al. 1985a, Youngblood et al. 1985b.

V.A.5.N.k.13. JUNCUS BALTICUS SEASONALLY FLOODED HERBACEOUS ALLIANCE

Baltic Rush Seasonally Flooded Herbaceous Alliance

JUNCUS BALTICUS HERBACEOUS VEGETATION

Baltic Rush Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This Baltic rush wet meadow community is found widely throughout the western United States. This wet meadow vegetation occurs as small, dense patches on flat stream benches, along overflow channels, and near springs. Soils are variable and range from poorly to well-drained, sandy clay loam to fine sand-textured and are usually mottled or gleyed. Stands are characterized by a dense sward of *Juncus balticus* and often minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis*, or *Carex utriculata*. Other common species include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Phleum alpinum*, and *Sporobolus airoides*. The introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera* codominate some stands. Forb cover is generally low and includes wetland species like *Caltha leptosepala* and *Dodecatheon pulchellum*. Shrubs are not common. This association is often considered to be a grazing-induced community since it increases with disturbance.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association is positioned between stream channel dams and natural wetland sites. Soil is a clay loam and litter cover is high.

Global Environment: This widespread herbaceous wetland community is found throughout western North America. Elevation ranges from 1420-3500 m. Stands usually occur as small, dense patches on flat to gently sloping sites near seeps and streams. Stream channels are highly variable in size and type ranging from narrow to moderately wide, and deeply entrenched to very sinuous (Kittel et al. 1999b). Soils are also variable and range from alluvial sandy and well-drained, to poorly drained silty clay loam, to organic; however, soils tend to be finer-textured, alkaline and may be saline (Brotherson and Barnes, Kittel et al. 1999b, Padgett et al. 1989). Cobbles and gravel are common on many sites, and gleyed and mottled horizons are often present because of flooding or high water tables (Kittel et al. 1999b).

VEGETATION DESCRIPTION

Zion National Park Vegetation: One documented stand of *Juncus balticus* has cover of 90%. Traces of *Poa pratensis* and *Pascopyrum smithii* are found at the stand margins. *Convolvulus arvensis*, a prostrate vine, trails through the stand. Other sampled stands are heterogeneous. *Juncus balticus* dominates or codominates with an array of mesic graminoid species, including *Juncus tenuis, Juncus longistylis, Carex microptera, Carex occidentalis, Agrostis stolonifera*, and *Poa pratensis*.

Global Vegetation: This association is characterized by a low (<50 cm), dense graminoid layer dominated by the rhizomatous perennial *Juncus balticus*. Minor cover of *Carex* species, including *Carex aquatilis, Carex praegracilis, Carex nebrascensis* or *Carex utriculata*, is often present. Other common graminoids include *Deschampsia caespitosa, Distichlis spicata, Glyceria striata, Hordeum jubatum, Muhlenbergia asperifolia, Phleum alpinum*, and *Sporobolus airoides*. Forb cover is generally low, but may include *Caltha leptosepala, Glaux maritima, Maianthemum stellatum*, and *Dodecatheon pulchellum*. Shrubs are not common, however occasional *Salix* spp. may occur. Some stands may be codominated by the introduced perennial sod grasses *Poa pratensis* or *Agrostis stolonifera*. Other introduced species, such as *Taraxacum officinale, Trifolium* spp., *Cirsium arvense, Lactuca serriola, Phleum pratense*, and *Thinopyrum intermedium*, may occur in disturbed stands.

Global Dynamics: This association is considered by some to be a grazing-induced community because *Juncus balticus* is tolerant of grazing (low palatability when mature) and increases with grazing disturbance (Hansen et al. 1995, Padgett et al. 1989). Nearly pure stands of *Juncus balticus* may indicate that the site was heavily grazed in the past (Hansen et al. 1995). However, this association also occurs as a stable, late-seral community in areas with low disturbance (Kittel and Lederer 1993).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Agrostis stolonifera, Carex microptera, Carex occidentalis, Juncus balticus, Poa pratensis*

Global

Stratum	**Species**
GRAMINOID	*Carex nebrascensis, Carex praegracilis, Juncus balticus*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Juncus balticus*

Global

Stratum	**Species**
GRAMINOID	*Juncus balticus*

GLOBAL SIMILAR ASSOCIATIONS:
- Eleocharis palustris - Juncus balticus Herbaceous Vegetation (CEGL001835)
- Juncus balticus - Carex rossii Herbaceous Vegetation (CEGL001839)

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G5.

Global Comments: This association is often considered to be a grazing-induced community since it increases with grazing disturbance.

ELEMENT DISTRIBUTION

Zion National Park Range: *Juncus balticus* occurs in a mosaic pattern with other wetland vegetation along streams, ponds, meadows, seeps and springs in Zion National Park. The stand sampled on the East Rim along the eastern boundary of the park is a uniquely homogeneous. Similar stands are likely scattered infrequently across the northern regions of the park. Other more heterogeneous stands have been documented in the northern region.

Global Range: This Baltic rush wet meadow community is found widely throughout the western United States, ranging from South Dakota and Montana west to Washington, south to possibly California, and east to New Mexico.

Nations: US
States/Provinces: CA? CO ID MT NM NV OR SD UT WA WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 51, 61, 67
Classification Confidence: 1 **Identifier:** CEGL001838
REFERENCES: Baker 1984a, Bourgeron and Engelking 1994, Brotherson and Barnes 1984, Bunin 1985, Driscoll et al. 1984, Faber-Langendoen 2001, Flowers 1962, Hall and Hansen 1997, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Hess 1981, Johnston 1987, Jones and Walford 1995, Kartesz 1994, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999, Kittel et al. 1999b, Komarkova 1986, Manning 1988, Muldavin et al. 2000a, Mutel 1973, Mutz and Graham 1982, Olson and Gerhart 1982, Padgett 1982, Padgett et al. 1989, Rector 1979, Richard et al. 1996, Shupe et al. 1986, Stewart 1940, Tuhy and Jensen 1982, Wasser and Hess 1982, Youngblood et al. 1985a

V.A.5.N.k.21. POA PRATENSIS SEMI-NATURAL SEASONALLY FLOODED HERBACEOUS ALLIANCE

Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Alliance

POA PRATENSIS SEMI-NATURAL SEASONALLY FLOODED HERBACEOUS ALLIANCE

Kentucky Bluegrass Semi-natural Seasonally Flooded Herbaceous Alliance

ELEMENT CONCEPT

GLOBAL SUMMARY: This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural meadows and riparian areas. Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid region it is restricted to relatively mesic sites. Soils are highly variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content. It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought. The vegetation is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs on gently sloping meadows of valleys and plateaus at elevations from 5700-8000 feet. Soil texture is clay or sandy loam.

Global Environment: This semi-natural grassland is widespread in the western U.S. and northern Great Plains where it has invaded natural prairies, meadows and riparian areas. Elevation ranges from 1100-2625 m (3600-8600 feet). Sites are generally flat to moderately sloping and occur on all aspects. Stands typically occur on pastures found in the plains, montane meadows, stream benches and terraces. In the semi-arid regions it is restricted to relatively mesic sites. Soils are variable, but *Poa pratensis* grows best on moist, fertile sandy to clayey alluvium with high organic content (Hansen et al. 1995). It does not tolerate prolonged flooding, high water tables or poor drainage well. However, it can tolerate mildly alkaline and saline soils, and some drought (Hansen et al. 1995, Hall and Hansen 1997, Kovalchik 1987, Manning and Padgett 1995, Padgett 1989).

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association is dominated by *Poa pratensis* with a cover of 50-80%. Other herbaceous species present in the three stands sampled are *Elymus lanceolatus, Achnatherum lettermanii, Elymus elymoides*, and *Bromus tectorum* on drier sites, and *Bromus inermis, Equisetum arvense, Agrostis stolonifera, Achillea millefolium, Trifolium longipes, Medicago lupulina, Trifolium longipes, Taraxacum officinale*, and *Tragopogon dubius* on wetter sites. These species contribute 5-20% additional cover. Herbaceous litter covers most of the bare ground. Montane woodlands and oak shrublands occur on the surrounding uplands.

Global Vegetation: This widespread, semi-natural plant association is characterized by a moderate to dense herbaceous canopy that is strongly dominated by the introduced perennial, sod-forming graminoid *Poa pratensis*. *Poa pratensis* has invaded many natural plant associations, but the diagnostic character in this association is that there is typically not enough of the native grassland left to classify it as a poor condition natural type. Associates are often those early-seral and weedy species that tolerate the historic heavy livestock grazing or other disturbance well, such as *Achillea millefolium, Cirsium arvense, Elymus repens, Equisetum* spp., *Fragaria virginiana, Hordeum* spp., *Juncus balticus, Linaria vulgaris, Potentilla gracilis, Taraxacum officinale*, and introduced forage species such as *Agrostis stolonifera, Bromus inermis*, and *Phleum pratense*. Remnant natives *Pascopyrum smithii, Deschampsia caespitosa*, and *Carex* spp. are often present in low cover. Occasional trees and shrubs may also be present.

At Wind Cave National Park in South Dakota, stands typically have moderate to dense herbaceous cover, ranging from 50-100%, and *Poa pratensis* contributes at least 75% of that cover. Other common herbaceous species include *Artemisia ludoviciana, Psoralidium tenuiflorum*, and *Ambrosia psilostachya*. *Andropogon gerardii* may be present, with high coverage in wetter seasons. On steeper slopes, it is not uncommon to find significant amounts of *Amorpha canescens* cover greater than 20% (H. Marriott pers. comm. 1999).

Global Dynamics: *Poa pratensis* is widespread in the western U.S. where, following disturbance, its extensive rhizome system allows it to spread and establish, outcompeting many native graminoids. It is tolerant of heavy grazing and increases at the expense of less tolerant native species (Hansen et al. 1995, Volland 1978). It is also adapted to burning and quickly resprouts after fire, except when burned during growing periods (Volland and Dell 1981).

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus inermis, Elymus lanceolatus, Poa pratensis*
FORB	*Achillea millefolium, Medicago lupulina, Trifolium longipes*
FERN	*Equisetum arvense*

Global

Stratum	**Species**
GRAMINOID	*Poa pratensis*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Poa pratensis*

Global

Stratum	**Species**
GRAMINOID	*Poa pratensis*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs in Pine Valley, Hop Valley, Kolob Canyons and near Lava Point in Zion National Park. All these locations are in the northern region of the park.

Global Range: This semi-natural grassland is widespread in the western U.S. and northern Great Plains.

Nations: US
States/Provinces: CA ID MT OR UT WA WY

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 62, 78
Classification Confidence: 2 **Identifier:** CEGL003081
REFERENCES: Franklin and Dyrness 1973, Hall and Hansen 1997, Hansen et al. 1995, Kauffman et al. 1983, Kauffman et al. 1985, Kovalchik 1987, Manning and Padgett 1995, Padgett et al. 1989, Sawyer and Keeler-Wolf 1995, Tuhy and Jensen 1982, Volland 1978, Volland and Dell 1981, Youngblood et al. 1985a

V.A.7.N.e. Medium-tall temperate or subpolar grassland with a sparse needle-leaved or microphyllous evergreen shrub layer

V.A.7.N.e.4. CHRYSOTHAMNUS VISCIDIFLORUS SHRUB HERBACEOUS ALLIANCE

Green Rabbitbrush Shrub Herbaceous Alliance

CHRYSOTHAMNUS VISCIDIFLORUS / POA PRATENSIS SEMI-NATURAL SHRUB HERBACEOUS VEGETATION [PROVISIONAL]

Green Rabbitbrush / Kentucky Bluegrass Semi-natural Shrub Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on a gently sloping meadow drainage at 7200 feet. Soil texture is loamy.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This association was documented once in Zion National Park. This stand is a couple acres in size and is slightly upland from the valley's stream channel and wetland vegetation. *Chrysothamnus viscidiflorus* and *Poa pratensis* codominate, both having 50% cover. Other stands of this size are not expected to occur elsewhere in the park.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHRUB	*Chrysothamnus viscidiflorus*
GRAMINOID	*Poa pratensis*
FORB	*Lupinus argenteus*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHRUB	*Chrysothamnus viscidiflorus*
GRAMINOID	*Poa pratensis*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is located along the Wildcat Canyon Trail of the Lower Kolob Plateau of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 60
Classification Confidence: 2 **Identifier:** CEGL002933
REFERENCES: None available.

V.B.2.N.e. Semipermanently flooded temperate perennial forb vegetation

V.B.2.N.e.400. EQUISETUM (ARVENSE, VARIEGATUM) SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

(Field Horsetail, Variegated Scouringrush) Semipermanently Flooded Herbaceous Alliance

EQUISETUM (ARVENSE, VARIEGATUM) HERBACEOUS VEGETATION

(Field Horsetail, Variegated Scouringrush) Herbaceous Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This wetland association is reported from Utah and Ontario, Canada, but its distribution is much broader. If its range is similar to the ranges of dominant and diagnostic species, then it likely occurs throughout much of northern and western North America. Sites include streambanks, wet meadows and ditches. Substrates are generally organic alluvium. This community is typically flooded much of the growing season. The water table is high even when surface water is gone. The vegetation is characterized by the moderately dense to dense herbaceous layer that is dominated or codominated by *Equisetum arvense* or *Equisetum variegatum*. Other wetland and facultative wetland plants may be present in low cover, but the dominance of *Equisetum* spp. is diagnostic of this type. Introduced graminoids such as the perennial *Poa pratensis* or the annual *Bromus diandrus* are known to codominate some stands.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: PALUSTRINE

Zion National Park Environment: This association occurs on gently sloping streambanks. Elevation for the documented stands of *Equisetum* spp. ranges 4000-5800 feet, but stands may occur at higher elevations in the park. The terrain is flat, and soils are moist from the proximity to the river. Soils are loamy sand and completely covered with litter/duff.

Global Environment: This wetland association is reported from Utah and Ontario, Canada, but the distribution is much broader. If its range is similar to the ranges of dominant and diagnostic species, then it likely occurs throughout much of northern and western North America. Sites include streambanks, wet meadows and ditches. Substrates are generally organic alluvium. This community is typically flooded much of the growing season. The water table is high even when surface water is gone.

VEGETATION DESCRIPTION

Zion National Park Vegetation: This herbaceous association is codominated by the introduced sod grass *Poa pratensis* and *Equisetum arvense or Equisetum variegatum.* The sampled stands had 10-70% combined cover of these species. Other species present in documented stands were *Bromus diandrus, Medicago lupulina, Tradescantia occidentalis*, and *Machaeranthera canescens*. Two unknown forbs are abundant in the stand.

Global Vegetation: This wetland association is characterized by the moderately dense to dense herbaceous layer that is dominated or codominated by *Equisetum arvense* or *Equisetum variegatum*. Other wetland and facultative wetland plants may be present in low cover, but the dominance or codominance of *Equisetum* spp. is diagnostic of this type. Introduced graminoids such as the perennial *Poa pratensis* or the annual *Bromus diandrus* are known to codominate some stands.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Poa pratensis*
FERN	*Equisetum arvense, Equisetum variegatum*

Global

Stratum	**Species**
GRAMINOID	*Equisetum arvense, Equisetum variegatum, Poa pratensis*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
FERN	*Equisetum arvense, Equisetum variegatum*

Global

Stratum	**Species**
GRAMINOID	*Equisetum arvense, Equisetum variegatum*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Type was established to accommodate southern Ontario vegetation types listed in Lee et al. (1998). This association may have been largely overlooked because of its small scale or included with other vegetation types.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented in Zion Canyon and Hop Valley, and occurs in less than 0.5-hectare stands along other canyon streams in the park.

Global Range: Documented from only Utah and Ontario, Canada, these wetlands likely occur throughout much of northern and western North America.

Nations: CA US
States/Provinces: ON UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH67, 78
Classification Confidence: 3 **Identifier:** CEGL005148
REFERENCES: Hauke 1993, Larson 1993, Lee et al. 1998

V.D.2.N.d. Short temperate annual grassland

V.D.2.N.d.2. BROMUS TECTORUM SEMI-NATURAL HERBACEOUS ALLIANCE
Cheatgrass Semi-natural Herbaceous Alliance

BROMUS TECTORUM SEMI-NATURAL HERBACEOUS ALLIANCE

Cheatgrass Herbaceous Semi-natural Alliance

ELEMENT CONCEPT

GLOBAL SUMMARY: This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to Intermountain West. It occurs after disturbance of a natural shrub- or grass-dominated community that results in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. *Bromus tectorum* typically dominates the community with over 80-90% of the total vegetation cover, making it difficult to determine what natural community was formerly present. This alliance also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species such as *Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. It is distinct from the annual *Bromus* communities found along the Pacific Coast typical of the Mediterranean or maritime climates.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: *Bromus tectorum* Semi-natural Herbaceous Alliance (CEGL003019) was observed in low-lying sites, washes and river floodplains, and dry meadows in upland areas. These sites are highly disturbed from human recreational use, past livestock grazing and cultivation.

Global Environment: This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S. Elevation ranges from sea level to 2200 m. Stands occur after disturbance of a natural shrub- or grass-dominated community resulting in the replacement of the natural vegetation by non-native, annual grass species of *Bromus*. At Wind Cave National Park in South Dakota, weedy non-native graminoid vegetation occurs on recently disturbed areas, most commonly along roads. Small stands also occur in prairie dog towns (H. Marriott pers. comm. 1999). In the Great Basin, *Bromus tectorum* grasslands has invaded large areas of burned-over sagebrush steppe. *Bromus tectorum* increases the fire frequency of steppe communities, which eventually eliminates sagebrush (FEIS 2001).

VEGETATION DESCRIPTION

Zion National Park Vegetation: This alliance is dominated by *Bromus tectorum*. Other species present are most commonly exotic forbs and agricultural grasses.

Global Vegetation: This alliance-level vegetation type is characterized by a sparse to dense short annual graminoid layer that is typically dominated by *Bromus tectorum* with over 80-90% of the total vegetation cover. Other Eurasian introduced annual species of *Bromus* which may alternatively dominate or codominate are *Bromus carinatus, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, or *Bromus rubens*. Although there may be remnant species of the former native vegetation, the high cover of annual bromes makes it difficult to determine what natural community was formerly present. At Wind Cave National Park in South Dakota, this weedy non-native graminoid vegetation is usually dominated by several perennial and annual brome grasses, including *Bromus inermis, Bromus japonicus*, and cheatgrass *Bromus tectorum*. Cover is variable (H. Marriott pers. comm. 1999).

Global Dynamics: *Bromus tectorum* is an annual grass and is able to complete its lifecycle in the spring before drying out mid-summer. Its fine structure makes it extremely flammable when dry, and it will increase the fire frequency of a site (FEIS 2001). Frequent fires favor *Bromus tectorum* because they eliminate competing perennial vegetation, but do not kill all the *Bromus tectorum* seeds, which survive in the unburned organic material (FEIS 2001). This altered ecological process has promoted the spread of *Bromus tectorum* and other exotic annual bromes at the expense of sagebrush shrublands in large parts of the western U.S. (Daubenmire 1975, Young and Evans 1973, 1978).

This type is most common where disturbances have eliminated or largely set back the native vegetation. Where the brome grasses are invading native vegetation, the types may still be tracked as native types, since the native species may still persist. A recent study (Karl et al. 1999) found that despite strong seed and seedling production by the exotic brome grasses (*Bromus japonicus, Bromus tectorum*), the large amount of herbaceous biomass produced by the two vegetatively propagating native grasses, *Bouteloua gracilis* and *Pascopyrum smithii*, suggests that these native grasses may well maintain their ecological importance in the stands.

In Nevada, Beatley (1976) found dense stands the introduced winter annual grass *Bromus tectorum* growing in disturbed *Artemisia* shrublands. *Bromus rubens* is more common in lower elevation sites, and *Bromus tectorum* is most common in higher elevation sagebrush and pinyon-juniper communities.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus tectorum*

Global

Stratum	**Species**
GRAMINOID	*Bromus tectorum, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, *Bromus rubens*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
GRAMINOID	*Bromus tectorum*

Global

Stratum	**Species**
GRAMINOID	*Bromus tectorum, Bromus hordeaceus, Bromus madritensis, Bromus japonicus, Bromus rigidus*, *Bromus rubens*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: GW.

Global Comments: This alliance also includes grasslands dominated or codominated by other Eurasian introduced annual *Bromus* species. It is distinct from the annual *Bromus* communities found along the Pacific Coast with Mediterranean or maritime climates because it does not have the introduced annual oatgrass (*Avena barbata* and *Avena fatua*), or other species typical of the California annual grassland (Sawyer and Keeler-Wolf 1995).

ELEMENT DISTRIBUTION

Zion National Park Range: No plots were taken for this vegetation type. It was observed in disturbed areas of Zion National Park at lower elevations and a variety of landforms, but is more common in lowlands, old agriculture fields and overgrazed pastures. This alliance is extensive in Main Canyon, Parunaweep Canyon, and Upper Coalpits.

Global Range: This alliance-level herbaceous vegetation type is found throughout much of western North America from the western Great Plains to intermountain and southwestern U.S.

Nations: US
States/Provinces: AZ CA UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: None. AA plots: Yes
Classification Confidence: 2 **Identifier:** CEGL003019
REFERENCES: Beatley 1976, Daubenmire 1975, FEIS 2001, Karl et al. 1999, Sawyer and Keeler-Wolf 1995, Young and Evans 1973, Young and Evans 1978

VII. SPARSE VEGETATION

VII.A.1.N.a. Cliffs with sparse vascular vegetation

VII.A.1.N.a.200. WOODED BEDROCK SPARSELY VEGATATED ALLIANCE
Wooded Bedrock Sparsely Vegetated Alliance

PINUS PONDEROSA SLICKROCK SPARSE VEGETATION

Ponderosa Pine Slickrock Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on steep Navajo sandstone slopes above 6000 feet elevation. Sandy soils accumulate in rock crevices to support opportunistic vegetation. There is high cover of exposed bedrock.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Plant species cover in these stands that occupy Navajo sandstone slopes are too sparse to classify them as woodland, shrublands or grasslands. Cover of *Pinus ponderosa* is between 5-20% and usually less than 15% cover. Other tree species may include *Pinus edulis, Pinus monophylla,* and/or *Juniperus osteosperma*. *Pinus ponderosa* trees typically have stunted growth, with heights averaging 10 m or less. Shrubs that commonly occur are *Arctostaphylos patula, Amelanchier utahensis, Quercus turbinella*, and *Cercocarpus intricatus*. Cover of shrubs is less than tree cover. The herbaceous layer is very sparse and inconsistent in composition. Even with the sparse vegetation cover, species composition may be relatively diverse, e.g., 27 species were recorded from one plot.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
TREE CANOPY	*Pinus ponderosa, Pinus monophylla*
TALL SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus intricatus*
GRAMINOID	*Aristida purpurea, Poa fendleriana, Sporobolus cryptandrus*
FORB	*Comandra umbellata, Heterotheca villosa, Phlox austromontana, Stephanomeria spp.*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
TREE CANOPY	*Pinus ponderosa*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs frequently on Navajo sandstone formations of the eastern side of Zion National Park and Kolob Canyons region.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH26, 127
Classification Confidence: 3 **Identifier:** CEGL002972
REFERENCES: None available.

VII.A.2.N.a. Pavement with sparse vascular vegetation

VII.A.2.N.a.200. CERCOCARPUS INTRICATUS SPARSELY VEGETATED ALLIANCE

Littleleaf Mountain-mahogany Sparsely Vegetated Alliance

CERCOCARPUS INTRICATUS SLICKROCK SPARSE VEGETATION

Littleleaf Mountain-mahogany Slickrock Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: The Navajo sandstone slopes where this association occurs are usually steep with various aspects. Where vegetation exists on these slopes, soils are sandy and shallow. Bedrock makes up 85-100% of ground cover.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Cercocarpus intricatus* dominates this association, but only averages 5-10% cover. Other shrubs commonly contributing to the sparse cover include *Arctostaphylos patula, Quercus turbinella, Amelanchier utahensis*, and *Yucca* spp. *Pinus edulis, Pinus monophylla, Juniperus osteosperma*, and *Pinus ponderosa* may be represented as few singular trees across the landscape. Herbaceous species present are diverse, inconsistent in composition, and very sparse. The common species that occur are *Heterotheca villosa, Arenaria fendleri, Sporobolus cryptandrus, Poa fendleriana*, and *Aristida purpurea*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHRUB	*Cercocarpus intricatus*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHRUB	*Arctostaphylos patula, Cercocarpus intricatus, Quercus turbinella, Yucca* spp.

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs extensively on the sandstone slopes of Springdale East quadrangle and less frequently in the Kolob Arch quadrangle.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH29, 5, 20, 107, 128, 250, 253
Classification Confidence: 2 **Identifier:** CEGL002977
REFERENCES: None available.

VII.C.3.N.b. Dry slopes

VII.C.3.N.b.200. CERCOCARPUS MONTANUS SPARSELY VEGETATED ALLIANCE
Mountain-mahogany Sparsely Vegetated Alliance

CERCOCARPUS MONTANUS ROCK PAVEMENT SPARSE VEGETATION

Mountain-mahogany Rock Pavement Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on gentle to steep mesa rims and mountain ridges where most of the exposed ground is rock pavement or high cover of small and large rock fragments. Soils are sandy or silty. Elevation ranges 6700 to 8200 feet.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Total shrub cover in this association is between 5 and 20%. *Cercocarpus montanus* usually dominates or codominates the shrub component with various combinations of *Amelanchier utahensis, Arctostaphylos patula*, and/or *Quercus gambelii*. *Cercocarpus montanus* was not present in one stand; however, the rest of the species composistion was consistent. Single standing *Juniperus osteosperma* and *Pinus edulis* may be found in the stand. Little bare ground is exposed and is usually entirely covered with small to large rock fragments forming a rock pavement. Few herbaceous species are present and they are extremely sparse in cover.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus, Quercus gambelii*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHRUB	*Amelanchier utahensis, Arctostaphylos patula, Cercocarpus montanus*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs on mesa rims and mountain ridges in the northern regions of the park. Goose Creek knoll and the western rim of Horse Ranch Mountain are representative sites.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 102, 115, 213, 309
Classification Confidence: 3 **Identifier:** CEGL002978
REFERENCES: None available.

VII.C.3.N.b.201. PAINTED DESERT SPARSELY VEGETATED ALLIANCE
Painted Desert Sparsely Vegetated Alliance

EPHEDRA NEVADENSIS / LICHEN SPARSE VEGETATION [PROVISIONAL]
Nevada Joint-fir / Lichen Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on the top of small alluvium hills on the Virgin River valley floor. Elevation is approximately 3800 feet, and soils are white in color and silty in texture. Ground cover is 85% cryptogamic crust.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Total vegetation cover for this association is less than 5%. Cryptogamic crust constitutes 85% of the ground cover, *Ephedra nevadensis* 3% foliar cover, *Atriplex canescens* 1%, and *Bromus tectorum* 1%.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Ephedra nevadensis*
GRAMINOID	*Bromus tectorum*
NONVASCULAR	Unknown lichen species

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Atriplex canescens, Ephedra nevadensis*
NONVASCULAR	Unknown lichen species

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association occurs east of Coalpits Wash at the southern boundary of the park. It may occur very infrequently in small stands along the southern and western boundary of the park.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH45
Classification Confidence: 3 **Identifier:** CEGL002976
REFERENCES: None available.

ERIOGONUM CORYMBOSUM BADLANDS SPARSE VEGETATION

Crispleaf Wild Buckwheat Badlands Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: Elevation for this association and most of the Chinle Formation is 4000 to 4300 feet. Slopes are generally steep, and vegetation has difficulty taking hold on the highly erosive silty clay soil. Chinle is a shale formation from the Triassic period colored in mauve, gray and white, and weathering to clay on exposure.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Vegetation is extremely sparse for this association, less than 20% total canopy cover of vascular plants. All species that occur contribute minimal cover. Those species that regularly occur are *Eriogonum corymbosum, Atriplex confertifolia, Ericameria nauseosa, Psorothamnus fremontii, Salvia dorrii, Gutierrezia sarothrae, Coleogyne ramosissima, Pleuraphis jamesii*, and *Elymus elymoides*.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Atriplex confertifolia, Eriogonum corymbosum, Ericameria nauseosa*
GRAMINOID	*Bromus tectorum, Elymus elymoides, Pleuraphis jamesii*

Global

Stratum	**Species**

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHORT SHRUB	*Atriplex confertifolia, Eriogonum corymbosum*

Global

Stratum	**Species**

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association is documented on the southern boundary of the park near Shunesburg. In the park, the Chinle Formation, for the most part, extends north from Rockville into the uplands of Scoggins Wash. It appears again in scattered locations to the northwestern region of the park. This association is likely to occur on other eroded Chinle sites.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH86, 4
Classification Confidence: 3 **Identifier:** CEGL002979
REFERENCES: None available.

Xx. HIERARCHY PLACEMENT UNDETERMINED

BACCHARIS EMORYI SHRUBLAND [PROVISIONAL]

Emory Seepwillow Shrubland

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association occurs on flat streambanks or stream terraces. Soils are sandy.

Global Environment: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

VEGETATION DESCRIPTION

Zion National Park Vegetation: *Baccharis emoryi* has 35-45% cover in the shrub layer. *Salix exigua* may be present but with less than 5% cover. Tree species, if present, are saplings. Some herbaceous species of minimal cover present include *Equisetum variegatum, Melilotus officinalis, Salsola tragus, Muhlenbergia asperifolia*, and *Poa pratensis*. This association occurs in a mosaic amongst mature *Populus fremontii - Fraxinus velutina* Woodland in Zion Canyon.

Global Vegetation: This association has only been described from Zion NP. Until further inventory is completed there is no global information.

Global Dynamics: Information not available.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	Species
SHRUB	*Baccharis emoryi*

Global

Stratum	Species

Information not available.

CHARACTERISTIC SPECIES

Zion National Park

Stratum	Species
SHRUB	*Baccharis emoryi*

Global

Stratum	Species

Information not available.

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: Information not available.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled in Zion Canyon on the banks of the Virgin River. It has been observed in small stands along the banks of the Virgin River and the East Fork of the Virgin River.

Global Range: This association has currently only been described from Zion NP in southwestern Utah.

Nations: US

States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: RH68
Classification Confidence: 3 **Identifier:** CEGL002974
REFERENCES: None available.

ERICAMERIA NAUSEOSA SAND DEPOSIT SPARSE VEGETATION [PROVISIONAL]

Rubber Rabbitbrush Sand Deposit Sparse Vegetation

ELEMENT CONCEPT

GLOBAL SUMMARY: This association has only been described from Zion National Park and Ouray National Wildlife Refuge in Utah, but is likely more common in similar habitats throughout the interior western U.S. At Zion, a stand was described from a colluvial slope below a sandstone cliff in sandy soil derived from sandstone residuum. Whereas at Ouray it was described from sand dunes on slopes below the bluff along the river and on sand sheets in flatter areas. Sites are generally gentle to moderately sloping, but range from flat to steep and may occur on any aspect. The vegetation is characterized by a typically sparse short-shrub layer 5-20% cover (but may range up to 30% cover) that is dominated by *Ericameria nauseosa* (at least half the cover). Other shrubs or dwarf-shrubs may include *Artemisia dracunculus, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Ipomopsis congesta, Gutierrezia sarothrae, Opuntia polyacantha,* or *Yucca elata var. utahensis.* The herbaceous layer is generally sparse and is dominated by perennial graminoids such as *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata,* and *Sporobolus cryptandrus.* Forb cover is sparse.

ENVIRONMENTAL DESCRIPTION

USFWS Wetland System: Not Applicable

Zion National Park Environment: This association was sampled at 6300 feet on a steep southwest-facing, colluvial slope below a sandstone wall. Soils are sandy. It has also been observed throughout the park on other naturally disturbed and human-caused disturbed sites, such as road cuts.

Global Environment: This association has only been described from Zion National Park and Ouray National Wildlife Refuge in Utah, but is likely more common in similar habitats throughout the interior western U.S. Elevation ranges from 1430-1920 m (4700-6300 feet). At Zion, a stand was described from a colluvial slope below a sandstone cliff in sandy soil derived from sandstone residuum. Whereas at Ouray it was described from sand dunes on slopes below the bluff along the river and on sand sheets in flatter areas (Von Loh et al. 2002). Sites are generally gentle to moderately sloping, but range from flat to steep and may occur on any aspect.

VEGETATION DESCRIPTION

Zion National Park Vegetation: Total vegetation cover at this site is only 25%. *Ericameria nauseosa* is the dominant shrub. Other shrubs present are *Ipomopsis congesta, Eriogonum corymbosum, Yucca elata var. utahensis*, and *Atriplex canescens*. Herbaceous species are extremely sparse and contribute minimal cover.

Global Vegetation: This association is characterized by a typically sparse short-shrub layer 5-20% cover (but may range up to 30% cover) that is dominated by *Ericameria nauseosa* (at least half the cover). Other shrubs or dwarf-shrubs may include *Artemisia dracunculus, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Eriogonum corymbosum, Ipomopsis congesta, Gutierrezia sarothrae, Opuntia polyacantha,* or *Yucca elata var. utahensis.* The herbaceous layer is generally sparse and is dominated by perennial graminoids such as *Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata,* and *Sporobolus cryptandrus.* Forbs associates may include *Chamaesyce glyptosperma, Cirsium* spp., *Heterotheca villosa, Penstemon palmeri, Phacelia heterophylla,* and *Sophora stenophylla.*

Global Dynamics: The sandy substrate is an important environmental variable whether created by active eolian processes or from sandstone residuum.

MOST ABUNDANT SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Ericameria nauseosa*

Global

Stratum	**Species**
SHRUB	*Ericameria nauseosa, Atriplex canescens, Chrysothamnus viscidiflorus, Ephedra torreyana, Gutierrezia sarothrae, Opuntia polyacantha*
GRAMINOID	*Achnatherum hymenoides, Aristida purpurea, Hesperostipa comata, Sporobolus cryptandrus*
FORB	*Heterotheca villosa*, *Sophora stenophylla*

CHARACTERISTIC SPECIES

Zion National Park

Stratum	**Species**
SHRUB	*Atriplex canescens, Ericameria nauseosa, Eriogonum corymbosum, Ipomopsis congesta, Yucca elata var utahensis*
GRAMINOID	*Achnatherum hymenoides, Hesperostipa comata*
FORB	*Heterotheca villosa, Penstemon palmeri, Phacelia heterophylla, Cirsium* spp.

Global

Stratum	**Species**
SHRUB	*Ericameria nauseosa, Chrysothamnus viscidiflorus*
GRAMINOID	*Achnatherum hymenoides, Hesperostipa comata, Sporobolus cryptandrus*

GLOBAL SIMILAR ASSOCIATIONS:
Information not available.

GLOBAL STATUS AND CLASSIFICATION COMMENTS

Global Conservation Status Rank: G?.

Global Comments: This association has been described from only 2 areas but is likely more common.

ELEMENT DISTRIBUTION

Zion National Park Range: This association was sampled on a slope in the Middle Fork of Taylor Creek drainage high above the canyon floor. It occurs occasionally throughout the park.

Global Range: This association has only been described from Zion National Park and Ouray National Wildlife Refuge in Utah, but is likely more common in similar habitats throughout the interior western U.S.

Nations: US
States/Provinces: UT

ELEMENT SOURCES

Zion National Park Inventory Notes: Plots: 36 & multiple AA points
Classification Confidence: 3 **Identifier:** CEGL002980
REFERENCES: Von Loh et al. 2002

REFERENCES CITED IN ASSOCIATION DESCRIPTIONS

Alexander, B. G., Jr., E. L. Fitzhugh, F. Ronco, Jr., and J. A. Ludwig. 1987. A classification of forest habitat types of the northern portion of the Cibola National Forest, NM. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-143. Fort Collins, CO. 35 pp.

Alexander, B. G., Jr., F. Ronco, Jr., E. L. Fitzhugh, and J. A. Ludwig. 1984a. A classification of forest habitat types of the Lincoln National Forest, New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-104. Fort Collins, CO. 29 pp.

Alexander, B. G., Jr., F. Ronco, Jr., A. S. White, and J. A. Ludwig. 1984b. Douglas-fir habitat types of northern Arizona. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-108. Fort Collins, CO. 13 pp.

Allman, V. P. 1952. A preliminary study of the vegetation in an exclosure in the chaparral of the Wasatch Mountains, Utah. Unpublished thesis. Brigham Young University, Provo, UT.

Andrews, T. 1983. Subalpine meadow and alpine vegetation of the upper Pecos River. USDA Forest Service, Southwestern Region. Report RM-51. Albuquerque, NM.

Annable, C. R. 1985. Vegetation and flora of the Funeral Mountains, Death Valley National Monument. California-Nevada Cooperative National Park Resources Studies Unit, National Park Service/University of Nevada Contribution 016/07. Las Vegas, NV. 188 pp.

Armstrong, J. D. 1969. Vegetation of the Virgin Mountains, Clark County, Nevada. Unpublished thesis. University of Nevada, Las Vegas. 104 pp.

Arno, S. F. 1980. Forest fire history in the northern Rockies. Journal of Forestry 78(8):460-465.

Baalman, R. J. 1965. Vegetation of the Salt Plains National Wildlife Refuge, Jet, Oklahoma. Unpublished Ph.D. dissertation, University of Oklahoma, Norman.

Bader, E. H. 1932. The vegetation of the Mesa Verde National Park, Colorado. Unpublished thesis. University of Colorado, Boulder. 64 pp.

Baker, W. L. 1980a. Alpine vegetation of the Sangre De Cristo Mountains, New Mexico: Gradient analysis and classification. Unpublished thesis. University of North Carolina, Chapel Hill. 55 pp.

Baker, W. L. 1982b. Natural vegetation of the Piceance Basin, Colorado. Appendix D, pages 1-113 in: J. S. Peterson and W. L. Baker, editors. Inventory of the Piceance Basin, Colorado. Unpublished report for the Bureau Land Management, Craig, CO.

Baker, W. L. 1983a. Alpine vegetation of Wheeler Peak, New Mexico, USA: Gradient analysis, classification, and biogeography. Arctic and Alpine Research 15(2):223-240.

Baker, W. L. 1983b. Some aspects of the presettlement vegetation of the Piceance Basin, Colorado. Great Basin Naturalist 43(4):687-699.

Baker, W. L. 1983c. Natural vegetation of part of northwestern Moffat County, Colorado. Unpublished report prepared for the State of Colorado Natural Areas Program, Department of Natural Resources, Denver by Colorado Natural Heritage Inventory, Denver.

Baker, W. L. 1984a. A preliminary classification of the natural vegetation of Colorado. Great Basin Naturalist 44(4):647-676.

Baker, W. L., and S. C. Kennedy. 1985. Presettlement vegetation of part of northwestern Moffat County, Colorado, described from remnants. Great Basin Naturalist 45(4):747-777.

Barbour, M. G., and J. Major, editors. 1977. Terrestrial vegetation of California. John Wiley and Sons, New York. 1002 pp.

Barney, M. A., and N. C. Frischknecht. 1974. Vegetation changes following fire in the pinyon-juniper types of west-central Utah. Journal of Range Management 27(2):91-96.

Bassett, R. L. 1987. Silvicultural systems for pinyon-juniper. Pages 273-278 in: R. L. Everett, compiler. Proceedings--pinyon-juniper conference: 1986 January 13-16; Reno, NV. USDA Forest Service, Intermountain Research Station. General Technical Report INT-215. Ogden, UT.

Beatley, J. C. 1976. Vascular plants of the Nevada Test Site and central-southern Nevada: Ecological and geographic distributions. Technical Information Center, Energy Research and Development Administration. TID-26881. Prepared for Division of Biomedical and Environmental Research. 297 pp.

Beetle, A. A., and K. L. Johnson. 1982. Sagebrush in Wyoming. Wyoming Agricultural Experiment Station Bulletin 779. University of Wyoming, Laramie.

Benedict, N. B. 1983. Plant associations of subalpine meadows, Sequoia National Park, California. Arctic and Alpine Research 15(3):383-396.

BIA [Bureau of Indian Affairs]. 1979. The secretarial land use plan for the addition to the Havasupai Indian Reservation. Unpublished draft Environmental Statement INT DES 79-42. Prepared by USDI Bureau of Indian Affairs, Phoenix Area Office with the assistance of Office of Arid Land Studies, University of Arizona, Tucson.

Blackburn, W. H. 1967. Plant succession on selected habitat types in Nevada. Unpublished thesis. University of Nevada, Reno. 162 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968a. Vegetation and soils of the Mill Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-43. Reno. 69 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1968c. Vegetation and soils of the Duckwater Watershed. Nevada Agricultural Experiment Station Bulletin R-40. Reno. 76 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969a. Vegetation and soils of the Cow Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-49. Reno. 80 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969b. Vegetation and soils of the Coils Creek Watershed. Nevada Agricultural Experiment Station Bulletin R-48. Reno. 81 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969c. Vegetation and soils of the Churchill Canyon Watershed. Nevada Agricultural Experiment Station Bulletin R-45. Reno. 157 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1969d. Vegetation and soils of the Pine and Mathews Canyon Watersheds. Nevada Agricultural Experiment Station Bulletin R-46. Reno. 111 pp.

Blackburn, W. H., P. T. Tueller, and R. E. Eckert, Jr. 1971. Vegetation and soils of the Rock Springs Watershed. Nevada Agricultural Experiment Station Bulletin R-83. Reno. 116 pp.

Blackburn, W. H., R. E. Eckert, Jr., and P. T. Tueller. 1969e. Vegetation and soils of the Crane Springs Watershed. Nevada Agricultural Experiment Station Bulletin R-55. Reno. 63 pp.

Blackhawk Coal Company. 1981. Vegetation resources. Chapter 9 Section 9.2, pages 9-1 through 9-27 in: Mining and Reclamation Plan for Willow Creek Mine, Blackhawk Coal Company. Utah Division of Oil, Gas & Mining Number ACT/007/002. Salt Lake City, UT.

Boles, P. H., and W. A. Dick-Peddie. 1983. Woody riparian vegetation patterns on a segment of the Mimbres River in southwestern New Mexico. Southwestern Naturalist 28:81-87.

Boucek, M. M. 1986. Vegetation survey at the Summit No.1 Coal Mine, Summit County, Utah. Volume 1, Section 783.19, Appendix 783.19. Pages 1-15 in Mining and Reclamation Plan. Summit Minerals Inc. Utah Division of Oil, Gas & Mining Number ACT/043/001. Salt Lake City.

Bourgeron, P. S., and L. D. Engelking, editors. 1994. A preliminary vegetation classification of the western United States. Unpublished report. The Nature Conservancy, Western Heritage Task Force, Boulder, CO. 175 pp. plus appendix.

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1993b. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Unpublished report prepared for The Nature Conservancy by the Western Heritage Task Force, Boulder, CO. (Volume I and II).

Bourgeron, P. S., L. D. Engelking, H. C. Humphries, E. Muldavin, and W. H. Moir. 1995. Assessing the conservation value of the Gray Ranch: Rarity, diversity and representativeness. Desert Plants 11:2-3.

Bowers, J. E. 1984. Plant geography of southwestern sand dunes. Desert Plants 6(1):31-42, 51-54.

Bowns, J. E., and N. E. West. 1976. Blackbrush (*Coleogynе ramosissima* Torr.) on southwestern Utah rangelands. Utah Agricultural Experiment Station Research Report 27. Logan, UT. 27 pp.

Bradley, A. F., N. V. Noste, and W. C. Fischer. 1992. Fire ecology of forests and woodlands in Utah. USDA Forest Service, Intermountain Research Station. General Technical Report INT-287. Ogden, UT. 128 pp.

Bradley, W. G. 1964. The vegetation of the desert game range with special reference to the desert bighorn. Pages 43-67 in: Transcripts of the Desert Bighorn Council. Las Vegas, NV.

Britton, C. M., and H. A. Wright. 1983. Brush management with fire. Pages 61-68 in: K. C. McDaniel, editor. Proceedings--brush management symposium: 1983 February 16; Albuquerque, NM. Society for Range Management, Denver, CO.

Brotherson, J. D., and S. J. Barnes. 1984. Habitat relationships of *Glaux maritima* in central Utah. Great Basin Naturalist 44(2):299-309.

Brotherson, J. D., and W. E. Evenson.1983. Vegetation communities surrounding Utah Lake and its bays. Utah Lake Vegetation Studies. Unpublished report done for the Utah Division of Wildlife Resources & USDI Bureau of Reclamation, Provo, UT. 401 pp.

Brown, D. E., C. H. Lowe, and J. F. Hausler. 1977a. Southwestern riparian communities: Their biotic importance and management in Arizona. Pages 201-211 in: Importance, preservation and management of the riparian habitat. July 9, 1977, Tucson, AZ.

Brown, D. E., editor. 1982. Biotic communities of the American Southwest-United States and Mexico. Desert Plants Special Issue 4(1-4):1-342.

Buffington, L. C., and C. H. Herbel. 1965. Vegetational changes on a semidesert grassland range from 1858 to 1963. Ecological Monographs 35(2):139-164.

Bunin, J. E. 1975c. The vegetation of the west slope of the Park Range, Colorado. Unpublished dissertation. University of Colorado, Boulder. 235 pp.

Bunin, J. E. 1985. Vegetation of the City of Boulder, Colorado open space lands. Report prepared for the City of Boulder, Real Estate/Open Space, Boulder, CO. 114 pp.

Bunting, S. C. 1987. Use of prescribed burning in juniper and pinyon-juniper woodlands. Pages 141-144 in: R. L. Everett, compiler. Proceedings--pinyon-juniper conference; 1986 January 13-16; Reno, NV. Department of Agriculture, Forest Service, Intermountain Research Station. General Technical Report INT-215. Ogden, UT.

Burgess, T. L. 1995. Desert grassland, mixed shrub savanna, shrub steppe, or semidesert scrub. Pages 31-67 in: M. P. McClaran and T. R. Van Devender, editors. The Desert Grassland. University of Arizona Press, Tucson.

Callison, J., Jr., J. D. Brotherson, and J. E. Bowns. 1985. The effects of fire on the blackbrush (*Coleogyne ramosissima*) community of southwestern Utah. Journal of Range Management 38(6):535-538.

Cannon, H. L. 1960. The development of botanical methods of prospecting for uranium on the Colorado Plateau. USDI Geological Survey Bulletin 1085-A. Washington, DC. 50 pp.

Carmichael, R. S., O. D. Knipe, C. P. Pase, and W. W. Brady. 1978. Arizona chaparral: Plant associations and ecology. USDA Forest Service Research Paper RM-202. 16 pp.

Cedar Creek Associates, Inc. 1987. Draft vegetation in formation for the Alton Coal Mining Project. Volume 6, Chapter 3, Appendix 3.6-B, pages 1-41 in: Mining & Reclamation Plan for Alton Mine, Utah International, Inc., Utah Division of Oil, Gas & Mining ACT/025/003.

Christensen, E. M. 1955. Ecological notes on the mountain brush in Utah. Proceedings of the Utah Academy of Science, Arts, and Letters 32:107-111.

Christy, S. 1973. An analysis of the woody vegetation on the South Platte River flood plain in northeastern Colorado. Unpublished thesis. University of Northern Colorado, Greeley. 82 pp.

Clary, W. P. 1992. Ecology and values of Gambel oak woodlands. Pages 87-95 in: USDA Forest Service General Technical Report RM-218. Ecology and management of oak and associated woodlands. Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 224 pp.

Collins, E. I. 1984. Preliminary classification of Wyoming plant communities. Unpublished classification prepared for the Wyoming Natural Heritage Program, The Nature Conservancy, Laramie, WY.

Cooper, D. J., and T. R. Cottrell. 1990. Classification of riparian vegetation in the northern Colorado Front Range. Unpublished report prepared for The Nature Conservancy, Colorado Field Office, Boulder. 115 pp.

Cooper, S. V., P. Lesica, R. L. DeVelice, and T. McGarvey. 1995. Classification of southwestern Montana plant communities with emphasis on those of Dillon Resource Area, Bureau of Land Management. Montana Natural Heritage Program, Helena, MT. 154 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Biological Service Program. FWS/OBS-79/31. Washington, DC. 103 pp.

Crane, M. F. 1982. Fire ecology of Rocky Mountain Region forest habitat types. USDA Forest Service final report. 272 pp.

Cronquist, A., A. H. Holmgren, N. H. Holmgren, J. L. Reveal, and P. K. Holmgren. 1977. Intermountain flora: Vascular plants of the Intermountain West, U.S.A. Volume 6: The Monocotyledons. Columbia University Press, New York. 584 pp.

Cronquist, A., N. H. Holmgren, and P. K. Holmgren. 1997. Intermountain flora: Vascular plants of the Intermountain West, USA. Volume 3, Part A, subclass Rosidae (except Fabeles). New York Botanical Garden, Bronx, NY. 446 pp.

Dastrup, B. C. 1963. Vegetational changes of the Uinta Basin since settlement. Unpublished thesis. Brigham Young University, Provo, UT. 118 pp.

Daubenmire, R. F. 1970. Steppe vegetation of Washington. Washington State University Agricultural Experiment Station Technical Bulletin No. 62. 131 pp.

Daubenmire, R. 1975. Floristic plant geography of eastern Washington and northern Idaho. Journal of Biogeography 2:1-18.

DeVelice, R. L. 1983. Forest vegetation of northern New Mexico and southern Colorado. Unpublished dissertation. New Mexico State University, Las Cruces. 191 pp.

DeVelice, R. L., and J. A. Ludwig. 1983a. Climax forest series of northern New Mexico and southern Colorado. Pages 45-53 in: Proceedings of the Workshop on Southwestern Habitat Types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwest Region, Albuquerque, NM.

DeVelice, R. L., and P. Lesica. 1993. Plant community classification for vegetation on BLM lands, Pryor Mountains, Carbon County, Montana. Unpublished report by Montana Natural Heritage Program, Helena, MT. 78 pp.

DeVelice, R. L., J. A. Ludwig, W. H. Moir, and F. Ronco, Jr. 1986. A classification of forest habitat types of northern New Mexico and southern Colorado. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-131. Fort Collins, CO. 59 pp.

Diamond, D. D. 1993. Classification of the plant communities of Texas (series level). Unpublished document. Texas Natural Heritage Program, Austin. 25 pp.

Dick-Peddie, W. A. 1993. New Mexico vegetation: Past, present, and future. University of New Mexico Press, Albuquerque. 244 pp.

Dillinger, K. C. 1970. Evaluation of mule deer habitat in Mesa Verde National Park. Unpublished thesis. Colorado State University, Fort Collins. 40 pp.

Dixon, H. 1935. Ecological studies on the high plateaus of Utah. Botanical Gazette 97:272-320.

Donart, G. B., D. D. Sylvester, and W. C. Hickey. 1978a. A vegetation classification system for New Mexico, USA. Pages 488-490 in: Rangeland Congress, Denver, CO, 14-18 August 1978. Society for Range Management, Denver.

Donart, G. B., D. D. Sylvester, and W. C. Hickey. 1978b. Potential natural vegetation-New Mexico. New Mexico Interagency Range Commission Report 11.

Dorn, R. D. 1997. Rocky Mountain region willow identification field guide. Renewable Resources R2-RR-97-01. USDA Forest Service, Rocky Mountain Region, Denver, CO. 107 pp.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA Forest Service. Miscellaneous Publication No. 1439. Washington, DC. 56 pp.

Eddleman, L. E., and R. Jaindl. 1994. Great Basin National Park vegetation analysis. USDI National Park Service Technical Report NPS/PNROSU/NRTR-94/02. USDI National Park Service, Pacific Northwest Region. 110 pp.

Edwards, M. C. 1987. Terrestrial ecosystem survey for the Carson National Forest. USDA Forest Service, Southwestern Region, Albuquerque, NM. [in preparation]

Ellis, S., and P. Hackney. 1981. Vegetation baseline report: Clear Creek property. Unpublished report prepared for Chevron Shale Oil Co., Denver, CO, by Environmental Research and Technology Inc., Fort Collins, CO.

Erdman, J. A. 1962. Ecology of the pinyon-juniper woodland of Wetherill Mesa, Mesa Verde National Park, Colorado. Unpublished thesis. University of Colorado, Boulder. 109 pp.

Erdman, J. A. 1969. Pinyon-juniper succession after fires on residual soils of the Mesa Verde, Colorado. Unpublished dissertation. University of Colorado, Boulder. 81 pp.

Erdman, J. A. 1970. Pinyon-juniper succession after natural fires on residual soils of Mesa Verde, Colorado. Brigham Young University Science Bulletin, Biological Series 11(2):1-26.

Everett, R. L. 1987. Plant response to fire in the pinyon-juniper zone. Pages 152-157 in R. L. Everett, compiler. Proceedings pinyon-juniper conference: 1986 January 13-16, Reno, NV. USDA Forest Service, General Technical Report INT-215. Intermountain Research Station, Ogden, UT.

Eyre, F. H., editor. 1980. Forest cover types of the United States and Canada. Society of American Foresters, Washington, DC. 148 pp.

Faber-Langendoen, D., editor. 2001. Plant communities of the Midwest: Classification in an ecological context. Association for Biodiversity Information, Arlington, VA. 61 pp. plus appendix (705 pp.).

FEIS [Fire Effects Information System]. 1998. USDA Forest Service. URL http://www.fs.fed.us/database/feis/.

FEIS [Fire Effects Information System]. 2001. USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2001, May). [Online] URL http://www.fs.fed.us/database/feis/. Accessed [07-20-01].

Ferchau, H. A. 1973. Vegetation inventory analysis & impact study of the Parachute Creek area, Garfield County, Colorado. Part II, Volume 1, Chapter VI:1-77 in: Unpublished Colony Environmental Report for Colony Develop. Operation, Denver, prepared by Thorne Ecological Institute, Boulder.

Fischer, W. C., and A. F. Bradley. 1987. Fire ecology of western Montana forest habitat types. USDA Forest Service General Technical Report INT-223. Intermountain Research Station, Ogden, UT. 95 pp.

Fitzhugh, E. L., W. H. Moir, J. A. Ludwig, and F. Ronco, Jr. 1987. Forest habitat types in the Apache, Gila, and part of the Cibola national forests. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-145. Fort Collins, CO. 116 pp.

Flowers, S. 1962. Vegetation of Morrow Point and Blue Mesa Reservoir basins of the upper Gunnison River, Colorado. Pages 47-102 in: A. M. Woodbury, editor. Ecological studies of the flora and fauna of the Curecanti Reservoir Basins, western Colorado. University of Utah, Anthropological Papers No. 59 (Upper Colo. Series No. 8).

Francis, R. E. 1983. Sagebrush-steppe habitat types in northern Colorado: A first approximation. Pages 67-71 in: Proceedings of the Workshop on Southwestern habitat types. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Francis, R. E. 1986. Phyto-edaphic communities of the Upper Rio Puerco Watershed, New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-272. Fort Collins, CO. 73 pp.

Francis, R. E., and E. F. Aldon. 1983. Preliminary habitat types of a semiarid grassland. Pages 62-66 in: W. H. Moir and L. Hendzel, technical coordinators. Proceedings of the workshop on southwestern habitat types, 6-8 April 1983, Albuquerque, NM. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. General Technical Report PNW-8. Portland, OR. 417 pp.

Freeman, C. E., and W. A. Dick-Peddie. 1970. Woody riparian vegetation in the Black and Sacramento Mountain ranges, southern New Mexico. The Southwestern Naturalist 15(2):145-164.

Gardner, J. L. 1951. Vegetation of the creosotebush area of the Rio Grande Valley in New Mexico. Ecological Monographs 21:379-403.

Gibbens, R. P., J. M. Tromble, J. T. Hennessy, and M. Cardenas. 1983. Soil movement in mesquite dunelands and former grasslands of southern New Mexico. Journal of Range Management 36(2):145-148.

Graybosch, R. A., and H. Buchanan. 1983. Vegetative types and endemic plants of the Bryce Canyon Breaks. Great Basin Naturalist 43:701-712.

Great Plains Flora Association. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence. 1402 pp.

Hall, F. C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southeastern Washington. USDA Forest Service, Pacific Northwest Region. R6 Area Guide 3-1. 62 pp.

Hall, J. B., and P. L. Hansen. 1997. A preliminary riparian habitat type classification system for the Bureau of Land Management districts in southern and eastern Idaho. Riparian and Wetland Research Program, School of Forestry, University of Montana. Idaho Bureau of Land Management, Technical Bulletin No. 97-11. 381 pp.

Hanks, J. P., E. L. Fitzhugh, and S. R. Hanks. 1983. A habitat type classification system for ponderosa pine forests of northern Arizona. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-97. Fort Collins, CO. 22 pp.

Hansen, P. L., R. D. Pfister, K. Boggs, B. J. Cook, J. Joy, and D. K. Hinckley. 1995. Classification and management of Montana's riparian and wetland sites. Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Miscellaneous Publication No. 54. 646 pp.

Hansen, P. L., S. W. Chadde, and R. D. Pfister. 1988b. Riparian dominance types of Montana. University of Montana Miscellaneous Publication 49. Montana Forest and Conservation Experiment Station, Missoula. 411 pp.

Hansen, P., K. Boggs, and R. Pfister. 1991. Classification and management of riparian and wetland sites in Montana. Unpublished draft version prepared for Montana Riparian Association, Montana Forest and Conservation Experiment Station, School of Forestry, University of Montana, Missoula. 478 pp.

Hanson, H. C., and W. S. Ball. 1928. An application of Raunkiaer's law of frequency to grazing studies. Ecology 9:467-473.

Harmon, W. E. 1980. Survey of the flora and vegetation of the Bodo Wildlife Management Area. Unpublished report prepared for The Nature Conservancy, Denver, CO. On file at the Colorado Natural Areas Program, Denver. 40 pp.

Harper, K. T., F. J. Wagstaff, and L. M. Kunzler. 1985. Biology and management of the Gambel oak vegetative type: a literature review. USDA Forest Service General Technical Report INT-179 Intermountain Forest and Range Experiment Station, Ogden, UT. 31 pp.

Hauke, R. L. 1993. Equisetaceae Michaux ex DeCandolle: Horsetail Family. Pages 76-84 in: Flora of North America, North of Mexico. Volume 2. Oxford University Press, New York.

Heinze, D. H., R. E. Eckert, and P. T. Tueller. 1962. The vegetation and soils of the Steptoe Watershed. Unpublished report prepared for the USDI Bureau of Land Management. 40 pp.

Helm, D. J. 1977. Variations in alpine snowfield vegetation. Unpublished thesis. Colorado State University, Fort Collins. 95 pp.

Helm, D. J. 1981. Vegetation diversity indexes in several vegetation types of western Colorado. Unpublished dissertation. Colorado State University, Fort Collins. 113 pp.

Hennessy, J. T., R. P. Gibbens, J. M. Tromble, and M. Cardenas. 1983. Vegetation changes from 1935 to 1980 in mesquite dunelands and former grasslands of southern New Mexico. Journal of Range Management 36(3):370-374.

Herbel, C. H., F. N. Ares, and R. Wright. 1972. Drought effects on a semidesert grassland range. Ecology 53:1084-1093.

Hess, K. 1981. Phyto-edaphic study of habitat types of the Arapaho-Roosevelt National Forest, Colorado. Unpublished dissertation. Colorado State University, Fort Collins. 558 pp.

Hess, K., and C. H. Wasser. 1982. Grassland, shrubland, and forest habitat types of the White River-Arapaho National Forest. Unpublished final report 53-82 FT-1-19. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 335 pp.

Hironaka, M., M. A. Fosberg, and A. H. Winward. 1983. Sagebrush-grass habitat types of southern Idaho. Forestry, Wildlife, and Range Experiment Station Bulletin No. 15, University of Idaho, Moscow. 44 pp.

Hoagland, B. 2000. The vegetation of Oklahoma: A classification for landscape mapping and conservation planning. The Southwestern Naturalist 45(4):385-420.

Hoagland, B. W. 1998. Oklahoma riparian vegetation. In: A. Fallon and M. Smolen, editors. Riparian area management handbook. Publication number E-952. Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater.

Hoagland, B. W. 1998a. Classification of Oklahoma vegetation types. Working draft. University of Oklahoma, Oklahoma Natural Heritage Inventory, Norman. 43 pp.

Hoffman, G. R., and R. R. Alexander. 1980. Forest vegetation of the Routt National Forest in northwestern Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-221. Fort Collins, CO. 41 pp.

Hoffman, G. R., and R. R. Alexander. 1983. Forest vegetation of the White River National Forest in western Colorado: A habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-249. Fort Collins, CO. 36 pp.

Holland, R. F. 1986b. Preliminary descriptions of the terrestrial natural communities of California. Unpublished report prepared for the California Department of Fish and Game, Nongame-Heritage Program and Natural Diversity Database, Sacramento. 156 pp.

Holm, T. 1927. The vegetation of the alpine region of the Rocky Mountains in Colorado. Pages 1-45 in: National Academy of Sciences 19. Third Memoir.

Humphrey, R. R. 1974. Fire in the deserts and desert grassland of North America. Pages 365-400 in: T. T. Kozlowski and C. E. Ahlgren, editors. Fire and Ecosystems. Academic Press, New York.

Isaacson, H. E. 1967. Ecological provinces within the pinyon-juniper type of the Great Basin and Colorado Plateau. Unpublished thesis. Utah State University, Logan. 44 pp.

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

Jensen, M. E., L. S. Peck, and M. V. Wilson. 1988a. A sagebrush community type classification for mountainous northeastern Nevada rangelands. Great Basin Naturalist 48(4):422-433.

Johnson, C. G., and R. R. Clausnitzer. 1992. Plant associations of the Blue and Ochoco Mountains. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest R6-ERW-TP-036-92. 163 pp. plus appendices.

Johnson, C. G., Jr., and S. A. Simon. 1987. Plant associations of the Wallowa-Snake Province Wallowa-Whitman National Forest. USDA Forest Service, Pacific Northwest Region, Wallowa-Whitman National Forest. Technical Paper R6-ECOL-TP-255A-86. 399 pp. plus appendices.

Johnson, J. R., and G. F. Payne. 1968. Sagebrush reinvasion as affected by some environmental influences. Journal of Range Management 21:209-213.

Johnston, B. C. 1984. Plant associations of Region Two. Edition 3.5. USDA Forest Service, Rocky Mountain Region. Lakewood, CO.

Johnston, B. C. 1987. Plant associations of Region Two: Potential plant communities of Wyoming, South Dakota, Nebraska, Colorado, and Kansas. R2-ECOL-87-2. USDA Forest Service, Rocky Mountain Region. Lakewood, CO. 429 pp.

Johnston, B. C., and L. Hendzel. 1985. Examples of aspen treatment, succession and management in western Colorado. USDA Forest Service, Range Wildlife Fisheries and Ecology. Denver, CO. 164 pp.

Jones, G. 1992b. Wyoming plant community classification (Draft). Wyoming Natural Diversity Database, Laramie, WY. 183 pp.

Jones, G. P., and G. M. Walford. 1995. Major riparian vegetation types of eastern Wyoming. Submitted to Wyoming Department of Environmental Quality, Water Quality Division. Wyoming Natural Diversity Database, Laramie, WY. 245 pp.

Jones, G. P., and W. Fertig. 1996. Plant associations and plant species of special concern in the Jack Morrow Hills ecosystem. Unpublished report prepared for the Bureau of Land Management, Rock Springs District by the Wyoming Natural Diversity Database. 2 volumes.

Kallender, H. R. 1959. Controlled burning in ponderosa pine stands of the Fort Apache Indian Reservation. Pages 20-22 in: R. R. Humphrey, compiler. Your range--its management. Special Report No. 2. University of Arizona, Agricultural Extension Service, Tucson, AZ.

Karl, M. G., R. K. Heitschmidt, and M. R. Haferkamp. 1999. Vegetation biomass dynamics and patterns of sexual reproduction in a northern mixed-grass prairie. The American Midland Naturalist 141:227-237.

Kartesz, J. T. 1994. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. Second edition. Volume 1--Checklist. Timber Press, Portland, OR. 622 pp.

Kartesz, J. T. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First edition. In: J. T. Kartesz and C. A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Kauffman, J. B., W. C. Krueger, and M. Vaura. 1983. Effects of late season cattle grazing on riparian plant communities. Journal of Range Management 37:685-691.

Kauffman, J. B., W. C. Krueger, and M. Vavra. 1985. Ecology and plant communities of the riparian area associated with Catherine Creek in northeastern Oregon. Technical Bulletin 147. Eastern Oregon Agricultural Experiment Station, Oregon State University, Corvallis. 35 pp.

Keammerer, W. R. 1974b. Vegetation of Parachute Creek Valley. Pages 4-91 in: Environmental inventory and impact analysis of a proposed utilities corridor in Parachute Creek Valley, Co. Unpublished report prepared for Colony Development Operation, Denver, Colo.

Keammerer, W. R. 1977. Final report: Vegetation baseline studies, oil shale tract C-b. Unpublished report. Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 183 pp.

Keammerer, W. R., and S. J. Peterson. 1981. Vegetation studies on the Naval Oil Shale Reserve. Unpublished report prepared for TRW Energy Systems Group, McLean, Virginia, by Stoecker-Keammerer and Associates, Ecological Consultants, Boulder, CO. 77 pp.

Kennedy, K. L. 1983a. A habitat-type classification for the pinyon-juniper woodlands of the Lincoln National Forest. Unpublished thesis. New Mexico State University, Las Cruces. 87 pp.

Kerr, C. W., and J. A. Henderson. 1979. Upland vegetation classification and map for a test area, Manti-La Sal National Forest. Appendix Report 15 in: J. A. Henderson, L. S. Davis, and E. M. Ryberg, editors. ECOSYM: A classification and information system for wildlife resource management. Utah State University, Logan. 53 pp.

Kettler, S., and A. McMullen. 1996. Routt National Forest riparian vegetation classification. Report prepared for Routt National Forest by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G. M. 1994. Montane vegetation in relation to elevation and geomorphology along the Cache la Poudre River, Colorado. Unpublished thesis. University of Wyoming, Laramie.

Kittel, G. M., and N. D. Lederer. 1993. A preliminary classification of the riparian vegetation of the Yampa and San Miguel/Dolores river basins. Unpublished report prepared for Colorado Department of Health and the Environmental Protection Agency by The Nature Conservancy, Colorado Field Office, Boulder.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, and J. Sanderson. 1999. A classification of the riparian plant associations of the Rio Grande and Closed Basin watersheds, Colorado. Unpublished report prepared by the Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Kittel, G., E. Van Wie, M. Damm, R. Rondeau, S. Kettler, A. McMullen, and J. Sanderson. 1999b. A classification of riparian and wetland plant associations of Colorado: A user's guide to the classification project. Colorado Natural Heritage Program, Colorado State University, Fort Collins CO. 70 pp. plus appendices.

Kittel, G., R. Rondeau, and A. McMullen. 1996. A classification of the riparian vegetation of the Lower South Platte and parts of the Upper Arkansas River basins, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency, Region VIII. Prepared by Colorado Natural Heritage Program, Fort Collins. 243 pp.

Kittel, G., R. Rondeau, and S. Kettler. 1995. A classification of the riparian vegetation of the Gunnison River Basin, Colorado. Submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Prepared by Colorado Natural Heritage Program, Fort Collins. 114 pp.

Kittel, G., R. Rondeau, N. Lederer, and D. Randolph. 1994. A classification of the riparian vegetation of the White and Colorado River basins, Colorado. Final report submitted to Colorado Department of Natural Resources and the Environmental Protection Agency. Colorado Natural Heritage Program, Boulder. 166 pp.

Kleiner, E. F. 1968. Comparative study of grasslands of Canyonlands National Park. Unpublished dissertation. University of Utah, Salt Lake City. 58 pp.

Kleiner, E. F. 1983. Successional trends in an ungrazed, arid grassland over a decade. Journal of Range Management 36(1):114-118.

Kleiner, E. F., and K. T. Harper. 1972. Environment and community organization in grasslands of Canyonlands National Park. Ecology 53(2):299-309.

Kleiner, E. F., and K. T. Harper. 1977. Occurrence of four major perennial grasses in relation to edaphic factors in a pristine community. Journal of Range Management 30(4):286-289.

Komarkova, V. 1986. Habitat types on selected parts of the Gunnison and Uncompahgre national forests. Unpublished final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO. 270 pp. plus appendices.

Komarkova, V., A. Peters, G. Kamani, W. Jones, V. Howard, H. Gordon, and K. Southwick. 1988a. Natural recovery of plant communities on disturbance plots and history of land use in the Niwot Ridge/Green Lakes Valley, Front Range, Colorado. University of Colorado Longterm Ecological Research Working Paper 88/1. Boulder, CO. 46 pp.

Komarkova, V. K., R. R. Alexander, and B. C. Johnston. 1988b. Forest vegetation of the Gunnison and parts of the Uncompahgre national forests: A preliminary habitat type classification. USDA Forest Service. Research Paper RM-163. 65 pp.

Koniak, S. 1985. Succession in pinyon-juniper woodlands following wildfire in the Great Basin. Great Basin Naturalist 45:556-566.

Kovalchik, B. L. 1987. Riparian zone associations - Deschutes, Ochoco, Fremont, and Winema national forests. USDA Forest Service Technical Paper 279-87. Pacific Northwest Region, Portland, OR. 171 pp.

Kovalchik, B. L. 1993. Riparian plant associations on the national forests of eastern Washington - Draft version 1. USDA Forest Service, Colville National Forest, Colville, WA. 203 pp.

Kunzler, L. M., K. T. Harper, and D. B. Kunzler. 1981. Compositional similarity within the oakbrush type in central and northern Utah. Great Basin Naturalist 41(1):147-153.

Lamb, S. H. 1975. Woody plants of the Southwest: A field guide with descriptive text, drawings, range maps and photographs. The Sunstone Press, Santa Fe, NM.

Larson, G. E. 1993. Aquatic and wetland vascular plants of the northern Great Plains. USDA Forest Service General Technical Report RM-238. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 681 pp.

Larson, M., and W. H. Moir. 1987. Forest and woodland habitat types of northern New Mexico and northern Arizona. Edition 2. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Lauver, C. L., K. Kindscher, D. Faber-Langendoen, and R. Schneider. 1999. A classification of the natural vegetation of Kansas. The Southwestern Naturalist 44:421-443.

Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig, and S. McMurray. 1998. Ecological land classification for southern Ontario: First approximation and its application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Lewis, M. E. 1975. Plant communities of the Jarbidge Mountain Complex, Humboldt National Forest. Unpublished report compiled for USDA Forest Service, Region IV, Ogden, UT. 22 pp.

Lillybridge, T. R., B. L. Kovalchik, C. K. Williams, and B. G. Smith. 1995. Field guide for forested plant associations of the Wenatchee National Forest. USDA Forest Service General Technical Report PNW-GTR-359, Pacific Northwest Research Station, Portland. Portland, OR. 335 pp.

Looman, J. 1982. The vegetation of the Canadian prairie provinces. III. Aquatic and semi-aquatic vegetation, Part 2. Freshwater marshes and bogs. Phytocoenologia 10(4):401-423.

Madany, M. H., and N. E. West. 1980b. Fire history of two montane forest areas of Zion National Park. Pages 50-56 in: M. A. Stokes and J. H. Dieterich, technical coordinators. Proceedings of the fire history workshop; 1980 October 20-24; Tucson, AZ. USDA

Madany, M. H., and N. E. West. 1984. Vegetation of two relict mesas in Zion National Park. Journal of Range Management 37(5):456-461.

Manning, M. 1988. Ecology and rooting characteristics of four intermountain meadow community types. Unpublished thesis. University of Nevada, Reno.

Manning, M. E., and W. G. Padgett. 1995. Riparian community type classification for Humboldt and Toiyabe national forests, Nevada and eastern California. USDA Forest Service, Intermountain Region. 306 pp.

Marr, J. W., D. Buckner, and C. Mutel. 1973a. Ecological analyses of potential shale oil products pipeline corridors in Colorado and Utah. Unpublished report prepared for Colony Development Operation, Atlantic Richfield Company, Denver, by Thorne Ecological Institute and University of Colorado, Boulder. 96 pp. plus appendices.

Marr, J. W., D. A. Boyce, and J. W. Todd. 1973b. Preliminary report on the Redcliff project, Eagle County, Colorado. Unpublished report to the D. E. Fleming Company, Denver, and the Colorado River Water Conservation District, Glenwood Springs, by University of Colorado, Boulder. 9 pp.

Marr, J. W., R. Fritz, J. Meyer, and P. Murphy. 1979. Final report-terrestrial plant ecology-stand ecosystem data tables, Juniper/Cross Mountain Project. Report prepared for Colorado River Water Conservation District, Glenwood Springs, CO, by University of Colorado, Boulder. 47 pp.

Marriott, H. J., and D. Faber-Langendoen. 2000. The Black Hills community inventory. Volume 2: Plant community descriptions. The Nature Conservancy, Midwest Conservation Science Center and Association for Biodiversity Information, Minneapolis, MN. 326 pp.

Mason, L. R., H. M. Andrews, J. A. Carley, and E. D. Haacke. 1967. Vegetation and soils of No Man's Mesa relict area. Journal of Range Management 20:45-59.

Mattson, D. J. 1984. Classification and environmental relationships of wetland vegetation in central Yellowstone National Park. Unpublished thesis. University of Idaho, Moscow. 409 pp.

Mauk, R. L., and J. A. Henderson. 1984. Coniferous forest habitat types of northern Utah. USDA Forest Service. General Technical Report INT-170. Intermountain Forest and Range Experiment Station, Ogden, UT. 89 pp.

McAuliffe, J. R. 1995. Landscape evolution, soil formation, and Arizona's desert grasslands. Pages 100-129 in: M. P. McClaran and T. R. Van Devender, editors. The Desert Grassland. University of Arizona Press, Tucson.

McLaughlin, S. P., and J. E. Bowers. 1982. Effects of wildfire on a Sonoran Desert plant community. Ecology 63(1):246-248.

McLean, A. 1970. Plant communities of the Similkameen Valley, British Columbia, and their relationships to soils. Ecological Monographs 40(4):403-424.

McPherson, G. R. 1995. The role of fire in the desert grasslands. Pages 130-151 in: M. P. McClaran and T. R. Van Devender, editors. The Desert Grassland. University of Arizona Press, Tucson.

Medina, A. L. 1986. Riparian plant communities of the Fort Bayard watershed in southwestern New Mexico. Southwestern Naturalist 31(3):345-359.

Milton, N. M., and T. L. Purdy. 1983. Plant and soil relationships in two hydrothermally altered areas of the Great Basin. Great Basin Naturalist 43(3):457-469.

Moir, W. H. 1963. Vegetational analysis of three southern New Mexico mountain ranges. Unpublished thesis. New Mexico State University, Las Cruces. 77 pp.

Moir, W. H., and J. A. Ludwig. 1979. A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Research Paper RM-207. Fort Collins, CO. 47 pp.

Moir, W. H., and J. O. Carleton. 1987. Classification of pinyon-juniper (P-J) sites on national forests in the Southwest. Pages 216-226 in: R. L. Everett, editor. Proceedings of the Pinyon-Juniper Conference, Reno, NV, 13-16 January 1986. USDA Forest Service, Intermountain Forest and Range Experiment Station. General Technical Report. Ogden, UT. 581 pp.

Mueggler, W. F. 1988. Aspen community types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT. 135 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1982. Aspen community types on the Caribou and Targhee national forests in southeastern Idaho. USDA Forest Service, Intermountain Forest and Range Experiment Station. Research Paper INT-294. Ogden, UT. 32 pp.

Mueggler, W. F., and R. B. Campbell, Jr. 1986. Aspen community types of Utah. USDA Forest Service Research Paper INT-362, Intermountain Forest and Range Experiment Station, Ogden, UT.

Muldavin, E. 1994. Organ Mountains sensitive species and plant community inventory. Unpublished report prepared by the New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E. H., R. L. DeVelice, and F. Ronco, Jr. 1996. A classification of forest habitat types southern Arizona and portions of the Colorado Plateau. USDA Forest Service General Technical Report RM-GTR-287. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 130 pp.

Muldavin, E., and P. Mehlhop. 1992. A preliminary classification and test vegetation map for White Sands Missile Range and San Andreas National Wildlife Refuge, New Mexico. University of New Mexico, New Mexico Natural Heritage Program.

Muldavin, E., B. Sims, and L. Johnson. 1993b. Pecos Wild and Scenic River in stream flow report. Final Report prepared for the USDA National Forest Service, Santa Fe National Forest, Santa Fe, NM.

Muldavin, E., G. Harper, P. Neville, and Y. Chauvin. 1998b. The vegetation of White Sands Missile Range, New Mexico. Volume II. Vegetation map. Final report for Cooperative Agreement No. 14-16-00-91-233 White Sands Missile Range, U.S. Fish & Wildlife Service. The Nature Conservancy and the University of New Mexico.

Muldavin, E., P. Durkin, M. Bradley, M. Stuever, and P. Mehlhop. 2000a. Handbook of wetland vegetation communities of New Mexico: Classification and community descriptions (volume 1). Final report to the New Mexico Environment Department and the Environmental Protection Agency prepared by the New Mexico Natural Heritage Program, University of New Mexico, Albuquerque, NM.

Muldavin, E., P. Mehlhop, and E. DeBruin. 1994a. A survey of sensitive species and vegetation communities in the Organ Mountains of Fort Bliss. Volume III: Vegetation communities. Report prepared for Fort Bliss, Texas, by New Mexico Natural Heritage Program, Albuquerque.

Muldavin, E., Y. Chauvin, and G. Harper. 2000b. Vegetation of White Sands Missile Range, New Mexico: Volume I Handbook of vegetation communities. Final Report to White Sands Missile Range by New Mexico Natural Heritage Program, University of New Mexico, New Mexico. 192 pp.

Mutel, C. F. 1973. An ecological study of the plant communities of certain montane meadows in the Front Range of Colorado. Unpublished thesis. University of Colorado, Boulder. 77 pp.

Mutel, C. F. 1976. From grassland to glacier: An ecology of Boulder County, Colorado. Johnson Publishing Company, Boulder. 169 pp.

Mutel, C., and J. W. Marr. 1973. A vegetative study of three montane herbaceous basins. Journal of the Colorado-Wyoming Academy of Science 7(4):28. (Abstract)

Mutz, K. M., and J. Queiroz. 1983. Riparian community classification for the Centennial Mountains and South Fork Salmon River, Idaho. Unpublished report prepared for USDA Forest Service Intermountain Region under contract 53-84M8-2-0048 by Meiiji Resource Consultants, Layton, UT. 168 pp.

Mutz, K. M., and R. Graham. 1982. Riparian community type classification-Big Piney Range District, Wyoming. Unpublished report prepared for USDA Forest Service, Intermountain Region under contract 53-84M8-1-974, by Meiiji Resource Consultants, Layton, UT. 88 pp.

Nachlinger, J. L. 1985. The ecology of subalpine meadows in the Lake Tahoe region, California and Nevada. Unpublished thesis. University of Nevada, Reno. 151 pp.

Nachlinger, J. L., and G. A. Reese. 1996. Plant community classification of the Spring Mountains National Recreation Area, Clark and Nye counties, Nevada. Unpublished report submitted to USDA Forest Service, Humboldt-Toiyabe National Forest, Spring Mountains National Recreation Area, Las Vegas, NV. The Nature Conservancy, Northern Nevada Office, Reno, NV. 85 pp. plus figures and appendices.

Nichol, A. A. 1937. The natural vegetation of Arizona. University of Arizona Agricultural Experiment Station Technical Bulletin 68:177-222.

NMNHP [New Mexico Natural Heritage Program]. No date. Unpublished data on file. Albuquerque, NM.

Northcutt, B. E. 1978. The plant ecology of Butler Wash, southeastern Utah. Unpublished thesis. University of Colorado, Boulder. 118 pp.

Norton, B. E., J. Tuhy, and S. Jensen. 1981. Riparian community classification for the Grey's River, Wyoming. Unpublished final report prepared by Department of Range Science, Utah State University, Logan for USDA Forest Service, Region 4, Ogden, UT. 188 pp.

Ode, Dave. Personal communication. South Dakota Natural Heritage Program, Pierre, SD.

Olson, R. A., and W. A. Gerhart. 1982. A physical and biological characterization of riparian habitat and its importance to wildlife in Wyoming. Unpublished report prepared for Wyoming Fish and Game Department, Cheyenne, WY. 188 pp.

Ortenberger, A. I., and R. D. Bird. 1933. The ecology of the western Oklahoma salt plains. Publications of the University of Oklahoma Biological Survey 5:49-64.

Ostler, W. K., D. J. Hansen, D. C. Anderson, and D. B. Hall. 2000. Classification of Vegetation on the Nevada Test Site. U.S. Department of Energy, DOE/NV/11718-477. Bechtel Nevada Ecologial Services, Las Vegas, NV. 102 pp.

Padgett, W. G. 1982. Ecology of riparian plant communities in southern Malheur National Forest. Unpublished thesis. Oregon State University, Corvallis. 143 pp.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1988b. Riparian community type classification of Utah. USDA Forest Service, Intermountain Region Publication R4-ECOL-88-01. Ogden, UT.

Padgett, W. G., A. P. Youngblood, and A. H. Winward. 1989. Riparian community type classification of Utah and southeastern Idaho. USDA Forest Service, Intermountain Region. Report R4-ECOL-89-01. Ogden, UT. 191 pp.

Pase, C. P., and A. W. Lindenmuth, Jr. 1971. Effects of prescribed fire on vegetation and sediment in oak-mountain mahogany chaparral. Journal of Forestry 69:800-805.

Paysen, T. E., J. A. Derby, H. Blake, Jr., V. C. Bleich, and J. W. Mincks. 1980. A vegetation classification system applied to southern California. USDA Forest Service General Technical Report PSW-45. USDA Forest Service, Pacific Southwest Research Station, Berkeley, CA.

Peet, R. K. 1975. Forest vegetation of the east slope of the northern Colorado Front Range. Unpublished dissertation. Cornell University, Ithaca, NY.

Peet, R. K. 1981. Forest vegetation of the Colorado Front Range. Vegetatio 45:3-75.

Peterson, P. M. 1984. Flora and physiognomy of the Cottonwood Mountains, Death Valley National Monument, California. University of Nevada Cooperative National Park Resources Studies Unit Report CPSU/UNLV 022/06. Las Vegas, NV.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest habitat types of Montana. USDA Forest Service. General Technical Report INT-34. Intermountain Forest and Range Experiment Station, Ogden, UT. 174 pp.

Poulton, C. E. 1955. Ecology of the non-forested vegetation in Umatilla and Morrow counties, Oregon. Unpublished dissertation. State College of Washington, Pullman. 166 pp.

Ramaley, F. 1919a. The role of sedges in some Colorado plant communities. American Journal of Botany 6:120-130.

Ramaley, F., and W. W. Robbins. 1909. Studies in lake and streamside vegetation. I. Redrock Lake near Ward, Colorado. University of Colorado Studies 6:133-168.

Ream, R. D. 1960. An ordination of the oak communities of the Wasatch Mountains. M.S. thesis. University of Utah, Salt Lake City. 52 pp.

Ream, R. R. 1964. The vegetation of the Wasatch Mountains, Utah and Idaho. Unpublished dissertation. University of Wisconsin, Madison. 190 pp.

Rector, C. D. 1979. Lower Gunnison River Basin wetland inventory and evaluation. Unpublished thesis. University of Colorado, Boulder. 71 pp.

Reed, R. M. 1976. Coniferous forest habitat types of the Wind River Mountains, Wyoming. The American Midland Naturalist 95(1):159-173.

Richard, C., G. Kittel, and S. Kettler. 1996. A classification of the riparian vegetation of the San Juan National Forest. Draft 1 report. Colorado Natural Heritage Program, Colorado State University, Fort Collins.

Rickard, W. H., and J. C. Beatley. 1965. Canopy-coverage of the desert shrub vegetation mosaic of the Nevada Test Site. Ecology 46(4):524-529.

Roberts, D. W., D. W. Wight, and G. P. Hallsten. 1992. Plant community distribution and dynamics in Bryce Canyon National Park. Unpublished final report for Bryce Canyon National Park Project PX1200-7-0966. 146 pp.

Savage, M., and T. W. Swetnam. 1990. Early 19th-century fire decline following sheep pasturing in a Navajo ponderosa pine forest. Ecology 71(6)2374-2378.

Sawyer, J. O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento. 471 pp.

Schlatterer, E. F. 1972. A preliminary description of plant communities found on the Sawtooth, White Cloud, Boulder, and Pioneer mountains. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 111 pp.

Schlesinger, W. H., J. F. Reynolds, G. L. Cunningham, L. F. Huenneke, W. M. Jarrell, R. A. Virginia, and W. G. Whitford. 1990. Biological feedbacks in global desertification. Science 247:1043-1048.

Schmoll, H. M. 1935. Vegetation of the Chimney Rock area, Pagosa-Piedra region, Colorado. Private Edition, Distributed by University of Chicago Libraries, Chicago, IL. 58 pp.

Schultz, L. M., E. E. Neely, and J. S. Tuhy. 1987. Flora of the Orange Cliffs of Utah. Great Basin Naturalist 47:287-298.

Seyer, S. C. 1979. Vegetative ecology of a montane mire, Crater Lake National Park, Oregon. Unpublished thesis. Oregon State University, Corvallis. 87 pp.

Shields, L. M., W. H. Rickard, and F. Drouet. 1959. A botanical study of nuclear effects at the Nevada Test Site. 1958 Annual Report, New Mexico Highlands University, to U.S. Atomic Energy Commission.

Shupe, J. B., J. D. Brotherson, and S. R. Rushforth. 1986. Patterns of vegetation surrounding springs in Goshen Bay, Utah County, Utah, U.S.A. Hydrobiologia 139:97-107.

Smith, S. D., and C. L. Douglas. 1989. The ecology of saltcedar (*Tamarix chinesis*) in Death Valley National Monument and Lake Mead National Recreation Area: An assessment of techniques and monitoring for saltcedar control in the park system. University of Nevada Cooperative National Park Resources Studies Unit Report 041/03, Las Vegas. 63 pp.

Smith, T. L. 1989. An overview of old-growth forests in Pennsylvania. Natural Areas Journal 9:40-44.

Soil Conservation Service. 1978. Range site descriptions for Colorado. Technical Guide, Section II-E. USDA Soil Conservation Service, Colorado State Office, Denver.

Somers, P., G. E. Nichols, and R. W. Stransky. 1980. Final report: Baseline ecological study of Narraguinnep Research Natural Area, San Juan National Forest. Unpublished report prepared by Fort Lewis College, Durango, CO. 23 pp.

Steele, R., R. D. Pfister, R. A. Ryker, and J. A. Kittams. 1981. Forest habitat types of central Idaho. USDA Forest Service General Technical Report INT-114. Intermountain Forest and Range Experiment Station, Ogden, UT. 138 pp.

Steele, R., S. V. Cooper, D. M. Ondov, D. W. Roberts, and R. D. Pfister. 1983. Forest habitat types of eastern Idaho - western Wyoming. USDA Forest Service General Technical Report INT-144. Intermountain Forest and Range Experiment Station, Ogden, UT. 122 pp.

Steinauer, G., and S. Rolfsmeier. 2000. Terrestrial natural communities of Nebraska. Unpublished report of the Nebraska Game and Parks Commission. Lincoln, NE. 143 pp.

Steinhoff, H. W. 1978. Management of Gambel oak associations for wildlife and livestock. Unpublished report prepared for USDA Forest Service, Denver, CO. 119 pp.

Stevens, R. L., and C. W. Shannon. 1917. Plant life in Oklahoma. In: C. W. Shannon, editor. Animal and plant life of Oklahoma. Oklahoma Geological Survey, Norman.

Stewart, B. K. 1940. Plant ecology and paleoecology of the Creede Valley, Colorado. Unpublished dissertation. University of Colorado, Boulder. 154 pp.

Stewart, G., W. P. Cottam, and S. S. Hutchings. 1940. Influence of unrestricted grazing on northern salt desert plant associations in western Utah. Journal of Agricultural Research 60(5):289-317.

Stromberg, J. 1995a. Mesquite bosques. Element Stewardship Abstract prepared for The Nature Conservancy, AZ. 30 pp.

Strong, L. L. 1980. Estimating phytomass production of habitat types on sagebrush steppe. Unpublished thesis. Colorado State University, Fort Collins. 133 pp.

Stubbendieck, J., S. L. Hatch, and C. H. Butterfield. 1992. North American range plants, 4th ed. University of Nebraska Press, Lincoln. 493 pp.

Stuever, M. C., and J. S. Hayden. 1997a. Plant associations of Arizona and New Mexico. Volume 2: Woodlands. USDA Forest Service, Southwestern Region, Habitat Typing Guides. 196 pp.

Stuever, M. C., and J. S. Hayden. 1997b. Plant associations of Arizona and New Mexico. Edition 3. Volume 1: Forests. USDA Forest Service, Southwestern Region. Habitat Typing Guides. 291 pp.

Szaro, R. C. 1989. Riparian forest and scrubland community types of Arizona and New Mexico. Desert Plants Special Issue 9(3-4):70-139.

Terwilliger, C., K. Hess, and C. Wasser. 1979a. Key to the preliminary habitat types of Region 2. Addendum to initial progress report for habitat type classification. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO.

Thilenius, J. F., G. R. Brown, and A. L. Medina. 1995. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. USDA Forest Service. General Technical Report RM-GTR-263. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 60 pp.

Thompson, J. 2001. Draft vegetation associations of Zion National Park, Utah. Prepared for Association for Biodiversity Information, Boulder.

Tiedemann, J. A. 1978. Phyto-edaphic classification of the Piceance Basin. Unpublished dissertation. Colorado State University, Fort Collins. 281 pp.

Tiedemann, J. A., and C. Terwilliger, Jr. 1978. Phyto-edaphic classification of the Piceance Basin. Colorado State University, Range Science Department Science Series 31. 265 pp.

Tiedemann, J. A., R. E. Francis, C. Terwilliger, Jr., and L. H. Carpenter. 1987. Shrub-steppe habitat types of Middle Park, Colorado. USDA Forest Service Research Paper RM-273. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 20 pp.

Tisdale, E. W., and M. Hironaka. 1981. The sagebrush-grass region: A review of the ecological literature. University of Idaho Forest, Wildlife, and Range Experiment Station Bulletin 33, Contribution 29. Moscow. 31 pp.

Tueller, P. T., and W. H. Blackburn. 1974. Condition and trend of the big sagebrush/needle-and-thread habitat type in Nevada. Journal of Range Management 27(1):36-40.

Tueller, P. T., D. H. Heinze, and R. E. Eckert. 1966. A tentative list of existing Nevada plant communities (A third approximation). Unpublished report prepared for the Department of Range Wildlife and Forestry, University of Nevada, Reno. 14 pp.

Tuhy, J. S. 1981. Stream bottom community classification for the Sawtooth Valley, Idaho. Unpublished thesis. University of Idaho, Moscow. 230 pp.

Tuhy, J. S., and S. Jensen. 1982. Riparian classification for the Upper Salmon and Middle Fork Salmon River drainages, Idaho. Unpublished report prepared for the USDA Forest Service, Intermountain Region by White Horse Associates, Smithfield, UT. 183 pp.

Ungar, I. A. 1968. Species-soil relationships on the Great Salt Plains of northern Oklahoma. The American Midland Naturalist 80(2):392-407.

USFS [U.S. Forest Service]. 1937. Range plant handbook. Dover Publications Inc., New York. 816 pp.

USFS [U.S. Forest Service]. 1981a. TES-7, South La Luz grazing allotment. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1981b. TES-2, Cuba Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices, and maps.

USFS [U.S. Forest Service]. 1982. TES-9, Heber Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1983a. TES-4, Coyote Ranger District. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1983b. Plant associations of Region Two. Third edition. USDA Forest Service, Region Two, Range, Wildlife, and Ecology, Denver, CO. 379 pp.

USFS [U.S. Forest Service]. 1985a. Forest and woodland plant associations (habitat types) for the Kaibab and Coconino national forests, Arizona. Unpublished training materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985c. TES-1, Terrestrial ecosystem survey handbook, appendix B. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1985d. Woodland and forest plant associations (habitat types) south of the Mogollon Rim, Arizona. Unpublished training materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

USFS [U.S. Forest Service]. 1985e. TES-3, western part Rio Arriba County. Unpublished report prepared for USDA Forest Service, Southwestern Region, Albuquerque, NM. Various pages, appendices and maps.

USFS [U.S. Forest Service]. 1985g. Key to woodland plant associations and plant communities, Lincoln National Forest. Unpublished materials. USDA Forest Service, Southwestern Region, Albuquerque, NM.

Utah Environmental and Agricultural Consultants. 1973. Pages 2-38 in: Environmental setting, impact, mitigation and recommendations for a proposed oil products pipeline between Lisbon Valley, Utah and Parachute Creek, Colorado. Unpublished report for Colony Development Operation, Atlantic Richfield Company, Denver, CO.

Volland, L. A. 1978. Trends in standing crop and species composition of a rested Kentucky bluegrass meadow over an 11-year period. Pages 525-529 in: D. N. Hyder, editor. Proceedings, First International Rangeland Congress, Denver, CO.

Volland, L. A., and J. D. Dell. 1981. Fire effects on Pacific Northwest forest and range vegetation. USDA Forest Service. Pacific Northwest Region, Portland, OR. 23 pp.

Von Loh, J., D. Cogan, D. Faber-Langendoen, D. Crawford, and M. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program, Badlands National Park, South Dakota. USDI Bureau of Reclamation. Technical Memorandum No. 8260-99-02. Denver, CO.

Von Loh, J., D. Cogan, K. Schulz, D. Crawford, T. Meyer, J. Pennell, and M. Pucherelli. 2002. USGS-USFWS Vegetation Mapping Program, Ouray National Wildlife Refuge, Utah. USDI Bureau of Reclamation, Remote Sensing and GIS Group, Technical Memorandum 8260-02-03. Denver Federal Center, Denver, CO.

Vories, K. C. 1974. A vegetation inventory and analysis of the Piceance Basin and adjacent drainages. Unpublished thesis. Western State College of Colorado, Gunnison. 243 pp.

Walford, G., G. Jones, W. Fertig, and K. Houston. 2001. Riparian and wetland plant community types of the Shoshone National Forest. General Technical Report RMRS-GTR-85. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. 122 pp.

Ware, G. H., and W. T. Penfound. 1949. The vegetation of the lower levels of the floodplain of the south Canadian River in central Oklahoma. Ecology 30:478-484.

Warren, P. L., and B. D. Treadwell. 1980. Vegetation of the Three-Bar Wildlife Study Area, Mazatzal Mountains, Arizona. Unpublished report prepared for Arizona Game and Fish Department.

Warren, P. L., and L. S. Anderson. 1985. Gradient analysis of a Sonoran Desert wash. Pages 150-155 in: Riparian ecosystems and their management: Reconciling conflicting uses. First North American Riparian Conference, 16-18 April 1985. Tucson, AZ. USDA Forest Service General Technical Report RM-120. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Warren, P. L., B. K. Mortensen, B. D. Treadwell, J. E. Bowers, and K. L. Reichhardt. 1981. Vegetation of Organ Pipe Cactus National Monument. Cooperative National Park Resources Studies Unit Technical Report 7. Tucson, AZ. 140 pp.

Warren, P. L., K. L. Reichhardt, D. A. Mouat, B. T. Brown, and R. R. Johnson. 1982. Vegetation of Grand Canyon National Park. Cooperative National Park Resources Studies Unit Technical Report 9. Tucson, AZ. 140 pp.

Wasser, C. H., and K. Hess. 1982. The habitat types of Region II. USDA Forest Service: A synthesis. Final report prepared for USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 140 pp.

Weaver, J. E., and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publishing Co., Lincoln, NE. 395 pp.

Wells, P. V. 1960. Physiognomic intergradation of vegetation on the Pine Valley Mountains in southwestern Utah. Ecology 41:553-556.

Welsh, S. L., N. D. Atwood, S. Goodrich, and L. C. Higgins, editors. 1987. A Utah flora. Great Basin Naturalist Memoirs 9. Provo, UT. 894 pp.

West, N. E. 1983d. Colorado Plateau-Mohavian blackbrush semi-desert. Pages 399-412 in: N. E. West, editor. Temperate deserts and semi-deserts. Ecosystems of the world, Volume 5. Elsevier Publishing Company, Amsterdam.

West, N. E., R. J. Tausch, and P. T. Tueller. 1998. A management-oriented classificaton of pinyon-juniper woodlands of the Great Basin. USDA Forest Service General Technical Report RMRS-GTR-12. USDA Forest Service, Rocky Mountain Research Station, Ogden, UT. 42 pp.

West, N. E., R. T. Moore, K. A. Valentine, L. W. Law, P. R. Ogden, F. C. Pinkney, P. T. Tueller, and A. A. Beetle. 1972. Galleta: Taxonomy, ecology and management of *Hilaria jamesii* on western rangelands. Utah Agricultural Experiment Station. Bulletin 487. Logan, UT. 38 pp.

West, N.E., and M.A. Hassan. 1985. Recovery of sagebrush-grass vegetation following wildfire. Journal of Range Management 38:131-134.

Williams, C. K., and T. R. Lillybridge. 1983. Forested plant associations of the Okanogan National Forest. USDA Forest Service, Pacific Northwest Region. R6-Ecol-132b-1983. 140 pp.

Williams, C. K., and T. R. Lillybridge. 1985. Forested plant associations of the Colville National Forest. Draft. Unpublished field guide prepared for USDA Forest Service.

Williams, C. K., T. R. Lillybridge, and B. G. Smith. 1990b. Forested plant associations of the Colville National Forest. Report prepared for USDA Forest Service, Colville National Forest, Colville, WA. 133 pp.

Wright, H. A. 1972. Shrub response to fire. Pages 204-217 in: Wildland shrubs: Their biology and utilization. USDA Forest Service. General Technical Report INT-1.

Wright, H. A. 1980. The role and use of fire in the semi-desert grass-shrub type. USDA Forest Service General Technical Report INT-85. Intermountain Forest and Range Experiment Station, Ogden, UT. 23 pp.

Wright, H. A., L. F. Neuenschwander, and C. M. Britton. 1979. The role and use of fire in sagebrush-grass and pinyon-juniper plant communities: A state of the art review. USDA Forest Service General Technical Report INT-58. Intermountain Forest and Range Experiment Station. Ogden, UT.

Wright, H. E., Jr., A. M. Bent, B. S. Hansen, and L. J. Mahar, Jr. 1973. Present and past vegetation of the Chuska Mountains, northwestern New Mexico. Geological Society of America Bulletin 84:1155-1179.

Yake, S., and J. D. Brotherson. 1979. Differentiation of serviceberry habitats in the Wasatch Mountains of Utah. Journal of Range Management 32(4):379-386.

York, J. C., and W. A. Dick-Peddie. 1969. Vegetation changes in southern New Mexico during the past hundred years. Pages 157-166 in: W. O. McGinnies and B. J. Goldman, editors. Arid lands in perspective. University of Arizona Press, Tucson.

Young, J. A., and R. A. Evans. 1973. Downy brome-intruder in the plant succession of big sagebrush communities in the Great Basin. Journal of Range Management 26:410-415.

Young, J. A., and R. A. Evans. 1978. Population dynamics after wildfires in sagebrush grasslands. Journal of Range Management 31:283-289.

Youngblood, A. P., and R. L. Mauk. 1985. Coniferous forest habitat types of central and southern Utah. USDA Forest Service, Intermountain Research Station. General Technical Report INT-187. Ogden, UT. 89 pp.

Youngblood, A. P., and W. F. Mueggler. 1981. Aspen community types on the Bridger-Teton National Forest in western Wyoming. USDA Forest Service. Research Paper INT-272. Intermountain Forest and Range Experiment Station, Ogden, UT. 34 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985a. Riparian community type classification of eastern Idaho-western Wyoming. USDA Forest Service, Intermountain Region. R4-Ecol-85-01. Ogden, UT. 78 pp.

Youngblood, A. P., W. G. Padgett, and A. H. Winward. 1985b. Riparian community type classification of northern Utah and adjacent Idaho. Unpublished report prepared for USDA Forest Service, Intermountain Region, Ogden, UT. 104 pp.

Zamora, B., and P. T. Tueller. 1973. *Artemisia arbuscula, A. longiloba*, and *A. nova* habitat types in northern Nevada. Great Basin Naturalist 33(4):225-242.

Zimmerman, T. 1978. Skull Creek Study Area Forestry. Unpublished report. USDI Bureau of Land Management, Craig District Office, Craig, CO. 62 pp.

APPENDIX G: ZION Helicopter Documents

MEMORANDUM

To: Zion Vegetation Mapping Team
From: Dan Cogan
Date: August 30, 2000
Subject: Summary of Helicopter Sampling Effort

On August 21, 2000, The Nature Conservancy (TNC) conducted vegetation sampling in remote locations throughout Zion National Park as part of the USGS/NPS Vegetation Mapping Program. This operation was supported by the United States Bureau of Reclamation (BOR) and the BOR's helicopter based in Salt Lake City, UT. The helicopter was piloted by Steve Chubbuck from the BOR's Upper Colorado Region.

Planning for the project was initiated by identifying potential sampling target sites. This selection was made by Dan Cohen and Dan Cogan based on locations of isolated mesa tops, sheer tower summits, canyon bottoms, and other areas inaccessible by foot. This selection resulted in 77 potential targets (see attachment) that were prioritized by their size, vegetation diversity, and grouped into four flight zones based on recommendations from Zion's Wilderness Committee and Aviation Manager. The four zones split the targets into four missions with zone boundaries based on minimizing overflights of sensitive Park areas, such as the main canyon.

The implementation of the study occurred over each of the four zones with each zone taking one day to complete. Each flight zone had a designated helispot located to maximize helicopter logistics and reduce helicopter flight path redundancy. During each day, an overflight reconnaissance was conducted either as a separate mission or in conjunction with shuttling a field team. Reconnaissance provided an opportunity to evaluate the targets for flat, clear helicopter landing sites and gave some opportunity to acquire photo verification. After the reconnaissance flight, the helicopter was solely responsible for shuttling field teams to and from landable targets.

On Monday, August 21, work started in Flight Zone 1, comprising the Kolob District of the Park (northern-most portion). At 8:00 a.m. all of the vegetation field crews met with Julie Thompson (TNC) at the Kolob Visitor Center and were briefed on the project. At 9:15 all project participants met at the helispot located at the terminus of the Kolob Scenic drive. Here, everyone was given a rigorous and thorough review of helicopter safety by Steve Chubbuck. Upon completion, four 2-person field teams were identified containing a botanist and a sampling (plot form) expert and shuttled to target sites. In addition, a radio service team was shuttled to Timber Top Mesa to perform maintenance and repairs to a NPS radio repeater.

On Tuesday, August 22, the project was moved to Fight Zone 2. This area was below the KT road, above the Coalpits watershed and west of the North Fork of the Virgin River. The helispot location was adjacent to a place called the Ponderosa Pine Pullout on the left side of the KT Road about 1/8 mile above the parking area for the wildcat trail head. Five two-person field teams were used to sample target sites in this area.

On Wednesday, August 23, work shifted to Flight Zone 3, basically the entire Coalpits drainage area west of the North Fork of the Virgin River. No reconnaissance flight was used and the field teams were immediately shuttled to their first target site. Again, five two-person teams were used to conduct the sampling. A radio service team was also shuttled to West Temple Mesa to perform maintenance and repairs to another NPS radio repeater.

Work was wrapped up in Flight Zone 4 on Thursday, August 24. This zone included the entire Park east of the North Fork of the Virgin River. One field team and Dan Cohan were shuttled to the Dakota Hill area (north east corner of the Park) to sample the vegetation and survey for potential goshawk nesting areas. The helispot location for this zone was at the Clear Creek Ranch east of the Park's east entrance. Six two-person field teams were used in this area.

All participates in this endeavor were conducted on and off the aircraft by NPS helicopter crewmembers and were required to wear leather boots, fire resistant flight suites and helmets while in the helicopter. Leather boots also helped reduce the risk of transporting noxious weed seeds into pristine areas. Denise Louie (Zion botanist) further addressed this issue of non-native contamination in her following checklist:

Ways to prevent carrying exotic plant seed into isolated mesa tops:

1) Each morning - visually check shoelaces, socks, pant cuffs, hats, everything - to make sure no seeds have hitchhiked onto you.

2) Everyone will wear gaitors at all times during helicopter fieldwork. This will reduce ability for seed to catch on shoelaces, socks, pant cuffs.

3) Prior to boarding the aircraft (both at the helispot and from the mesa top) - visually inspect all possible clothing surfaces where seed could have hitched onto you.

4) We will bring spray bottles filled w/ water so you can wash off the bottom of shoes if needed.

5) Be extra aware of this issue - it would be really awful to be responsible for introducing an invasive non-native plant into a pristine area!

Thanks for your help!

Upon landing at each target site a GPS fix was recorded creating a point coverage of helicopter landing sites for the Park administration. GPS locations and ground photos were also recorded for each vegetation plot as specified in the protocols. All GPS data collected were set to UTM projection and coordinates in NAD27.

In summary, this project was completed in four working days representing **24.1** flight hours. A total of **78** vegetation plots were sampled at **31** remote areas. The information contained in these plots represents unique baseline data for relatively inaccessible and pristine areas of Zion. The plots collected on this project will be combined with similar plots collected in 1999 and 2000 for ordination analysis by TNC ecologists.

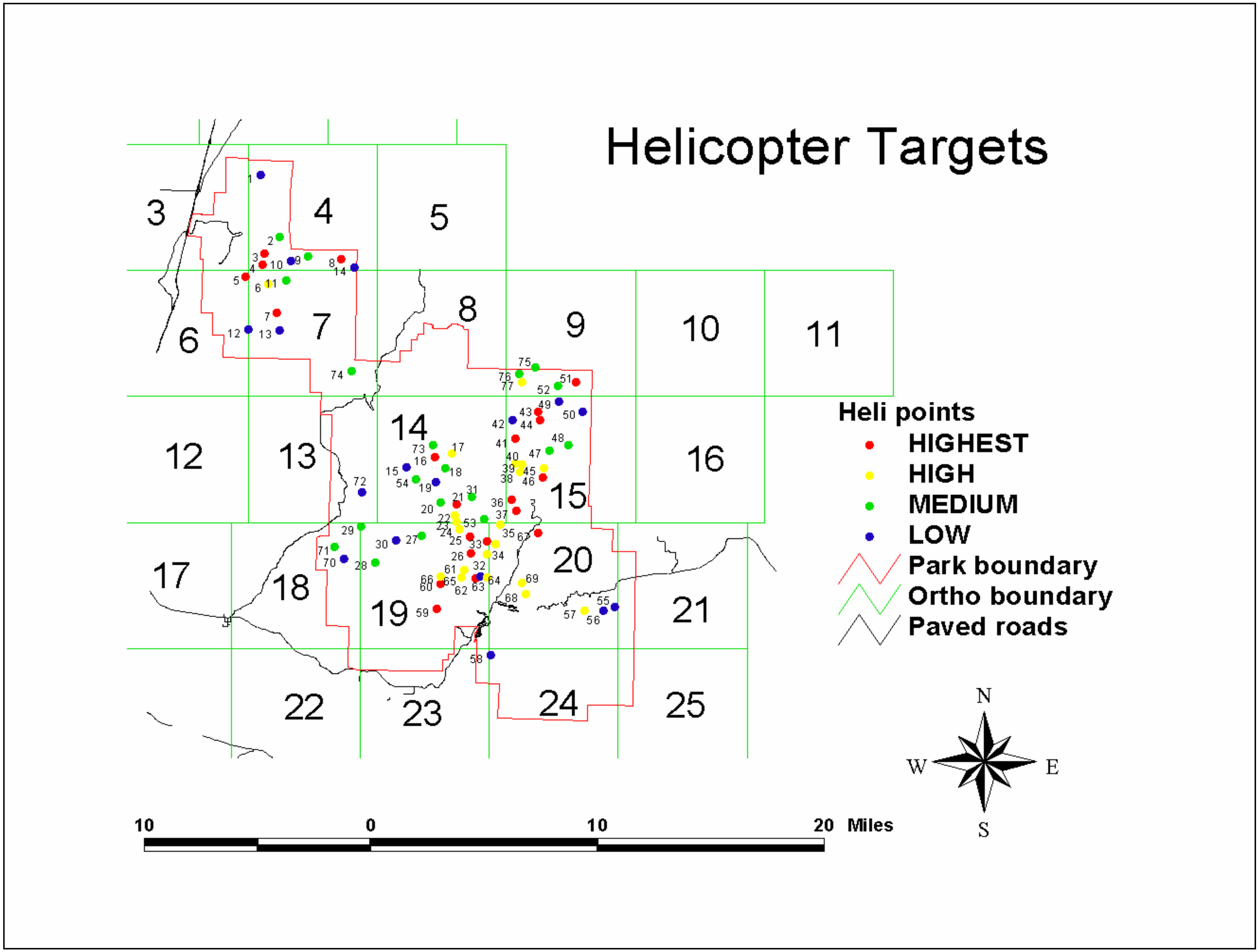
Undoubtedly, the valuable data collected during this trip will greatly enhance our understanding of the distribution and composition of Zion's plant communities both for this project and many others. Fortunately this project occurred without incident allowing everyone to go home safe and sound. This commitment to safety reflects the professionalism of those involved, even while under the stress of a complex and challenging endeavor. The following people should be commended for their participation; they include:

Zion National Park

Research and Resource Management	**Fire Program**
Jeff Bradybaugh	**Art Latteral**
Dan Cohan	**Henry Bastian**
Denise Louie	**Mike Lewelling**
Clare Poulson	**Kirsten Gillman**
Sunshine Ciccone	**Mark Oetzmann**
	Kelly Mathis
	Dana Cohen

The Bureau of Reclamation	**The Nature Conservancy**
Jim Von Loh	**Keith Schulz**
Dan Cogan	**Julie Thompson**
Mike Pucherelli	**Kelly Lewelling**
	Frank "Buddy" Smith

Brigham Young University	**Miscellaneous**
Dr. Duane Atwood	**Margret Malm**
Dr. Stanley Welsh (emeritus)	**Dr. William Reid**
	Marti Atkins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Ortho boundary
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APPENDIX H: ZION Species List

(List compiled from the 1999 and 2000 sample plots, not a complete list of species)
(Genus only records indicate an unknown species)

Family	Scientific Name	Common Name
Aceraceae	*Acer grandidentatum* Nutt.	bigtooth maple
	Acer negundo L.	boxelder
Agavaceae	*Yucca baccata* Torr.	banana yucca
	Yucca elata var. utahensis (McKelvey) Reveal	Utah yucca
Anacardiaceae	*Rhus aromatica* Ait.	fragrant sumac
	Rhus trilobata Nutt.	skunkbush sumac
	Rhus trilobata var. trilobata Nutt.	skunkbush sumac
Apiaceae	*Osmorhiza depauperata* Phil.	bluntseed sweetroot
	Osmorhiza occidentalis (Nutt. ex Torr. & Gray) Torr.	western sweetroot
Asclepiadaceae	*Asclepias subverticillata* (Gray) Vail	whorled milkweed
Aspleniaceae	*Asplenium* L.	spleenwort
Asteraceae	*Achillea millefolium* L.	common yarrow
	Agoseris Raf.	agoseris
	Ambrosia acanthicarpa Hook.	flatspine burr ragweed
	Antennaria Gaertn.	pussytoes
	Antennaria dimorpha (Nutt.) Torr. & Gray	low pussytoes
	Arnica L.	arnica
	Artemisia campestris L.	field sagewort
	Artemisia dracunculus L.	wormwood
	Artemisia filifolia Torr.	sand sagebrush
	Artemisia ludoviciana Nutt.	Louisiana sagewort
	Artemisia nova A. Nels.	black sagebrush
	Artemisia tridentata Nutt.	big sagebrush
	Artemisia tridentata ssp. tridentata Nutt.	basin big sagebrush
	Artemisia tridentata ssp. vaseyana (Rydb.) Beetle	mountain big sagebrush
	Aster L.	aster
	Aster glaucodes Blake	gray aster
	Baccharis emoryi Gray	Emory's baccharis
	Baccharis L.	baccharis
	Baccharis salicifolia (Ruiz & Pavon) Pers.	mule's fat
	Baileya multiradiata Harvey & Gray ex Gray	desert marigold
	Balsamorhiza sagittata (Pursh) Nutt.	arrowleaf balsamroot
	Brickellia Ell.	brickellia
	Brickellia atractyloides Gray	spearleaf brickellbush
	Brickellia californica (Torr. & Gray) Gray	California brickellbush
	Brickellia grandiflora (Hook.) Nutt.	tasselflower brickellbush
	Brickellia longifolia S. Wats.	longleaf brickellbush
	Chaenactis DC.	chaenactis
	Chaenactis douglasii (Hook.) Hook. & Arn.	Douglas' dustymaiden
	Chaetopappa ericoides (Torr.) Nesom	rose heath
	Chrysothamnus Nutt.	rabbitbrush
	Chrysothamnus depressus Nutt.	longflower rabbitbrush
	Chrysothamnus viscidiflorus (Hook.) Nutt.	green rabbitbrush
	Cirsium P. Mill.	thistle
	Cirsium calcareum (M.E. Jones) Woot. & Standl.	Cainville thistle
	Cirsium vulgare (Savi) Ten.	bull thistle
	Cirsium wheeleri (Gray) Petrak	Wheeler's thistle
	Ericameria linearifolia (DC.) Urbatsch & Wussow	narrowleaf heathgoldenrod
	Ericameria nauseosa ssp. nauseosa var. nauseosa (Pallas ex Pursh) Nesom & Baird	rabbitbrush
	Ericameria parryi var. parryi (Gray) Nesom	rabbitbrush
	Erigeron L.	fleabane

Family	Scientific Name	Common Name
	Erigeron pumilus Nutt.	shaggy fleabane
	Erigeron speciosus var. macranthus (Nutt.) Cronq.	aspen fleabane
	Erigeron utahensis Gray	Utah fleabane
	Geraea canescens Torr. & Gray	hairy desertsunflower
	Grindelia squarrosa (Pursh) Dunal	curlycup gumweed
	Gutierrezia microcephala (DC.) Gray	threadleaf snakeweed
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	broom snakeweed
	Helianthus petiolaris Nutt.	prairie sunflower
	Heliomeris multiflora var. multiflora Nutt.	showy goldeneye
	Hesperodoria scopularum (M.E. Jones) Greene	Grand Canyon glowweed
	Heterotheca villosa (Pursh) Shinners	hairy goldenaster
	Hymenopappus filifolius Hook.	fineleaf hymenopappus
	Lactuca serriola L.	prickly lettuce
	Machaeranthera canescens (Pursh) Gray	hoary aster
	Machaeranthera gracilis (Nutt.) Shinners	slender goldenweed
	Machaeranthera Nees	machaeranthera
	Petradoria pumila (Nutt.) Greene	grassy rockgoldenrod
	Pluchea sericea (Nutt.) Coville	arrowweed
	Senecio L.	groundsel
	Senecio eremophilus Richards.	desert groundsel
	Senecio integerrimus Nutt.	lambstongue groundsel
	Senecio multilobatus Torr. & Gray ex Gray	lobeleaf groundsel
	Senecio spartioides Torr. & Gray	broom groundsel
	Solidago L.	goldenrod
	Solidago velutina DC.	threenerve goldenrod
	Stephanomeria exigua Nutt.	small wirelettuce
	Stephanomeria Nutt.	wirelettuce
	Taraxacum officinale G.H. Weber ex Wiggers	common dandelion
	Tetradymia axillaris A. Nels.	longspine horsebrush
	Tetradymia canescens DC.	spineless horsebrush
	Tragopogon dubius Scop.	yellow salsify
Berberidaceae	*Mahonia repens* (Lindl.) G. Don	Oregongrape
Betulaceae	*Betula occidentalis* Hook.	water birch
Boraginaceae	*Cryptantha* Lehm. ex G. Don	cryptantha
	Cryptantha humilis (Gray) Payson	roundspike catseye
	Mertensia Roth	bluebells
	Mertensia arizonica Greene	aspen bluebells
Brassicaceae	*Arabis* L.	rockcress
	Arabis holboellii Hornem.	Holboell's rockcress
	Brassica L.	mustard
	Descurainia Webb & Berth.	tansymustard
	Descurainia pinnata (Walt.) Britt.	western tansymustard
	Draba L.	whitlowgrass
	Erysimum capitatum var. argillosum (Greene) R.J. Davis	sanddune wallflower
	Lesquerella S. Wats.	bladderpod
	Physaria chambersii Rollins	Chambers' twinpod
	Physaria newberryi Gray	Newberry's twinpod
	Rorippa nasturtium-aquaticum (L.) Hayek	watercress
	Stanleya pinnata (Pursh) Britt.	desert princesplume

Family	Scientific Name	Common Name
Cactaceae	*Echinocereus* Engelm.	hedgehog cactus
	Echinocereus engelmannii (Parry ex Engelm.) Lem.	saints cactus
	Echinocereus triglochidiatus Engelm.	kingcup cactus
	Opuntia P. Mill.	pricklypear
	Opuntia chlorotica Engelm. & Bigelow	dollarjoint pricklypear
	Opuntia echinocarpa Engelm. & Bigelow	staghorn cholla
	Opuntia erinacea Engelm. & Bigelow ex Engelm.	grizzlybear pricklypear
	Opuntia macrorhiza Engelm.	twistspine pricklypear
	Opuntia phaeacantha Engelm.	tulip pricklypear
	Opuntia whipplei Engelm. & Bigelow	Whipple cholla
Caprifoliaceae	*Sambucus* L.	elderberry
	Symphoricarpos oreophilus Gray	whortleleaf snowberry
Caryophyllaceae	*Arenaria* L.	sandwort
	Arenaria fendleri Gray	Fendler's sandwort
	Arenaria macradenia S. Wats.	Mojave sandwort
	Pseudostellaria jamesiana (Torr.) W.A. Weber & R.L. Hartman	tuber starwort
	Stellaria L.	starwort
Celastraceae	*Paxistima myrsinites* (Pursh) Raf.	boxleaf myrtle
Chenopodiaceae	*Atriplex canescens* (Pursh) Nutt.	fourwing saltbush
	Atriplex confertifolia (Torr. & Frem.) S. Wats.	shadscale saltbush
	Chenopodium fremontii S. Wats.	Fremont's goosefoot
	Salsola kali ssp. tragus (L.) Celak.	prickly Russian thistle
Commelinaceae	*Tradescantia occidentalis* (Britt.) Smyth	prairie spiderwort
Convolvulaceae	*Convolvulus arvensis* L.	field bindweed
	Ipomoea purpurea (L.) Roth	tall morningglory
Cupressaceae	*Cupressus arizonica* Greene	Arizona cypress
	Juniperus L.	juniper
	Juniperus osteosperma (Torr.) Little	Utah juniper
	Juniperus scopulorum Sarg.	Rocky Mountain juniper
Cyperaceae	*Carex* L.	sedge
	Carex geyeri Boott	elk sedge
	Carex microptera Mackenzie	smallwing sedge
	Carex nebrascensis Dewey	Nebraska sedge
	Carex occidentalis Bailey	western sedge
	Carex rossii Boott	Ross' sedge
	Carex utriculata Boott	Northwest Territory sedge
	Eleocharis R. Br.	spikerush
	Schoenoplectus americanus (Pers.) Volk. ex Schinz & R. Keller	chairmaker's bulrush
	Schoenoplectus tabernaemontani (K.C. Gmel.) Palla	softstem bulrush
	Scirpus L.	bulrush
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn	western brackenfern
Elaeagnaceae	*Elaeagnus angustifolia* L.	Russian olive
	Shepherdia rotundifolia Parry	roundleaf buffaloberry
Ephedraceae	*Ephedra nevadensis* S. Wats.	Nevada jointfir
	Ephedra viridis Coville	mormon tea

Family	Scientific Name	Common Name
Equisetaceae	*Equisetum* L.	horsetail
	Equisetum arvense L.	field horsetail
	Equisetum laevigatum A. Braun	smooth horsetail
	Equisetum variegatum Schleich. ex F. Weber & D.M.H. Mohr	variegated scouringrush
Ericaceae	*Arctostaphylos patula* Greene	greenleaf manzanita
	Arctostaphylos pungens Kunth	pointleaf manzanita
Euphorbiaceae	*Chamaesyce albomarginata* (Torr. & Gray) Small	whitemargin sandmat
	Chamaesyce fendleri (Torr. & Gray) Small	Fendler's sandmat
	Chamaesyce parryi (Engelm.) Rydb.	Parry's sandmat
	Euphorbia L.	spurge
	Tragia ramosa Torr.	branched noseburn
Fabaceae	*Astragalus* L.	milkvetch
	Astragalus subcinereus Gray	Silver's milkvetch
	Dalea searlsiae (Gray) Barneby	Searls' prairieclover
	Lathyrus L.	peavine
	Lotus L.	trefoil
	Lotus rigidus (Benth.) Greene	shrubby deervetch
	Lotus utahensis Ottley	Utah birdsfoot trefoil
	Lupinus L.	lupine
	Lupinus argenteus Pursh	silvery lupine
	Lupinus concinnus J.G. Agardh	scarlet lupine
	Lupinus sericeus Pursh	silky lupine
	Melilotus officinalis (L.) Lam.	yellow sweetclover
	Prosopis glandulosa Torr.	honey mesquite
	Psorothamnus fremontii (Torr. ex Gray) Barneby	Fremont's dalea
	Psorothamnus fremontii var. fremontii (Torr. ex Gray) Barneby	Fremont's dalea
	Trifolium L.	clover
	Trifolium gymnocarpon Nutt.	hollyleaf clover
	Trifolium longipes Nutt.	longstalk clover
	Vicia L.	vetch
	Vicia americana Muhl. ex Willd.	American vetch
Fagaceae	*Quercus gambelii* Nutt.	Gambel's oak
	Quercus turbinella Greene	shrub live oak
Gentianaceae	*Frasera speciosa* Dougl. ex Griseb.	showy frasera
Geraniaceae	*Geranium* L.	geranium
	Geranium caespitosum James	pineywoods geranium
Hydrophyllaceae	*Phacelia heterophylla* Pursh	varileaf phacelia
	Phacelia Juss.	phacelia
Iridaceae	*Sisyrinchium demissum* Greene	dwarf blueeyed grass
Juncaceae	*Juncus* L.	rush
	Juncus balticus Willd.	Baltic rush
	Juncus ensifolius Wikstr.	swordleaf rush
	Juncus longistylis Torr.	longstyle rush
	Juncus tenuis Willd.	poverty rush
	Juncus torreyi Coville	Torrey's rush
	Luzula parviflora (Ehrh.) Desv.	smallflowered woodrush
Lamiaceae	*Agastache urticifolia* (Benth.) Kuntze	nettleleaf giant hyssop
	Dracocephalum parviflorum Nutt.	American dragonhead
	Mentha arvensis L.	wild mint
	Monardella odoratissima Benth.	Pacific monardella

Family	Scientific Name	Common Name
	Salvia dorrii (Kellogg) Abrams	grayball sage
Liliaceae	*Allium* L.	wild onion
	Calochortus Pursh	Mariposa lily
	Calochortus nuttallii Torr. & Gray	sego lily
	Maianthemum racemosum ssp. Racemosum (L.) Link	feather Solomon's seal
	Maianthemum stellatum (L.) Link	starry false Solomon's seal
	Linum perenne L.	blue flax
Malvaceae	*Sphaeralcea* St.-Hil.	globemallow
	Sphaeralcea ambigua Gray	desert globemallow
	Sphaeralcea coccinea (Nutt.) Rydb.	scarlet globemallow
Monotropaceae	*Pterospora andromedea* Nutt.	woodland pinedrops
Nyctaginaceae	*Abronia fragrans* Nutt. ex Hook.	snowball sand verbena
	Allionia incarnata L.	trailing windmills
	Mirabilis multiflora (Torr.) Gray	Colorado four o'clock
Oleaceae	*Fraxinus anomala* Torr. ex S. Wats.	singleleaf ash
	Fraxinus velutina Torr.	velvet ash
Onagraceae	*Epilobium brachycarpum* K. Presl	autumn willowweed
	Epilobium canum ssp. garrettii (A. Nels.) Raven	Garrett's firechalice
	Gayophytum A. Juss.	groundsmoke
	Oenothera L.	eveningprimrose
	Oenothera cespitosa Nutt.	tufted eveningprimrose
	Oenothera longissima Rydb.	longstem eveningprimrose
	Oenothera pallida Lindl.	pale eveningprimrose
Pinaceae	*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.	white fir
	Pinus edulis Engelm.	twoneedle pinyon
	Pinus monophylla Torr. & Frem.	singleleaf pinyon
	Pinus ponderosa P.& C. Lawson	ponderosa pine
	Pseudotsuga menziesii (Mirbel) Franco	Douglas fir
Plantaginaceae	*Plantago patagonica* Jacq.	woolly plantain
Poaceae	*Achnatherum hymenoides* (Roemer & J.A. Schultes) Barkworth	Indian ricegrass
	Achnatherum lettermanii (Vasey) Barkworth	Letterman's needlegrass
	Achnatherum nelsonii ssp. nelsonii (Scribn.) Barkworth	Columbia needlegrass
	Agropyron cristatum (L.) Gaertn.	crested wheatgrass
	Agrostis exarata Trin.	spike bentgrass
	Agrostis stolonifera L.	creeping bentgrass
	Andropogon gerardii Vitman	big bluestem
	Aristida purpurascens Poir.	arrowfeather threeawn
	Aristida purpurea Nutt.	purple threeawn
	Bouteloua Lag.	grama
	Bouteloua barbata Lag.	sixweeks grama
	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama
	Bromus L.	brome
	Bromus anomalus Rupr. ex Fourn.	nodding brome
	Bromus diandrus Roth	ripgut brome
	Bromus inermis Leyss.	smooth brome
	Bromus rubens L.	foxtail brome
	Bromus tectorum L.	cheatgrass
	Cenchrus longispinus (Hack.) Fern.	innocent-weed
	Dactylis glomerata L.	orchardgrass
	Elymus L.	wildrye

Family	Scientific Name	Common Name
	Elymus canadensis L.	Canada wildrye
	Elymus elymoides (Raf.) Swezey	bottlebrush squirreltail
	Elymus lanceolatus (Scribn. & J.G. Sm.) Gould	streambank wheatgrass
	Elytrigia intermedia (Host) Nevski	intermediate wheatgrass
	Elytrigia intermedia ssp. intermedia (Host) Nevski	intermediate wheatgrass
	Elytrigia repens (L.) Desv. ex B.D. Jackson	creeping quackgrass
	Festuca L.	fescue
	Frasera speciosa Dougl. ex Griseb.	showy frasera
	Hesperostipa comata ssp. comata (Trin. & Rupr.) Barkworth	needle and thread
	Hordeum brachyantherum Nevski	meadow barley
	Koeleria macrantha (Ledeb.) J.A. Schultes	prairie Junegrass
	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	alkali muhly
	Muhlenbergia montana (Nutt.) A.S. Hitchc.	mountain muhly
	Muhlenbergia porteri Scribn. ex Beal	bush muhly
	Muhlenbergia racemosa (Michx.) B.S.P.	marsh muhly
	Muhlenbergia thurberi Rydb.	Thurber's muhly
	Muhlenbergia wrightii Vasey ex Coult.	spike muhly
	Pascopyrum smithii (Rydb.) A. Love	western wheatgrass
	Phleum pratense L.	timothy
	Phragmites australis (Cav.) Trin. ex Steud.	common reed
	Pleuraphis jamesii Torr.	James' galleta
	Poa L.	bluegrass
	Poa fendleriana (Steud.) Vasey	muttongrass
	Poa pratensis L.	Kentucky bluegrass
	Poa secunda J. Presl	Sandberg bluegrass
	Polypogon Desf.	polypogon
	Pseudoroegneria spicata ssp. spicata (Pursh) A. Love	bluebunch wheatgrass
	Puccinellia distans (Jacq.) Parl.	weeping alkaligrass
	Schizachyrium scoparium (Michx.) Nash	little bluestem
	Sorghastrum nutans (L.) Nash	yellow Indiangrass
	Sporobolus R. Br.	dropseed
	Sporobolus cryptandrus (Torr.) Gray	sand dropseed
	Stipa L.	needlegrass
	Triticum aestivum L.	common wheat
	Vulpia octoflora var. octoflora (Walt.) Rydb.	sixweeks fescue
Polemoniaceae	*Ipomopsis aggregata* (Pursh) V. Grant	skyrocket gilia
	Ipomopsis congesta ssp. Congesta (Hook.) V. Grant	ballhead gilia
	Leptodactylon pungens (Torr.) Torr. ex Nutt.	granite pricklygilia
	Phlox L.	phlox
	Phlox austromontana Coville	desert phlox
	Phlox hoodii Richards.	spiny phlox
	Phlox longifolia Nutt.	longleaf phlox
Polygonaceae	*Eriogonum* Michx.	eriogonum
	Eriogonum flavum Nutt.	yellow eriogonum
	Eriogonum inflatum Torr. & Frem.	Native American pipeweed
	Eriogonum microthecum Nutt.	slender buckwheat
	Eriogonum panguicense (M.E. Jones) Reveal	Panguitch buckwheat
	Eriogonum racemosum Nutt.	redroot buckwheat
	Eriogonum umbellatum Torr.	sulphur wildbuckwheat
	Polygonum L.	knotweed

Family	Scientific Name	Common Name
	Polygonum douglasii Greene	Douglas' knotweed
	Rumex acetosella L.	common sheep sorrel
Portulacaceae	*Claytonia perfoliata ssp. perfoliata var. nubigena* (Greene) Poelln.	miner's lettuce
Ranunculaceae	*Clematis columbiana* (Nutt.) Torr. & Gray	rock clematis
	Clematis ligusticifolia Nutt.	western white clematis
	Thalictrum fendleri Engelm. ex Gray	Fendler's meadowrue
Rhamnaceae	*Ceanothus fendleri* Gray	Fendler's ceanothus
Rosaceae	*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roemer	Saskatoon serviceberry
	Amelanchier utahensis Koehne	Utah serviceberry
	Cercocarpus intricatus S. Wats.	littleleaf mt. mahogany
	Cercocarpus ledifolius Nutt.	curlleaf mountain mahogany
	Cercocarpus montanus Raf.	true mountain mahogany
	Coleogyne ramosissima Torr.	blackbrush
	Holodiscus dumosus (Nutt. ex Hook.) Heller	rockspirea
	Ivesia sabulosa (M.E. Jones) Keck	Intermountain mousetail
	Peraphyllum ramosissimum Nutt.	squaw apple
	Petrophyton caespitosum (Nutt.) Rydb.	mat rockspirea
	Potentilla glandulosa Lindl.	gland cinquefoil
	Prunus L.	prunus
	Prunus virginiana L.	common chokecherry
	Purshia DC. ex Poir.	bitterbrush
	Purshia mexicana (D. Don) Henrickson	Mexican cliffrose
	Purshia stansburiana (Torr.) Henrickson	Stansbury cliffrose
	Purshia tridentata (Pursh) DC.	antelope bitterbrush
	Rosa woodsii Lindl.	Woods' rose
Rubiaceae	*Galium* L.	bedstraw
	Galium aparine L.	stickywilly
	Kelloggia galioides Torr.	milk kelloggia
Salicaceae	*Populus angustifolia* James	narrowleaf cottonwood
	Populus fremontii S. Wats.	Fremont's cottonwood
	Populus tremuloides Michx.	quaking aspen
	Salix L.	willow
	Salix exigua Nutt.	sandbar willow
	Salix gooddingii Ball	Goodding's willow
	Salix ligulifolia (Ball) Ball ex Schneid.	strapleaf willow
	Salix lucida Muhl.	shining willow
	Salix scouleriana Barratt ex Hook.	Scouler's willow
Santalaceae	*Comandra umbellata* (L.) Nutt.	bastard toadflax
	Comandra umbellata ssp. pallida (A. DC.) Piehl	pale bastard toadflax
Saxifragaceae	*Heuchera rubescens var. versicolor* (Greene) M.G. Stewart	pink alumroot
Scrophulariaceae	*Castilleja* Mutis ex L. f.	Indian paintbrush
	Castilleja applegatei ssp. martinii (Abrams) Chuang & Heckard	wavyleaf Indian paintbrush
	Castilleja linariifolia Benth.	Wyoming Indian paintbrush
	Collinsia parviflora Lindl.	smallflower blue eyed Mary
	Cordylanthus parviflorus (Ferris) Wiggins	purple bird's beak
	Linaria dalmatica (L.) P. Mill.	Dalmatian toadflax
	Penstemon Schmidel	penstemon
	Penstemon eatonii Gray	Eaton's penstemon

Family	Scientific Name	Common Name
	Penstemon lentus Pennell	handsome beardtongue
	Penstemon leonardii Rydb.	Leonard's beardtongue
	Penstemon linarioides Gray	toadflax penstemon
	Penstemon pachyphyllus Gray ex Rydb.	thickleaf beardtongue
	Penstemon palmeri Gray	Palmer's penstemon
	Penstemon rostriflorus Kellogg	Bridge penstemon
	Verbascum thapsus L.	common mullein
Solanaceae	*Datura* L.	datura
	Datura wrightii Regel	sacred thornapple
	Lycium pallidum Miers	pale wolfberry
	Nicotiana attenuata Torr. ex S. Wats.	coyote tobacco
	Physalis hederifolia Gray	ivyleaf groundcherry
	Physalis heterophylla Nees	clammy groundcherry
	Solanum elaeagnifolium Cav.	silverleaf nightshade
Tamaricaceae	*Tamarix ramosissima* Ledeb.	saltcedar
Typhaceae	*Typha angustifolia* L.	narrowleaf cattail
	Typha domingensis Pers.	southern cattail
Ulmaceae	*Celtis laevigata var. reticulata* (Torr.) L. Benson	netleaf hackberry
Verbenaceae	*Verbena bracteata* Lag. & Rodr.	bigbract verbena
Violaceae	*Viola* L.	violet
Viscaceae	*Phoradendron juniperinum* Engelm.	juniper mistletoe
Vitaceae	*Vitis arizonica* Engelm.	canyon grape
Zygophyllaceae	*Tribulus terrestris* L.	puncturevine

APPENDIX I: Photo Interpretation Mapping Conventions and Visual Key

Upland Grasslands

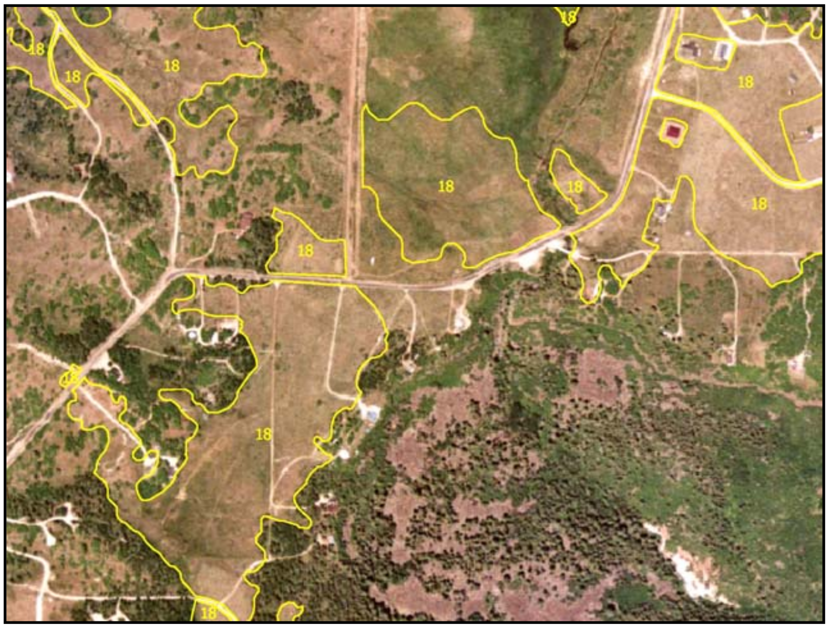
18 *Poa pratensis - Bromus inermis* Semi-natural Grassland Complex
Perennial Disturbed Grassland Complex

Associations:
-Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation
-Poa pratensis Semi-natural Seasonally Flooded Herbaceous Alliance

Common species:
Bromus inermis
Elymus lanceolatus
Poa pratensis
Achillea millefolium
Medicago lupulina
Trifolium longipes
Equisetum arvense

Project Specifics:
Frequency = 303 total polygons
86 polygons ZION, 217 polygons Environs
Area = 989 total acres
272 acres ZION, 717 acres Environs
Average Size = 3 acres

Photo Signature Example



Description:
This map class is common in old agricultural fields, pastures, road-sides, and other heavily disturbed areas. The presence of semi-natural grasses along with annual forbs yields a multitude of variation in the photo signature. This can vary from bright green in high moisture, high growth areas to dark brown and gray in arid and dormant sites. Typically this map class may be confused with other herbaceous types especially native grasslands

Ground Photos

19 *Bromus tectorum* Semi-natural Herbaceous Alliance
Cheatgrass Annual Disturbed Grassland

Alliance:
-*Bromus tectorum* Semi-natural Herbaceous Alliance

Common species:
Bromus tectorum

Project Specifics:
Frequency = 207 total polygons
70 polygons ZION, 137 polygons Environs
Area = 623 total acres
138 acres ZION, 485 acres Environs
Average Size = 3 acres

Photo Signature Example

Description:
This map class was based on field observations since no plots were taken. It was observed in disturbed areas of ZION at lower elevations and a variety of landforms, but was more common in lowlands, old agriculture fields and overgrazed pastures. This alliance is extensive in Main Canyon, Parunaweep Canyon, and Upper Coalpits. The photo signature for this type usually reflected the substrate since actively growing vegetation was minimal at the time of the photography.

Ground Photo

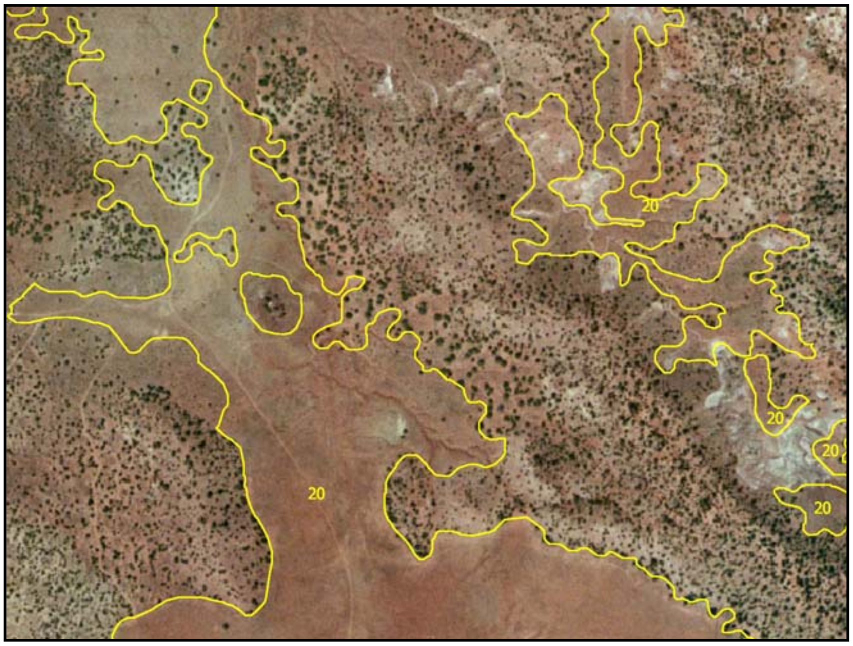
20 *Pleuraphis jamesii* Herbaceous Vegetation
James' Galleta Herbaceous Vegetation

Association:
-Pleuraphis jamesii Herbaceous Vegetation

Common species:
Pleuraphis jamesii
Opuntia spp.
G*utierrezia microcephala*
Bromus tectorum
Pinus monophylla
Juniperus osteosperma

Project Specifics:
Frequency = 55 total polygons
31 polygons ZION, 24 polygons Environs
Area = 1036 total acres
257 acres ZION, 778 acres Environs
Average Size = 19 acres

Photo Signature Example



Description:
This map class is common at ZION in the southern regions of the Park throughout the semi-arid and desert portions. Galleta grass is characterized on the area of the photos by a lack of shrubs and trees. In surrounding areas, Galleta grass is the primary understory species, which may cause some confusion when trees/shrubs become extremely sparse. The color of the photo signature can vary from red to brown to white depending on the dryness of the area and the color of the substrate.

Ground Photos

21 *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation
Sand Dropseed Great Basin Herbaceous Vegetation

Photo Signature Example

Association:
-*Sporobolus cryptandrus* Great Basin Herbaceous Vegetation

Common species:
Bromus tectorum
Pleuraphis jamesii
Sporobolus cryptandrus

Project Specifics:
Frequency = 111 total polygons
103 polygons ZION, 8 polygons Environs
Area = 177 total acres
144 acres ZION, 34 acres Environs
Average Size = 2 acres

Description:
Sand Dropseed is common throughout the Park but mainly forms a true association on sand deposits alongside the Virgin River and its major tributaries. Other grass species are common in this type including a high percentage of non-native and semi-natural species. In disturbed areas alongside roads and trails this type also contains many early succession forbs and shrubs such as rabbitbrush and matchbrush snakeweed. This map class appears brown-tan due to the dryness of the sites and the color of sand substrate.

Ground Photo

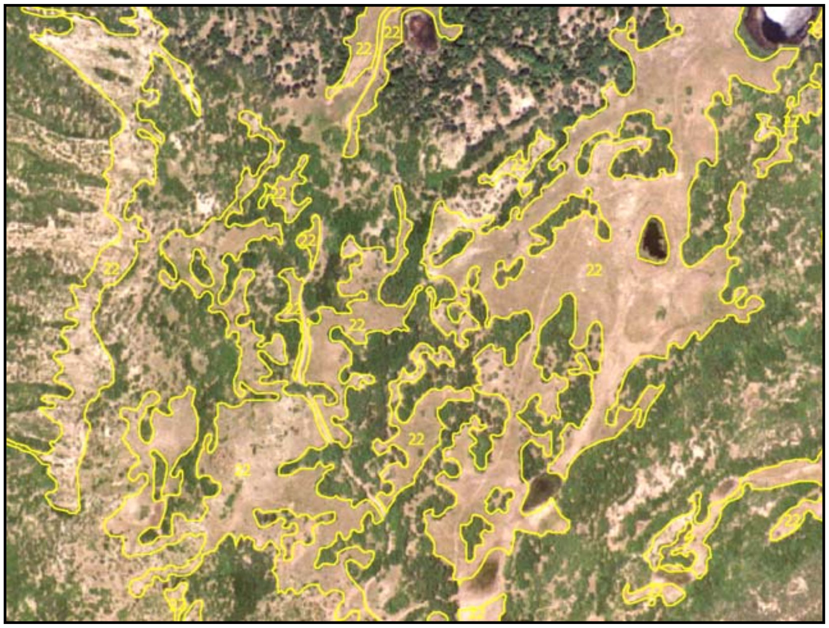
22 Dry Meadow Mixed Herbaceous Vegetation Mosaic

Associations:
-Bouteloua gracilis – Hesperostipa comata Herbaceous Vegetation
-Hesperostipa comata Great Basin Herbaceous Vegetation
-Muhlenbergia (pungens, montana)-Heterotheca villosa Herbaceous Vegetation
-Thinopyrum intermedium Herbaceous Vegetation Herbaceous Vegetation

Common species:
Bouteloua gracilis
Hesperostipa comata
Muhlenbergia pungens
Muhlenbergia Montana
Heterotheca villosa
Thinopyrum intermedium

Project Specifics:
Frequency = 987 total polygons
300 polygons ZION, 687 polygons Environs
Area = 2,233 total acres
554 acres ZION, 1679 acres Environs
Average Size = 2 acres

Photo Signature Example



Description:
This map class was fairly common from the mid to high elevations at ZION. This class represents grasslands occurring in either natural woodland meadows or previously cleared pastures. Typically no one or two species dominated these sites, instead small patches of different graminoids usually intermixed. In areas with high ground moisture this type was replaced by the Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic map class with some overlap in species. The photo signature for this type was usually brown or gray corresponding to the dryness of the site and the color of the substrates.

Ground Photos

Mesic Herbaceous Vegetation

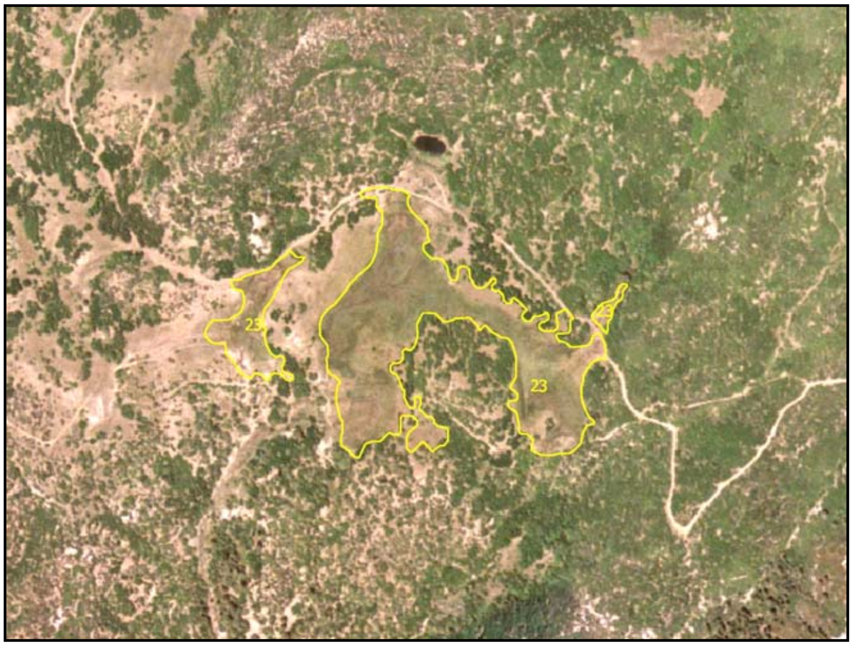
23 *Carex spp.- Juncus spp.* Wet Meadow Herbaceous Vegetation Mosaic
Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic

Associations:
-*Carex utriculata* Herbaceous Vegetation
-*Carex nebrascensis* Herbaceous Vegetation
-*Equisetum (arvense, variegatum)* Herbaceous Vegetation
-*Juncus balticus* Herbaceous Vegetation

Common species:
Carex utriculata
Carex nebrascensis
Equisetum arvense
Equisetum variegatum
Juncus balticus

Project Specifics:
Frequency = 384 total polygons
68 polygons ZION, 316 polygons Environs
Area = 866 total acres
102 acres ZION, 764 acres Environs
Average Size = 2 acres

Photo Signature Example



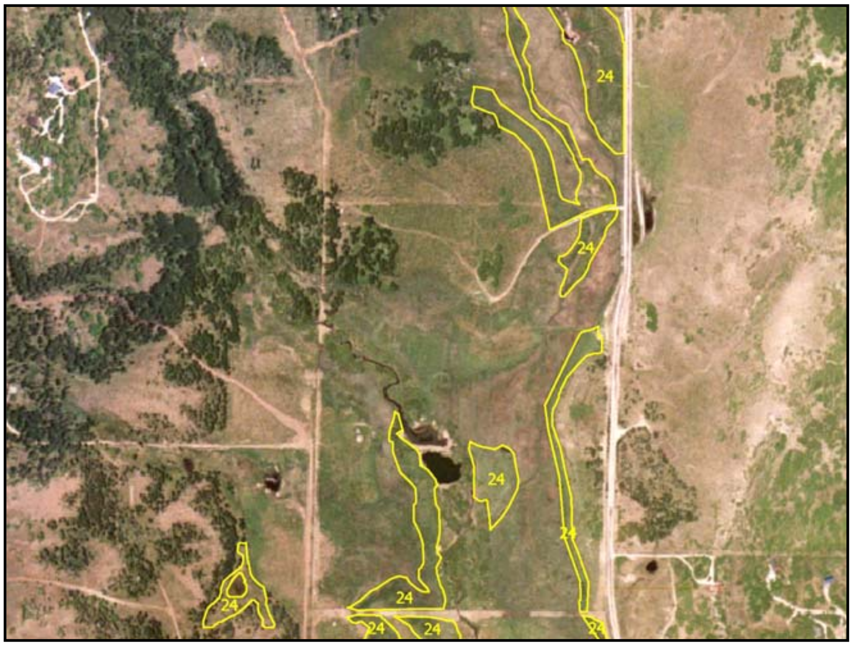
Description:
Wet meadows common in the mid and higher elevations of ZION contain a very intricate mix of mesic graminoids. Typically this type appears green on the aerial photos with slender drainages weaving through the site. The lack of shrubs and trees helps identify and delineate this map class from the surrounding vegetation.

Ground Photos

Wetland Herbaceous Vegetation

24 *Typha spp., Scirpus spp.* Emergent Wetland Complex
Cattail, Bulrush, Emergent Wetland Complex

Photo Signature Example



Association:
(none; too infrequent to classify)

Common species:
Typha spp.
Scirpus spp.
Carex spp.

Project Specifics:
Frequency = 73 total polygons
2 polygons ZION, 71 polygons Environs
Area = 121 total acres
3 acres ZION, 119 acres Environs
Average Size = 2 acres

Description:
This map class is very rare in the project area and only occurs adjacent to man-made water bodies such as stock ponds and canals. This type usually contains many of the same species as the Sedge-Rush Wet Meadow Herbaceous Vegetation Mosaic map class. The vast majority of this type occurs in the environs. The photo signature is bright green, rough in texture, and may have braided streams or standing water.

Ground Photo

Xeric Shrublands

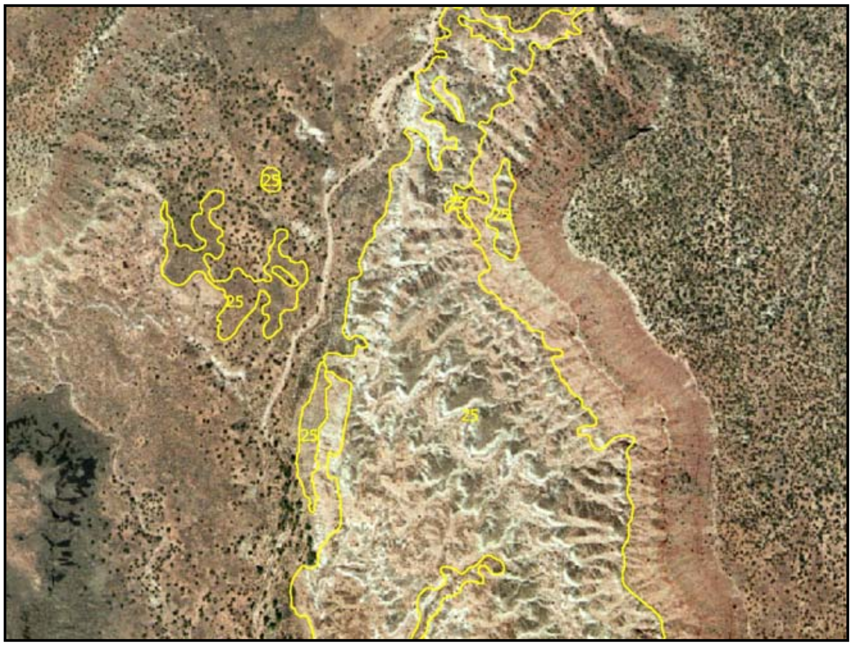
25 *Coleogyne ramosissima* Shrubland Complex
Blackbrush Shrubland Complex

Associations:
-*Atriplex canescens* Shrubland
-*Coleogyne ramosissima* Shrubland
-*Coleogyne ramosissima / Pleuraphis jamesii* Shrubland

Common species:
Atriplex canescens
Coleogyne ramosissima
Pleuraphis jamesii
Gutierrezia sarothrae

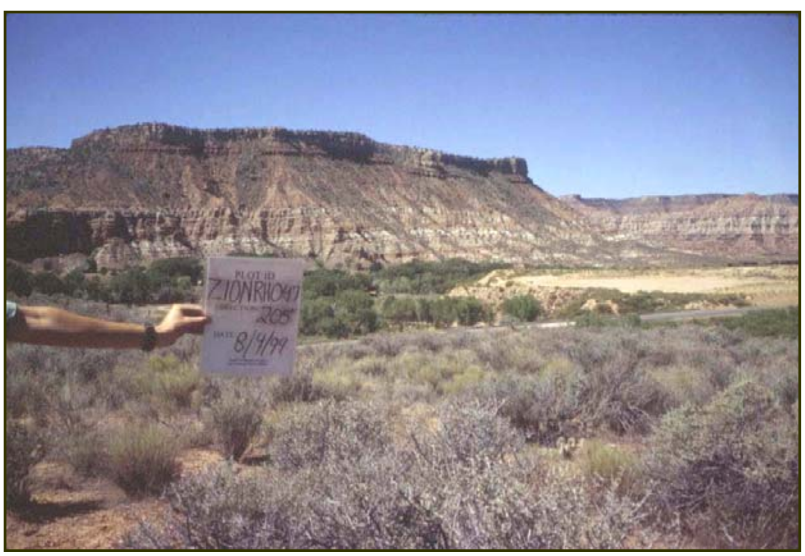
Project Specifics:
Frequency = 173 total polygons
69 polygons ZION, 104 polygons Environs
Area = 1791 total acres
681 acres ZION, 1,110 acres Environs
Average Size = 10 acres

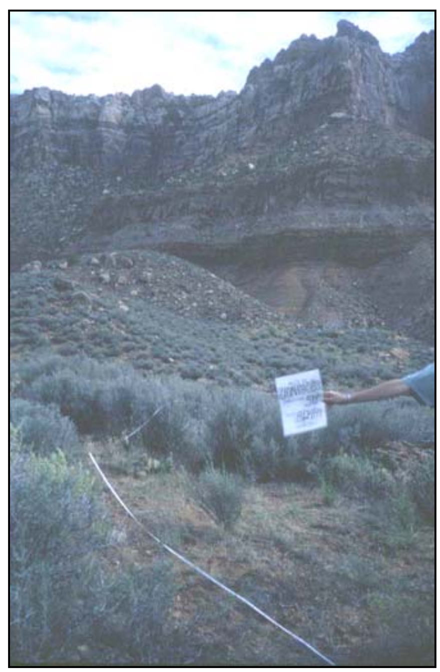
Photo Signature Example



Description:
This is a common semi-arid shrubland found extensively throughout the southern half of ZION and the project's environs. This map class can vary dramatically in density depending on substrate and moisture. In more mesic areas this class can appear dark gray due to the high density of shrubs. Conversely in dry sites, this type will only appear as small gray stipples overwhelmed by the red, white, or brown color of the substrate. Other marginal desert shrubs such as big sagebrush, matchbrush snake weed, and saltbush may exist either as co-dominants or intermixed with this map class.

Ground Photos





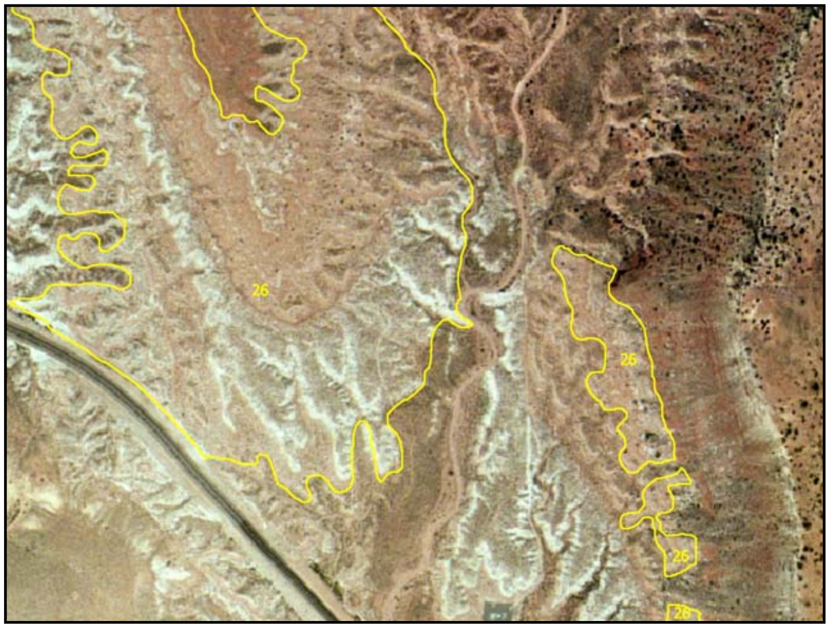
26 *Ephedra nevadensis - Eriogonum corymbosum* Badlands Sparse Vegetation
Painted Desert Sparsely Vegetated Alliance

Associations:
(PAINTED DESERT SPARSELY VEGETATED ALLIANCE)
-*Ephedra nevadensis* / Lichen Sparse Vegetation
-*Eriogonum corymbosum* Badlands Sparse Vegetation

Common species:
Eriogonum corymbosum
Ephedra nevadensis
Bromus tectorum
Atriplex canescens
Atriplex confertifolia
Ericameria nauseosa
Elymus elymoides
Pleuraphis jamesii
Unknown lichen species

Project Specifics:
Frequency = 63 total polygons
24 polygons ZION, 39 polygons Environs
Area = 664 total acres
410 acres ZION, 254 acres Environs
Average Size = 11 acres

Photo Signature Example



Description:
Badlands related to the Chinle geologic formations are relatively rare at ZION. Occurring only in the southern-most portions of the project area, this map class is very dry but does support a mix of xeric shrubs and forbs. On the photos this type looked similar to sparse forms of the Blackbrush Shrubland Complex and to the barren Chinle geology map classes.

Ground Photos

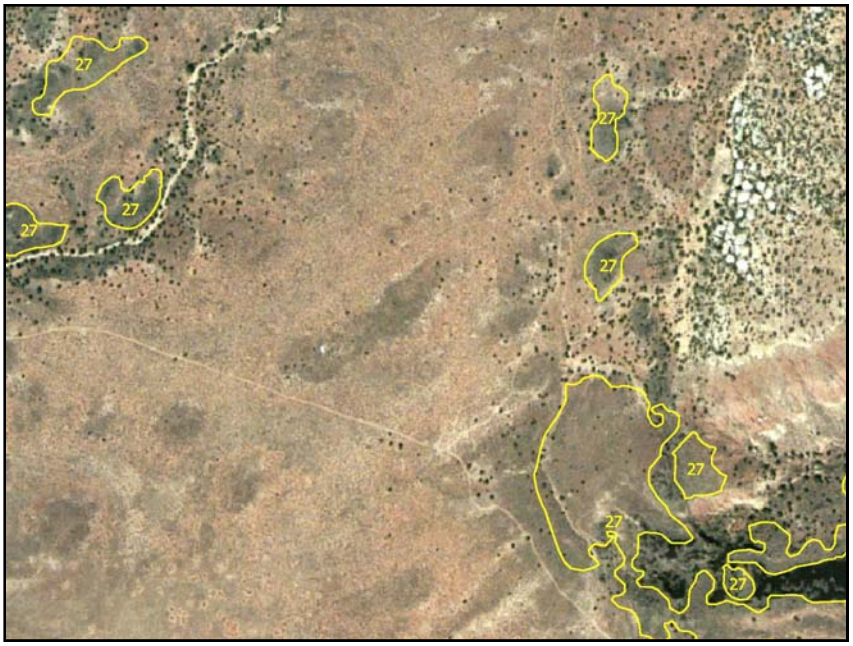
27 *Ephedra nevadensis* Basalt Shrubland
Nevada Joint-fir Basalt Shrubland

Photo Signature Example

Association:
-*Ephedra nevadensis* Basalt Shrubland

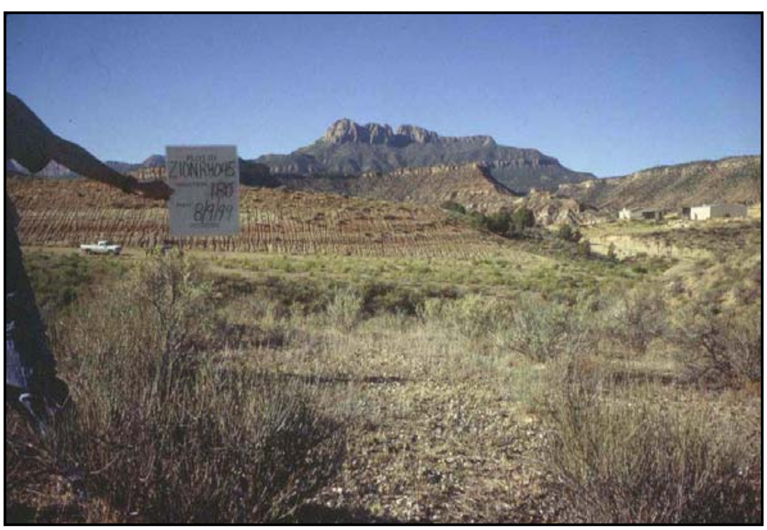
Common species:
Eriogonum corymbosum
Ephedra nevadensis
Bromus tectorum
Atriplex canescens
Atriplex confertifolia
Ericameria nauseosa
Elymus elymoides
Pleuraphis jamesii
Unknown lichen species

Project Specifics:
Frequency = 36 total polygons
12 polygons ZION, 24 polygons Environs
Area = 453 total acres
201 acres ZION, 252 acres Environs
Average Size = 13 acres



Description:
This map class is very similar in species composition to the Painted Desert Sparsely Vegetated Alliance map class although it occurs on a dramatically different substrate, volcanic basalt. The black color of substrate allowed for relatively straight-forward interpretation of this map class from the aerial photos. In extremely sparse stands, this map class may have been mapped as barren basalt outcrop or volcanic cinders.

Ground Photos



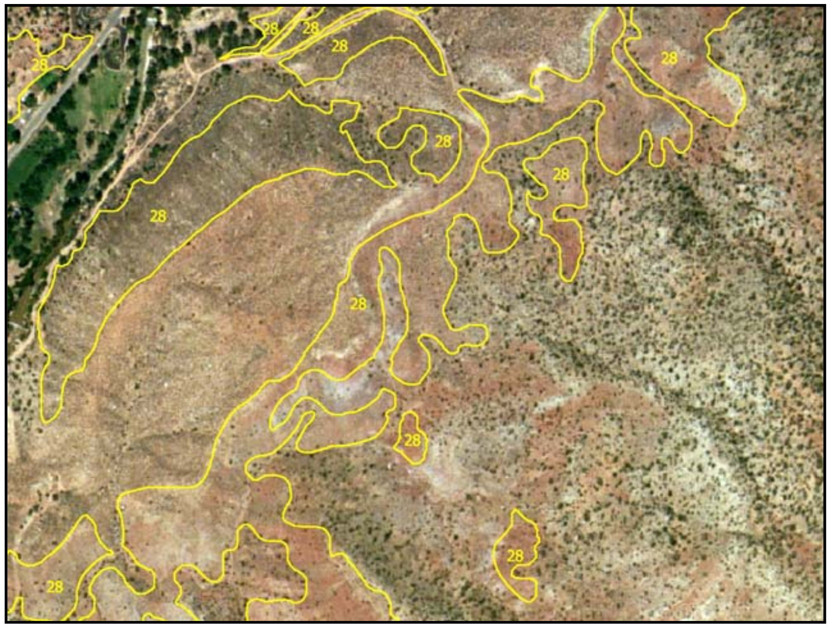
28 *Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii* Dwarf-shrubland
Snakeweed - (Prickly-pear species) / James' Galleta Dwarf-shrubland

Associations:
-Gutierrezia sarothrae - (Opuntia spp.) / Pleuraphis jamesii Dwarf-shrubland

Common species:
Gutierrezia sarothrae
Opuntia spp.
Pleuraphis jamesii
Bromus tectorum
Elymus elymoides,

Project Specifics:
Frequency = 412 total polygons
232 polygons ZION, 180 polygons Environs
Area = 1,846 total acres
642 acres ZION, 1,205 acres Environs
Average Size = 4.7 acres

Photo Signature Example



Description:
This map class occurs in many harsh habitats throughout ZION including old fields, pastures, arid sandy deposits and south-facing slopes. Disturbance may be important in maintaining this map class, as some stands have been created by removal of trees and grazing by livestock. The scarcity of cover in this type likely makes it appear as other arid, herbaceous and barren map classes.

Ground Photos

29 *Prosopis juliflora* Shrub Stands
Honey Mesquite Shrub Stands

Photo Signature Example

Associations:
(none; too small to classify)

Common species:
Prosopis juliflora

Project Specifics:
Frequency = 6 total polygons
0 polygons ZION, 6 polygons Environs
Area = 2 total acres
0 acres ZION, 2 acres Environs
Average Size = 0.3 acres

Description:
Stands of mesquite only occurred in 6 documented sites all outside the boundary of ZION. Here, each stand was comprised of a handful of individual tall shrubs. This type was mapped solely from field observations and GPS points.

Ground Photo

Upland Shrublands

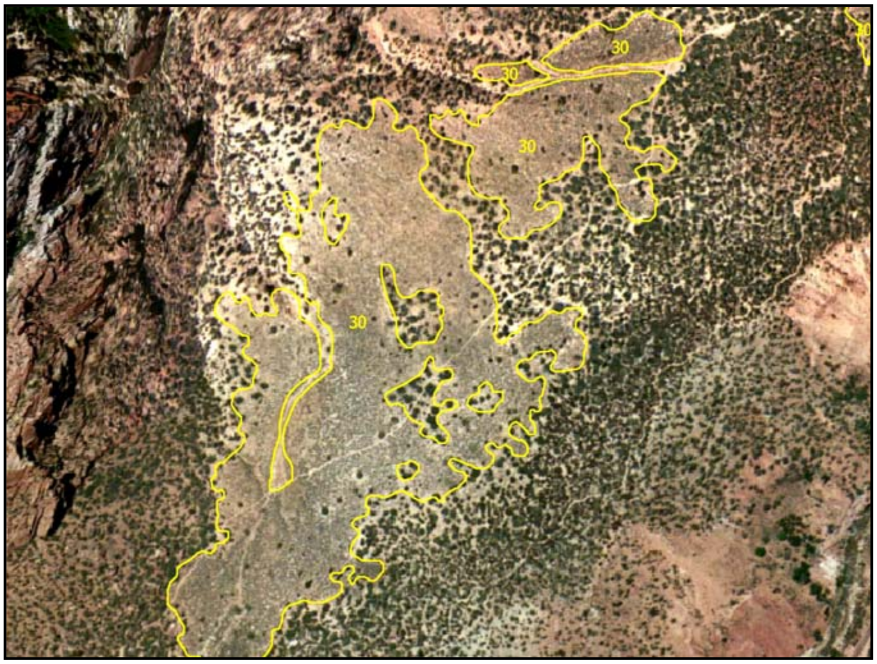
30 *Artemisia filifolia* Colorado Plateau Shrubland
Sand Sagebrush Colorado Plateau Shrubland

Association:
-*Artemisia filifolia* Colorado Plateau Shrubland

Common species:
Artemisia filifolia
Bromus tectorum
Sporobolus cryptandrus

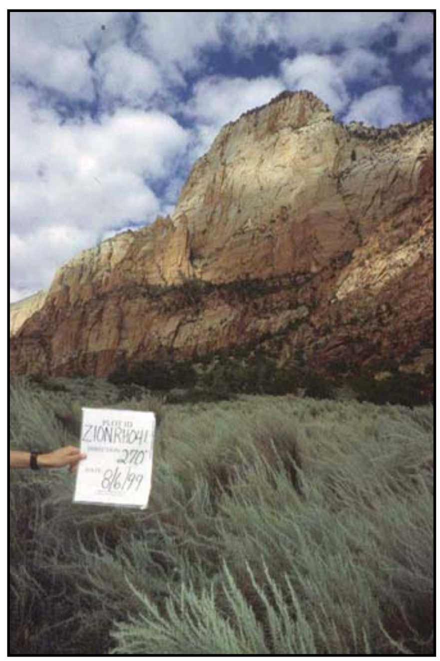
Project Specifics:
Frequency = 43 total polygons
41 polygons ZION, 2 polygons Environs
Area = 127 total acres
124 acres ZION, 3 acres Environs
Average Size = 3 acres

Photo Signature Example



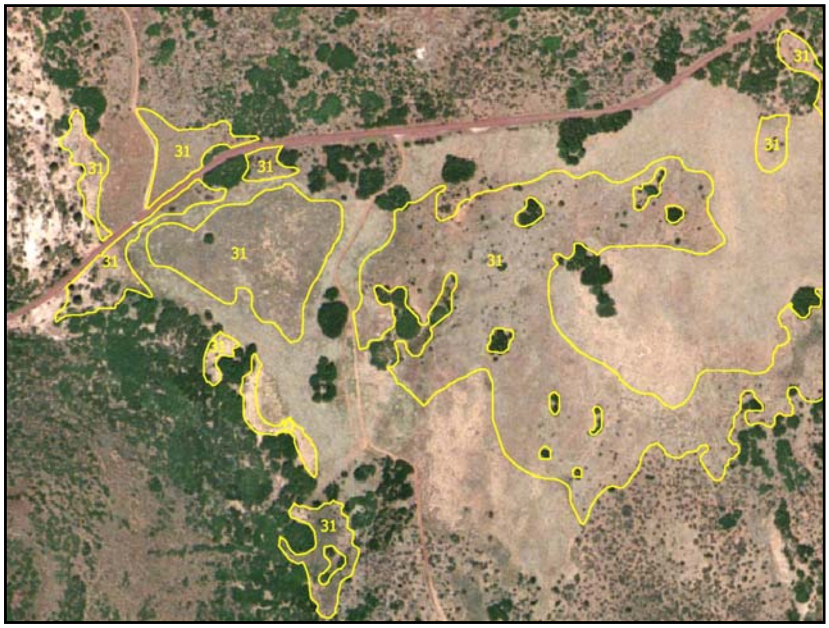
Description:
This map class was fairly rare at ZION, only occurring in a few sandy deposits in the southern half of the Park. Sand sagebrush was also present in other sagebrush and shrub map classes but only as a minor component. One large sand deposit in the main canyon (pictured above) represented a majority of the area covered by this type. Other sagebrush types likely intermingle with this map class, appearing similar on the aerial photos.

Ground Photos



31 *Artemisia tridentata* Shrubland Complex
Big Sagebrush Shrubland Complex

Photo Signature Example



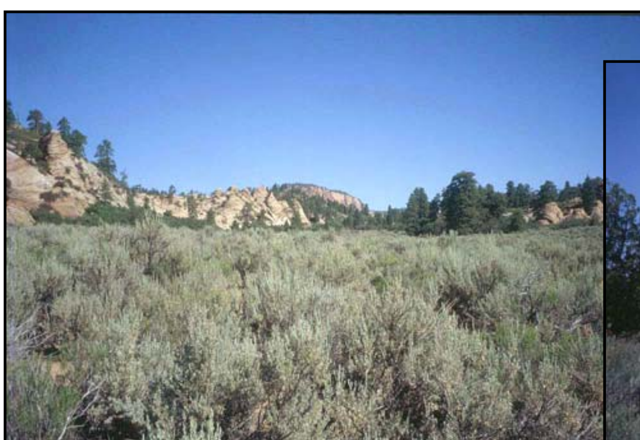
Associations:
-Artemisia tridentata / Bouteloua gracilis Shrubland
-A. tridentata - (Ericameria nauseosa) / Bromus tectorum Shrubland
-A. tridentata ssp. tridentata / Pascopyrum smithii - (Elymus lanceolatus) Shrubland
-Artemisia tridentata ssp. vaseyana / Hesperostipa comata Shrubland
-Atriplex canescens - Artemisia tridentata Shrubland
-Tetradymia canescens - Ephedra viridis Shrubland

Common species:
Artemisia tridentata ssp. tridentata
Artemisia tridentata ssp. vaseyana
Atriplex canescens
Elymus lanceolatus
Ericameria nauseosa
Bouteloua gracilis
Tetradymia canescens
Ephedra viridis
Hesperostipa comata

Project Specifics:
Frequency = 1,408 total polygons
628 polygons ZION, 780 polygons Environs
Area = 6,745 total acres
2,201 acres ZION, 4,544 acres Environs
Average Size = 5 acres

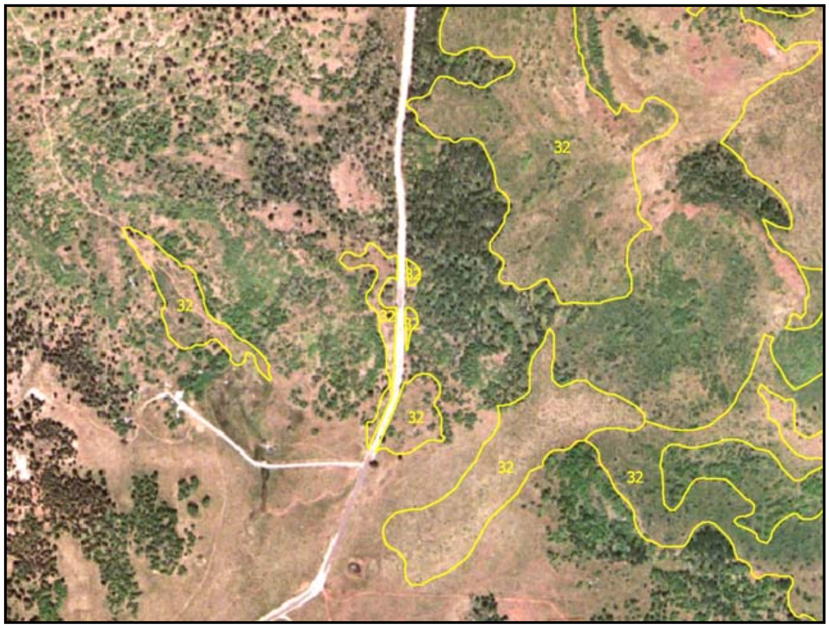
Description:
Big sagebrush is widespread through the Park shifting from the basin big sagebrush subspecies (spp. *tridentata*) in the south to mountain big sagebrush (spp. *vaseyana*) in the middle and northern portions. The gray color of the sagebrush is readily apparent on the aerial photos but is very similar to other sagebrushes (i.e. sand, black). Due to extreme similarities in height, color, and habitat, spineless horsebrush could not be separated from big sagebrush. Instead, horsebrush was combined with big sagebrush to form a complex, which closely matches their tendency to intermix on the ground as well.

Ground Photos



32 *Ericameria (Chrysothamnus) spp.* Shrubland Complex
Rabbitbrush Shrubland Complex

Photo Signature Example



Associations:
-Chrysothamnus viscidiflorus / Poa pratensis Shrub Herbaceous Vegetation [Provisional]
-Ericameria nauseosa / Bromus tectorum Shrubland
-Ericameria nauseosa Slide Deposit Sparse Vegetation

Common species:
Chrysothamnus viscidiflorus
Ericameria nauseosa
Poa pratensis
Artemisia tridentata
Gutierrezia sarothrae
Opuntia spp.
Pleuraphis jamesii

Project Specifics:
Frequency = 438 total polygons
197 polygons ZION, 241 polygons Environs
Area = 1,087 total acres
357 acres ZION, 730 acres Environs
Average Size = 2 acres

Description:
This map class combined two species of rabbitbrush into one map class in order to increase accuracy and reduce confusion in their signatures. *Chrysothamnus viscidiflorus* was more common in the northern half of the Park and *Ericameria nauseosa* was found throughout, mainly on disturbed early seral sites. On the aerial photos, the signature varied depending on density and substrate. When rabbitbrush was dense, a green signature was given; in sparse situations the color of the substrate was more prevalent. The location of the signature in and next to disturbed sites such as old agricultural fields and roadways helped to delineate this type.

Ground Photos

33 *Cercocarpus intricatus Slickrock* Sparse Vegetation
Littleleaf Mountain-mahogany Slickrock Sparse Vegetation

Association:
-*Cercocarpus intricatus* Slickrock Sparse Vegetation

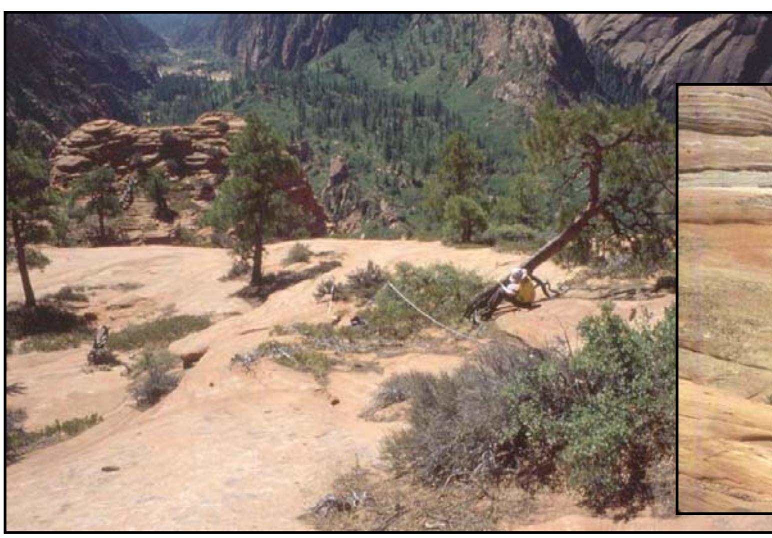
Common species:
Cercocarpus intricatus
Arctostaphylos patula
Pinus ponderosa
Pinus edulis
Purshia stansburiana

Project Specifics:
Frequency = 1,248 total polygons
1,049 polygons ZION, 199 polygons Environs
Area = 4,631 total acres
3,723 acres ZION, 908 acres Environs
Average Size = 4 acres

Photo Signature Example

Description:
This widespread map class was found throughout the Navajo, slickrock portions of ZION. This type was extremely sparse, occurring in rock crevices, canyon walls, and small ledges. Other shrubs such as manzanita and cliff-rose may be present and partially distort the photo signature. Extremely sparse stands of ponderosa pine and pinyon pine may also intermingle with this map class.

Ground Photos



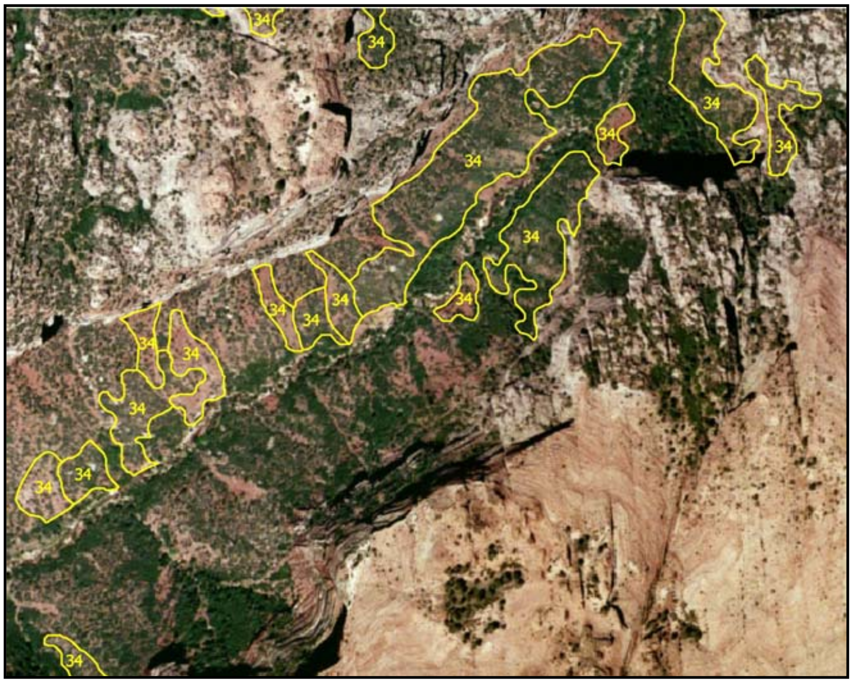
34 *Quercus turbinella - (Amelanchier utahensis)* Colluvial Shrubland
Talus Mixed Shrubland

Association:
-Quercus turbinella - (Amelanchier utahensis) Colluvial Shrubland

Common species:
Quercus turbinella
Amelanchier utahensis
Juniperus osteosperma
Pinus edulis
Shepherdia rotundifolia

Project Specifics:
Frequency = 871 total polygons
784 polygons ZION, 87 polygons Environs
Area = 3,114 total acres
2,796 acres ZION, 871 acres Environs
Average Size = 4 acres

Photo Signature Example



Description:
The live oak map class occurred throughout the Park on rocky, colluvial slopes (mainly toe and foot slopes). It was especially prevalent on the talus fields below the Navajo sandstone formation. The density and height of this shrub varied with aspect, substrate, and moisture; ranging from tall, thick shrubs to stunted, sparse communities. It also tended to intermix with pinyon – juniper types forming a prevalent understory in many cases. In the north, live oak mixed with other shrubs to form the mixed mountain shrubland map class. This map class appeared gray on the aerial photos that may have resulted in it being confused with other gray shrubs such as serviceberry and sagebrush.

Ground Photos

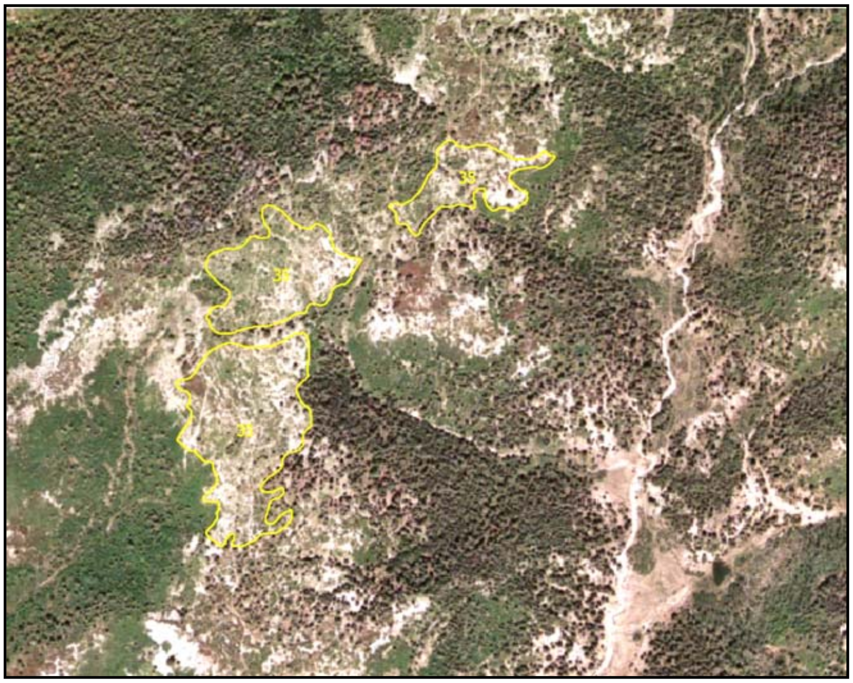
35 *Symphoricarpos oreophilus / Poa pratensis* Semi-natural Shrubland
Mountain Snowberry / Kentucky Bluegrass Semi-natural Shrubland

Associations:
-*Symphoricarpos oreophilus / Poa pratensis* Semi-natural Shrubland

Common species:
Symphoricarpos oreophilus
Poa pratensis
Quercus gambelii

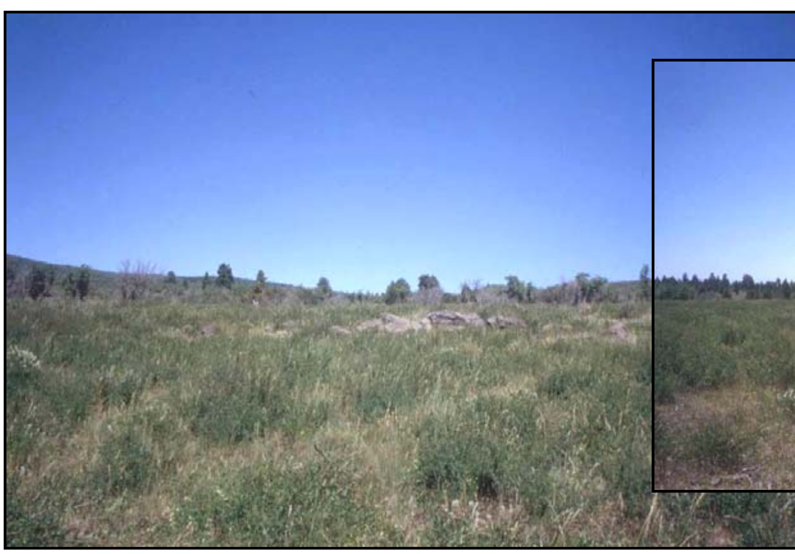
Project Specifics:
Frequency = 68 total polygons
43 polygons ZION, 25 polygons Environs
Area = 281 total acres
186 acres ZION, 95 acres Environs
Average Size = 4 acres

Photo Signature Example



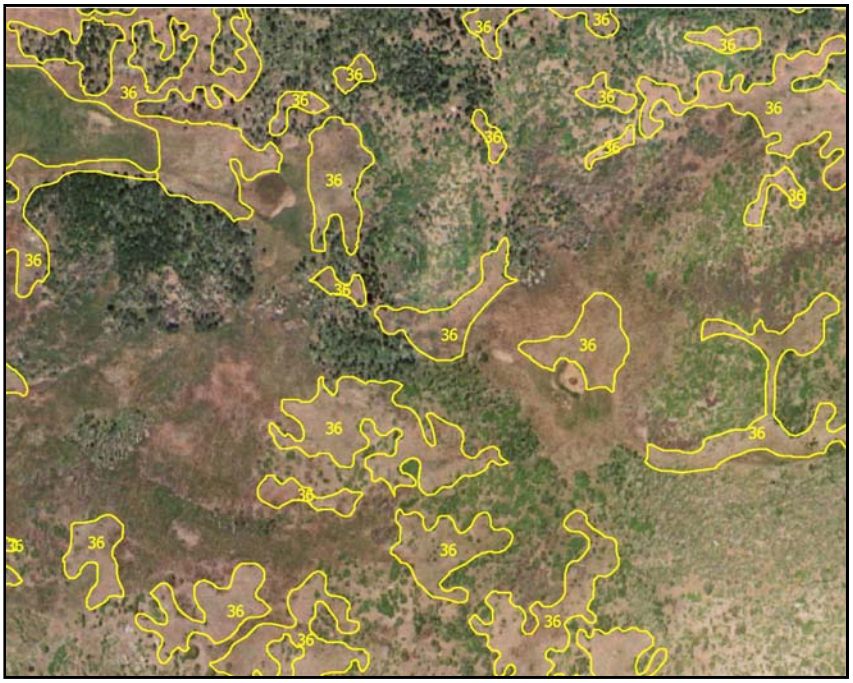
Description:
Typically this map class occurred on post-fire sites where the intensity of the fire appeared to completely burn off the shrub and tree layers. Also, mountain snowberry appeared to occur on primarily white substrates belonging to the Carmel geologic formation. The shrubs appeared green on the aerial photos and this coupled with post-burn evidence and white substrates helped locate and delineate this type. Gambel oak and other deciduous shrubs appearing green on the photography looked similar to this map class and may have led to some omission error.

Ground Photos



36 *Artemisia nova Dwarf-shrubland* Complex
Black Sagebrush Dwarf-shrubland Complex

Photo Signature Example



Associations:
-Artemisia nova / Elymus elymoides
Dwarf-shrubland
-Artemisia nova / Hesperostipa comata
Dwarf-shrubland
-Artemisia nova / Poa fendleriana
Dwarf-shrubland

Common species:
Artemisia nova
Poa fendleriana
Hesperostipa comata
Elymus elymoides
Poa pratensis

Project Specifics:
Frequency = 214 total polygons
147 polygons ZION, 67 polygons Environs
Area = 909 total acres
464 acres ZION, 446 acres Environs
Average Size = 4 acres

Description:
This dwarf shrubland was common throughout the northern portion of the Park in natural woodland meadows and old agricultural pastures. The low stature of this shrub made this map class appear much like herbaceous types although its gray color helped greatly in distinguishing it from other map classes. Similar shrubs such as stunted mountain big sagebrush may have been mapped as this type in some isolated instances.

Ground Photos

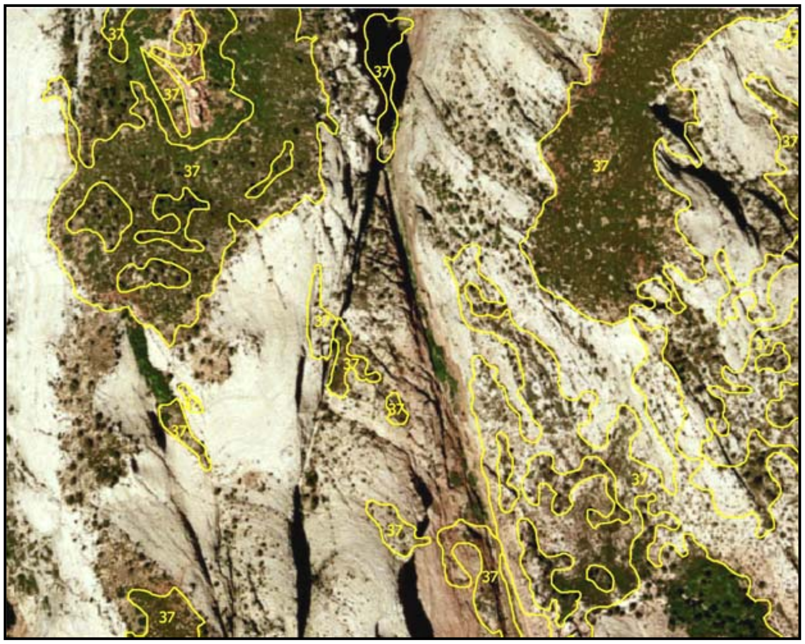
37 *Arctostaphylos patula* Shrubland Complex
Greenleaf Manzanita Shrubland Complex

Associations:
-*Arctostaphylos patula - Artemisia tridentata ssp. vaseyana* Shrubland
-*Arctostaphylos patula* Shrubland
-*Purshia stansburiana - Arctostaphylos patula* Shrubland

Common species:
Arctostaphylos patula
Artemisia tridentata ssp. Vaseyana
Purshia stansburiana
Cercocarpus intricatus

Project Specifics:
Frequency = 2,245 total polygons
1,702 polygons ZION, 543 polygons Environs
Area = 11,022 total acres
7,860 acres ZION, 3,162 acres Environs
Average Size = 5 acres

Photo Signature Example



Description:
Besides gambel oak, greenleaf manzanita was probably the next most common shrub found at ZION during this study. This map class occurred park-wide and in a wide array of diverse habitats ranging from dense stands on plateau tops to sparse, stunted groups on slickrock. The olive green color of greenleaf manzanita really stood out on the true color aerial photography, making for relatively easy interpretation of this type. Some minor confusion may have existed when gambel oak grew in close proximity changing the call to Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland map class. Green-leaf manzanita also occurred as a common understory species with ponderosa pine, often intermixing.

Ground Photos

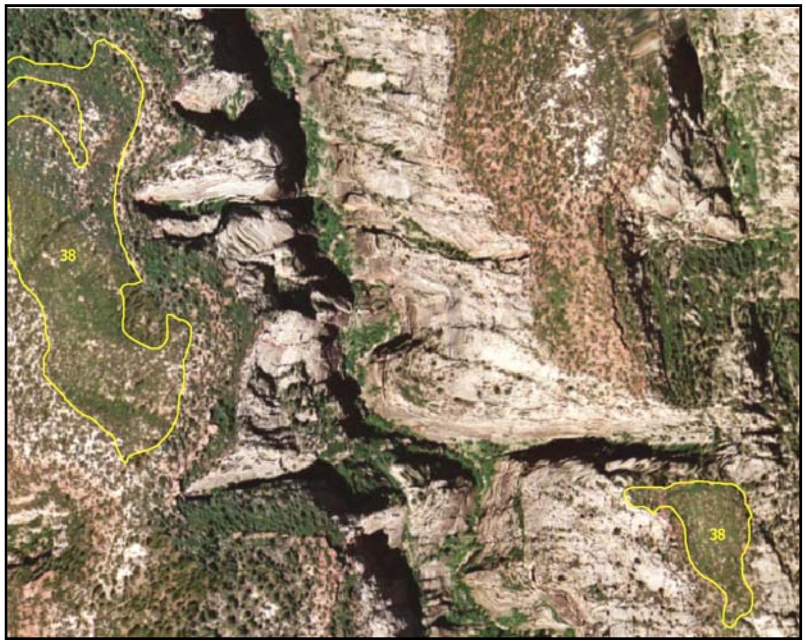
38 *Arctostaphylos patula - Quercus gambelii - (Amelanchier utahensis)* Shrubland
Greenleaf Manzanita - Gambel Oak - (Utah Serviceberry) Shrubland

Association:
Arctostaphylos patula - Quercus gambelii (Amelanchier utahensis) Shrubland

Common species:
Arctostaphylos patula
Quercus gambelii
Amelanchier utahensis

Project Specifics:
Frequency = 185 total polygons
144 polygons ZION, 41 polygons Environs
Area = 1,427 total acres
1,000 acres ZION, 427 acres Environs
Average Size = 8 acres

Photo Signature Example



Description:
This map class differed from the Greenleaf Manzanita Shrubland Complex type by the presence of gambel oak and other shrubs. When gambel oak and greenleaf manzanita appeared to occur in stands at roughly 50%-50% cover this map class was used as the label. On the ground, this association tended to occur on more mesic mesa and plateau tops, appearing dense and somewhat diverse.

Ground Photos

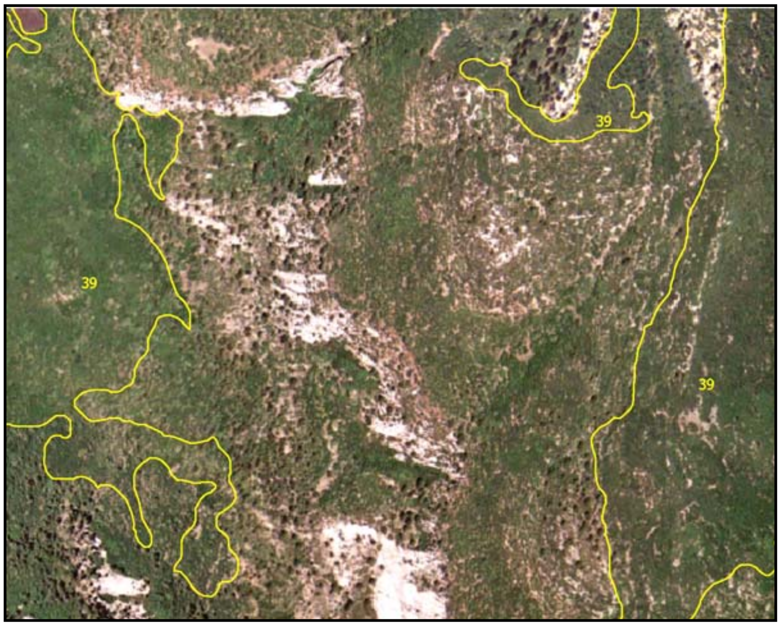
39 *Quercus gambelii* Shrubland Alliance
Gambel Oak Shrubland Alliance

Associations:
-Quercus gambelii / Amelanchier utahensis Shrubland
-Quercus gambelii / Artemisia tridentata Shrubland
-Quercus gambelii - Cercocarpus montanus / (Carex geyeri) Shrubland
-Quercus gambelii / Symphoricarpos oreophilus Shrubland
-Quercus gambelii / Poa fendleriana Shrubland

Common species:
Quercus gambelii
Amelanchier utahensis
Artemisia tridentata
Cercocarpus montanus
Symphoricarpos oreophilus
Carex geyeri
Poa fendleriana

Project Specifics:
Frequency = 3,199 total polygons
2,164 polygons ZION, 1,035 polygons Environs
Area = 17,579 total acres
10,990 acres ZION, 6,589 acres Environs
Average Size = 5 acres

Photo Signature Example



Description:
Gambel oak was the most common shrub at ZION in terms of area covered. This widespread map class covered large areas ranging from mesic valley floors to broad post-fire mesa tops. The true green color of this shrub was very evident on the aerial photos, providing relatively straight-forward interpretation.

Ground Photos

40 *Mixed Mountain* Shrubland Complex
Mixed Mountain Shrubland Complex

Photo Signature Example

Associations:
-*Arctostaphylos pungens* Shrubland
-*Arctostaphylos patula - Artemisia tridentata ssp. vaseyana* Shrubland *
-*Arctostaphylos patula* Shrubland *
-*Purshia stansburiana - Arctostaphylos patula* Shrubland*
-*Quercus turbinella - (Amelanchier utahensis)* Colluvial Shrubland *
-*Cercocarpus montanus* Rock Pavement Sparse Vegetation

Common species:
Arctostaphylos pungens
Arctostaphylos patula
Artemisia tridentata ssp. vaseyana
Purshia stansburiana
Quercus turbinella
Amelanchier utahensis
Cercocarpus montanus

Project Specifics:
Frequency = 1,134 total polygons
720 polygons ZION, 414 polygons Environs
Area = 6,518 total acres
3,986 acres ZION, 2,532 acres Environs
Average Size = 6 acres

Description:
The Mixed Mountain Shrubland Complex represents an unique map unit that occurs in the northern portions of ZION. This map unit contains an intricate mix of both an unique shrub association (*Arctostaphylos pungens* Shrubland) and other more common shrub associations at ZION (denoted by *). Habitat characteristics for this type includes rocky or colluvial substrates, moderately mesic conditions and close proximity to other shrub and pinyon – juniper map classes. This map unit likely represents a broad ecotone containing many common species. On the aerial photos this type is represented by a gray stippled signature caused by the presence of tall shrubs.

Ground Photos

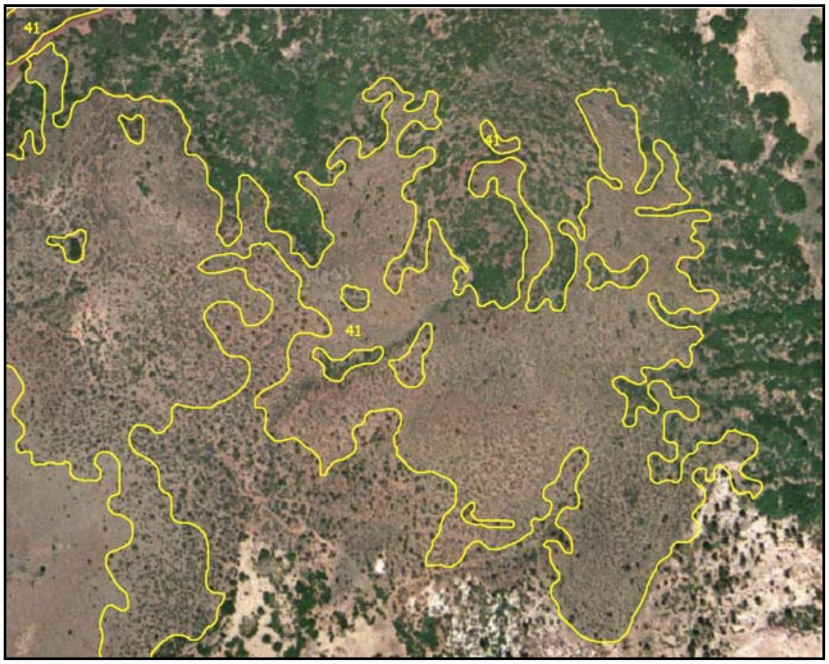
41 *Amelanchier utahensis* Shrubland
Utah Serviceberry Shrubland

Photo Signature Example

Association:
-*Amelanchier utahensis* Shrubland

Common species:
Amelanchier utahensis
Artemisia tridentata

Project Specifics:
Frequency = 86 total polygons
75 polygons ZION, 11 polygons Environs
Area = 593 total acres
462 acres ZION, 132 acres Environs
Average Size = 7 acres



Description:

Pure Utah serviceberry stands were relatively rare at ZION even though the species was a common component in many other shrubland map classes. Typically this type occurred on the slopes of volcanic cinder cones and on cinder fields appearing as regular spaced gray dots. Other tall shrubland map classes, especially the Mixed Mountain Shrubland Complex may have been confused with this type where the they intermix.

Ground Photos

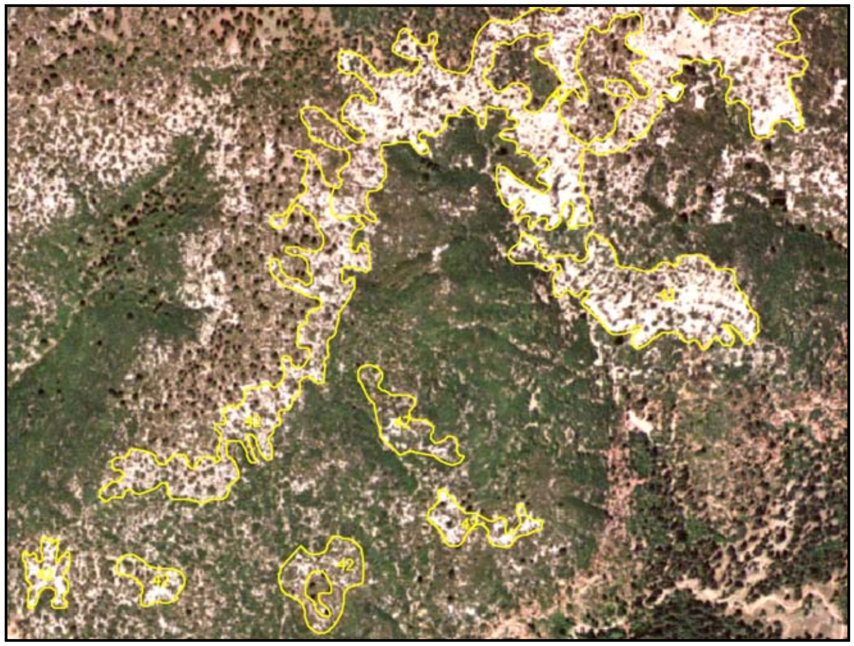
42 *Cercocarpus montanus* Rock Pavement Sparse Vegetation
Mountain-mahogany Rock Pavement Sparse Vegetation

Association:
-Cercocarpus montanus Rock Pavement Sparse Vegetation

Common species:
Cercocarpus montanus
Arctostaphylos patula
Quercus gambelii
Amelanchier utahensis

Project Specifics:
Frequency = 128 total polygons
60 polygons ZION, 68 polygons Environs
Area = 744 total acres
295 acres ZION, 449 acres Environs
Average Size = 6 acres

Photo Signature Example



Description:
At ZION, exposed Carmel geologic formations form a characteristic white cap in some of the highest portions of the Park. On this rugged terrain stunted mountain mahogany shrubs form unique associations that were observable on the aerial photography. In fact, the white substrate helped locate and delineate this type and is included in the naming of the association.

Ground Photos

Riparian Shrublands

43 *Baccharis emoryi* Shrubland
Emory Seepwillow Shrubland

Associations:
-Baccharis emoryi Shrubland

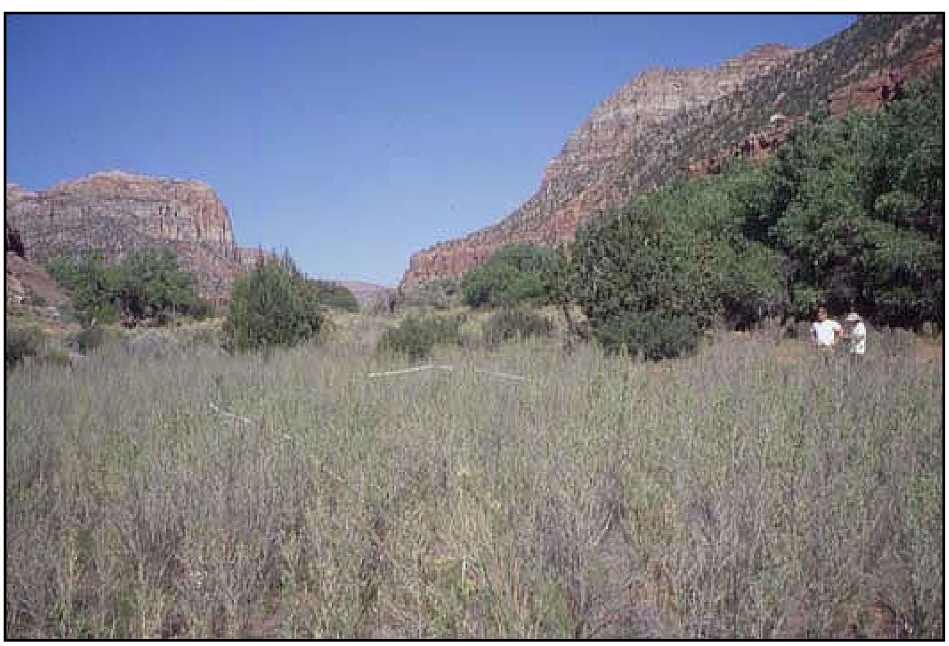
Common species:
Baccharis emoryi
Equisetum variegatum
Melilotus officinalis
Salsola tragus
Muhlenbergia asperifolia
Poa pratensis

Project Specifics:
Frequency = 121 total polygons
96 polygons ZION, 25 polygons Environs
Area = 66 total acres
53 acres ZION, 13 acres Environs
Average Size = 0.5 acres

Photo Signature Example

Description:
Seepwillow was common in Zion Canyon and along other streams in the southern portion of the project area growing on flat streambanks or stream terraces. In these situations, this map class often occurred in a mosaic amongst mature *Populus fremontii - Fraxinus velutina* Woodland. On the aerial photos, seepwillow ranged from green to gray depending on amount of leaf cover. The location of this type on sandbars and sandy beaches helped locate and delineate it.

Ground Photo



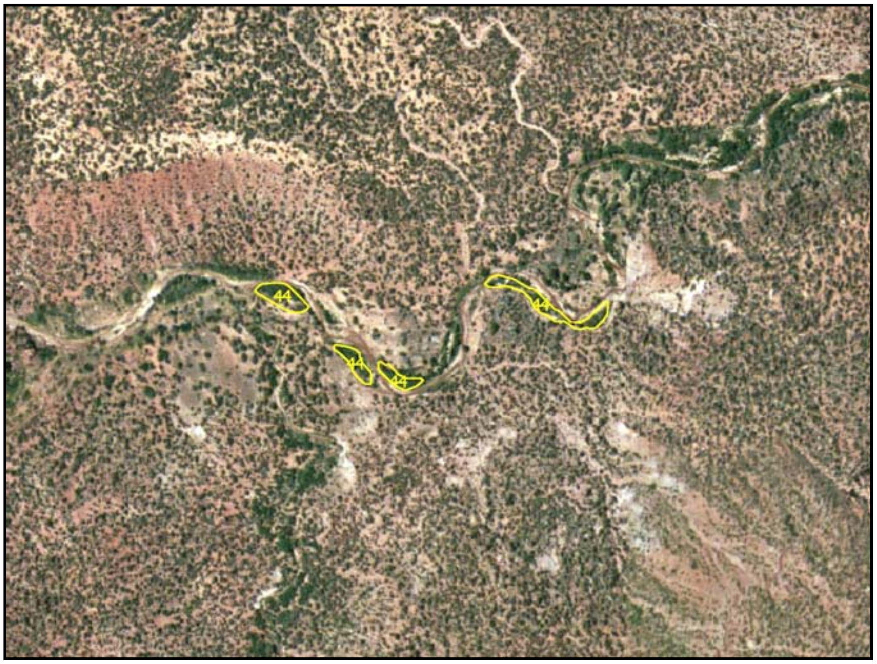
44 *Salix exigua* Shrubland Alliance
Sandbar Willow Shrubland Alliance

Associations:
SALIX (EXIGUA, INTERIOR)
TEMPORARILY FLOODED SHRUBLAND ALLIANCE
-*Salix exigua* / Barren Shrubland
-Salix exigua / Mesic Graminoids Shrubland

Common species:
Salix exigua
Agrostis stolonifera
Bromus tectorum
Juncus longistylis
Artemisia campestris
Rumex acetosella
Senecio spartioides

Project Specifics:
Frequency = 60 total polygons
52 polygons ZION, 8 polygons Environs
Area = 40 total acres
35 acres ZION, 6 acres Environs
Average Size = 0.7 acres

Photo Signature Example



Description:
Sandbar willow was common throughout the Park on sandy soils adjacent to streams and rivers. This particular map class was reserved for stands occurring in the middle and northern portions of the Park were it grew without seepwillow. In the south, particularly in Zion Canyon, sandbar willow usually occurred with seepwillow and was mapped using the Emory Seepwillow Shrubland designation. On the aerial photos, sandbar willow ranged from green to gray depending on amount of leaf cover. The location of this type on sandbars and sandy beaches helped locate and delineate it.

Ground Photos

45 *Tamarix* spp. Temporarily Flooded Shrubland
Tamarisk spp. Temporarily Flooded Shrubland

Associations:
-*Tamarix* spp. Temporarily Flooded Shrubland

Common species:
Tamarix ramosissima
Salix exigua
Baccharis emoryi
Populus fremontii
Elaeagnus angustifolia

Project Specifics:
Frequency = 128total polygons
10 polygons ZION, 118 polygons Environs
Area = 199 total acres
3 acres ZION, 199 acres Environs
Average Size = 2 acres

Photo Signature Example

Description:
This non-native map class was found primarily outside of ZION along the Virgin River floodplain. Tamarisk tended to form dense stands that were characterized with a dark green signature. Other floodplain and riparian map classes tended to intermingle with this type. In the Park this type was limited to some isolated stands in the South due to an active control and eradication program.

Ground Photo

46 *Pluchea sericea* Seasonally Flooded Shrubland
Arrow-weed Seasonally Flooded Shrubland

Association:
-*Pluchea sericea* Seasonally Flooded Shrubland

Common species:
Pluchea sericea
Gutierrezia sarothrae
Sporobolus cryptandrus
Melilotus officinalis

Project Specifics:
Frequency = 3 total polygons
0 polygons ZION, 3 polygons Environs
Area = 8 total acres
0 acres ZION, 8 acres Environs
Average Size = 3 acres

Photo Signature Example

Description:
This type was very rare in the project area occurring in only 2 stands large enough to map. In these situations, arrow-weed was clearly the dominant covering most of the site. Some exotic species were present likely due to exposure to human and/or livestock disturbance. This map class was located and delineated from field observations and GPS locations.

Ground Photo

47 *Salix ligulifolia / Carex utriculata* Shrubland
Strapleaf Willow / Beaked Sedge Shrubland

Association:
-Salix ligulifolia / Carex utriculata Shrubland

Common species:
Salix ligulifolia
Carex utriculata
Poa pratensis
Maianthemum stellatum

Project Specifics:
Frequency = 24 total polygons
5 polygons ZION, 19 polygons Environs
Area = 39 total acres
5 acres ZION, 34 acres Environs
Average Size = 2 acres

Photo Signature Example

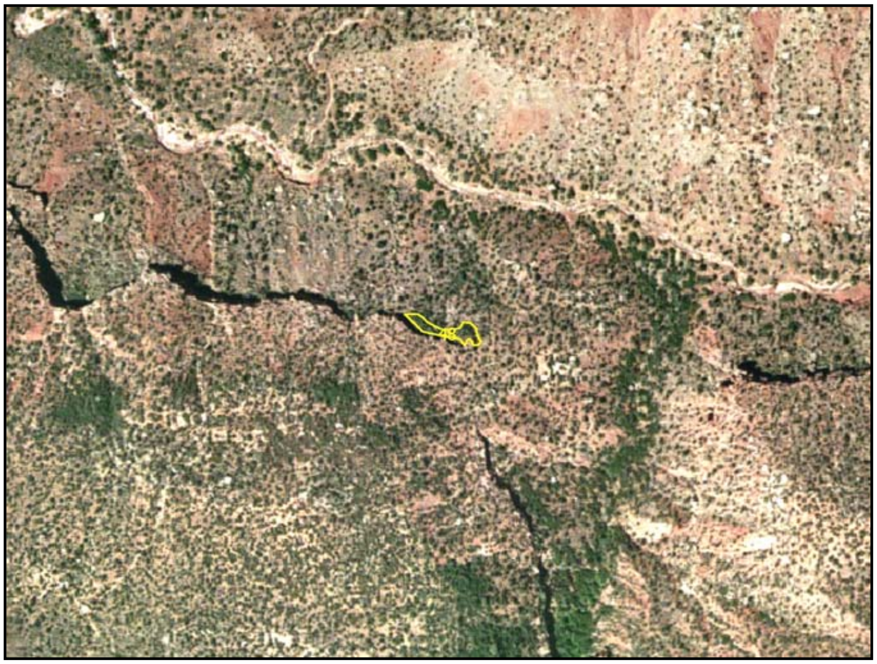
Description:
Strapleaf willow occurred in isolated patches in the northern-most reaches of the projects area in high elevations. This map class was fairly rare but was distinctive as tall, light green - gray shrubs. The wet meadow habitat of this type also helped with locating and separating it from other deciduous shrubs. This type tended to grow in isolated stands and some very small patches may have been overlooked in the photo interpretation.

Ground Photo

Riparian Woodlands

48 *Fraxinus anomala* Woodland
Single-leaf Ash Woodland

Photo Signature Example



Association:
-Fraxinus anomala Woodland

Common species:
Fraxinus anomala
Quercus gambelii
Amelanchier alnifolia
Ericameria nauseosa
Rhus trilobata

Project Specifics:
Frequency = 1 total polygons
1 polygons ZION, 0 polygons Environs
Area = 0.9 total acres
0.9 acres ZION, 0 acres Environs
Average Size = 0.9 acres

Description:
Single-leaf ash stands big enough to map were extremely rare in this project. Single-leaf was fairly common as a shrub or sub-canopy component in many other riparian and deciduous woodlands but was not found very often as a true association. This type was likely confused with gambel oak shrubland and other deciduous shrubland map classes. The one polygon mapped was based off the only known plot location.

Ground Photo

49 *Acer negundo* Woodland Alliance
Boxelder Woodland Alliance

Photo Signature Example

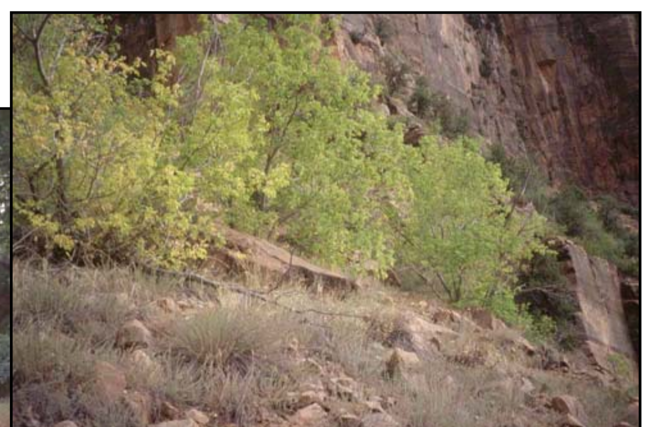
Associations:
-Acer negundo / Brickellia grandiflora Woodland
-Acer negundo / Disturbed Understory Wodland

Common species:
Acer negundo
Brickellia grandiflora
Bromus tectorum

Project Specifics:
Frequency = 44 total polygons
42 polygons ZION, 2 polygons Environs
Area = 69 total acres
67 acres ZION, 1 acre Environs
Average Size = 2 acres

Description:
This rare map class occurs mainly in the Park as small stands along waterways and on floodplains. Boxelder is one of the more prominent riparian tree species at ZION, especially in the lower elevations of the Park. Boxelder is also fairly abundant in other mixed deciduous stands but its foliage is identical to cottonwood, velvet ash, and other deciduous trees on the true-color aerial photos. This type was mapped in known areas based on ground observations, plot and observation point locations, and in areas that had very similar habitat.

Ground Photos



50 *Populus fremontii* Woodland Complex
Fremont Cottonwood Woodland Complex

Photo Signature Example

Associations:
-Populus fremontii / Betula occidentalis Wooded Shrubland
-Populus fremontii / Salix exigua Forest
-Populus fremontii / Baccharis emoryi Woodland

Common species:
Populus fremontii
Salix exigua
Betula occidentalis
Baccharis emoryi
Ericameria nauseosa
Bromus diandrus
Bromus tectorum
Muhlenbergia asperifolia
Melilotus officinalis

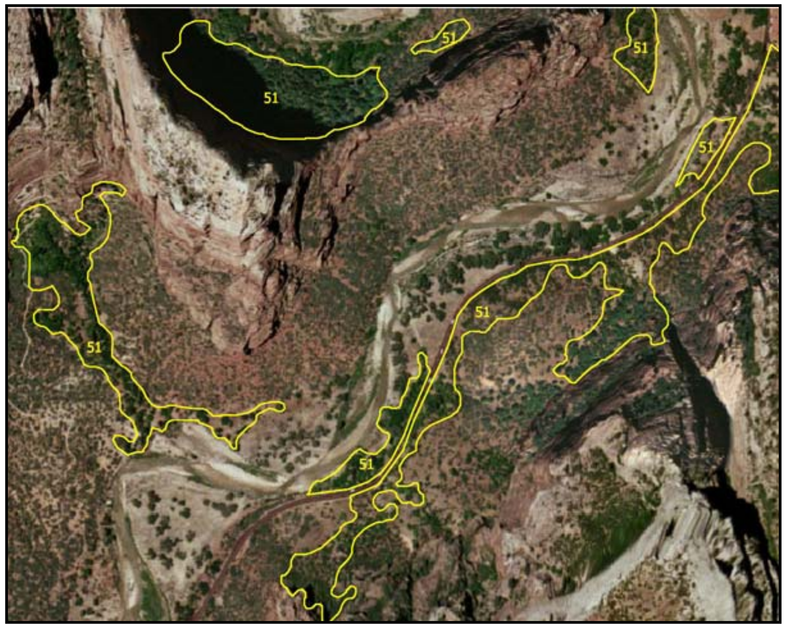
Project Specifics:
Frequency = 390 total polygons
126 polygons ZION, 264 polygons Environs
Area = 669 total acres
425 acres ZION, 244 acres Environs
Average Size = 2 acres

Description:
This is a fairly common map class at ZION, typical of the Virgin River Floodplain and in other prominent drainages. The photo signature of this type varies from dark lush green to gray-brown depending on the age, height, and health of the trees. In most cases this type occurs intermixed with other riparian and floodplain map classes like Mixed Riparian Woodlands and Sandbar Willow Shrublands. This map class may be confused on the photos with other deciduous woodland types.

Ground Photos

51 *Populus fremontii – Fraxinus velutina* Woodland
Fremont Cottonwood – Velvet Ash Woodland

Photo Signature Example



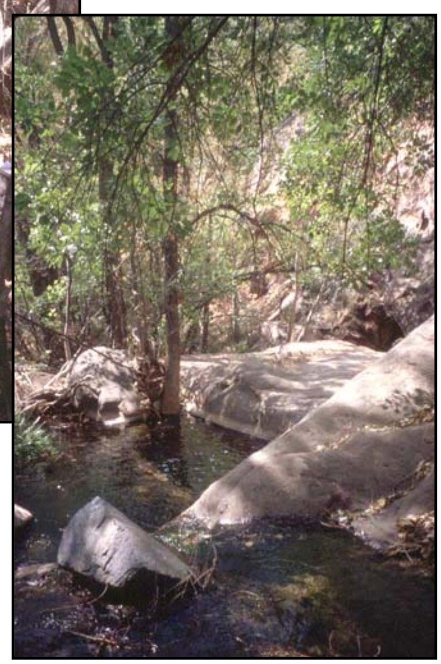
Association:
-Populus fremontii - Fraxinus velutina Woodland

Common species:
Fraxinus velutina
Populus fremontii
Acer negundo
Quercus gambelii
Bromus diandrus
Bromus tectorum

Project Specifics:
Frequency = 800 total polygons
548 polygons ZION, 252 polygons Environs
Area = 1,627 total acres
1,136 acres ZION, 491 acres Environs
Average Size = 2 acres

Description:
This map class strived to account for the high species diversity found in the floodplain and riparian deciduous woodlands found throughout the project area. In these stands various mixes of tree species could occur including cottonwood, boxelder, velvet ash, single-leaf ash, and gambel oak. Although only cross-walked to one association this map class actually represented mosaics of many other deciduous woodland types as well. The intricate intermingling of species and sudden change in composition between stands made mapping individual associations impossible. On the aerial photos this type appeared as mottled dark or bright green and occurred in canyon bottoms and on floodplain terraces. This type was distinguished from the Fremont Cottonwood Woodland Complex map class by the presence of other tree species and their corresponding different photo signature tones.

Ground Photos



52 *Elaeagnus angustifolia* Semi-natural Woodland
Russian Olive Semi-natural Woodland

Association:
-*Elaeagnus angustifolia* Semi-natural Woodland

Common species:
Elaeagnus angustifolia
Salix exigua
Populus fremontii
Tamarix spp

Project Specifics:
Frequency = 43 total polygons
1 polygons ZION, 42 polygons Environs
Area = 73 total acres
0.7 acres ZION, 72 acres Environs
Average Size = 2 acres

Photo Signature Example

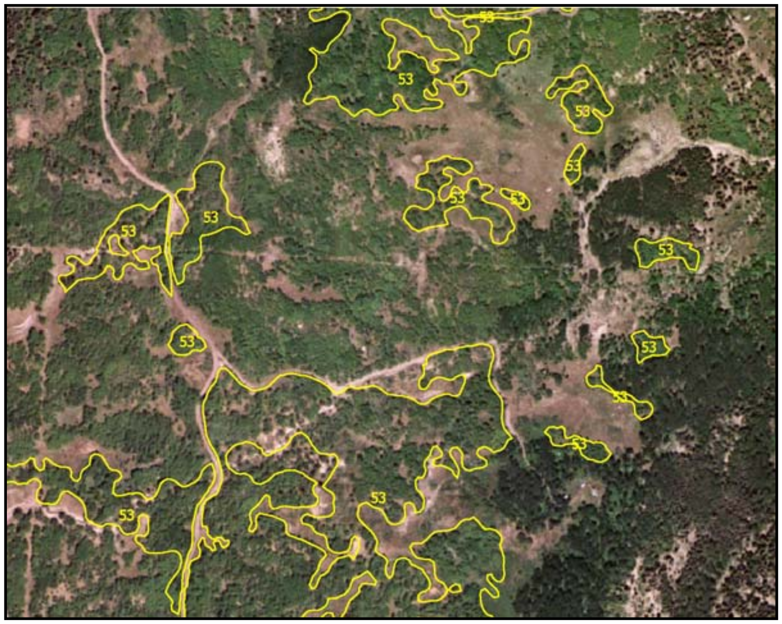
Description:
This map class is limited to one known location in ZION but is more prevalent outside the Park on the Virgin River Floodplain. The blue-gray color of the Russian olive foliage is very distinctive on the true color aerial photography. In some places, small patches may have been over looked or mapped as another deciduous floodplain woodland map classes. In the Environs this type often intermingled with the salt cedar shrubland map class.

Ground Photo

Deciduous Forests

53 *Quercus gambelii* Woodland
Gambel Oak Woodland

Photo Signature Example



Associations:
-*Quercus gambelii / Amelanchier utahensis* Shrubland
-*Quercus gambelii / Artemisia tridentata* Shrubland
-*Quercus gambelii - Cercocarpus montanus / (Carex geyeri)* Shrubland
-*Quercus gambelii / Symphoricarpos oreophilus* Shrubland
-*Quercus gambelii / Poa fendleriana* Shrubland

Common species:
Quercus gambelii
Artemisia tridentata
Poa fendleriana
Symphoricarpos oreophilus
Cercocarpus montanus
Carex geyeri
Amelanchier utahensis

Project Specifics:
Frequency = 1568 total polygons
780 polygons ZION, 788 polygons Environs
Area = 4,479 total acres
2,046 acres ZION, 2,433 acres Environs
Average Size = 3 acres

Description:
This map class is identical to the gambel oak shrubland map class except for the structure of the gambel oak. On the aerial photos the woodland form appeared taller and usually occurred in more mesic areas such as valleys, floodplains, and north-facing footslopes. In a majority of cases, this type had a closed canopy preventing understory species from being interpreted from the aerial photography. The presence of bigtooth maple was all that separated this map class from the Bigtooth Maple / Gambel Oak Forest map class and led to some confusion when the maple was in low abundance.

Ground Photos

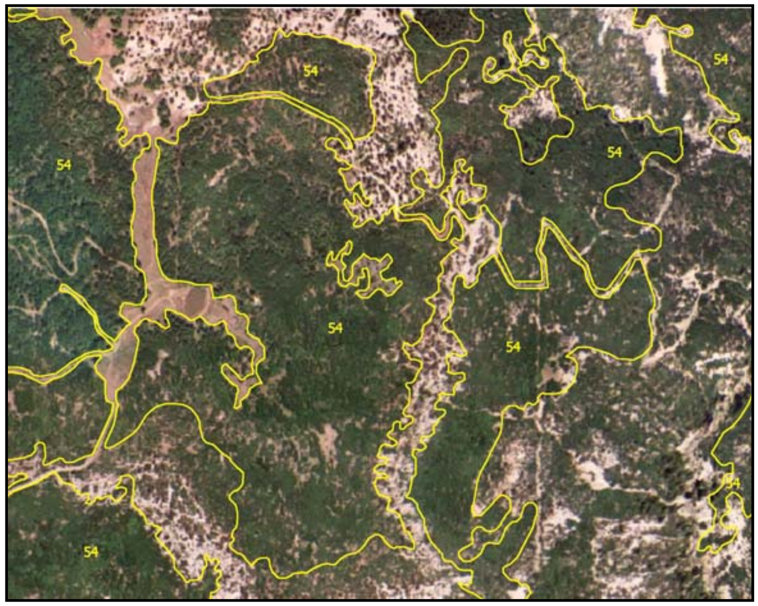
54 *Acer grandidentatum / Quercus gambelii* Forest
Bigtooth Maple / Gambel Oak Forest

Association:
-Acer grandidentatum – Quercus gambelii Forest

Common Species:
Prunus viriginiana
Rosa woodsii
Symphoricarpos oreophilus
Physiocarpus malvaceus
Berberis repens

Project Specifics:
Frequency = 331 total polygons
98 polygons ZION, 233 polygons Environs
Area = 9,130 total acres
1,362 acres ZION, 7,768 acres Environs
Average Size = 28 acres

Photo Signature Example



Description:
This map class generally occurs on middle and lower slopes with northern aspects in the higher areas of ZION. It is distinguished from the other gambel oak types by the high percentage of bigtooth maple; 50-50 in some cases. In dryer areas the maple disappears and transitions to a gambel oak woodland type. Aspen and white fir may intermingle with this class.

Ground Photos

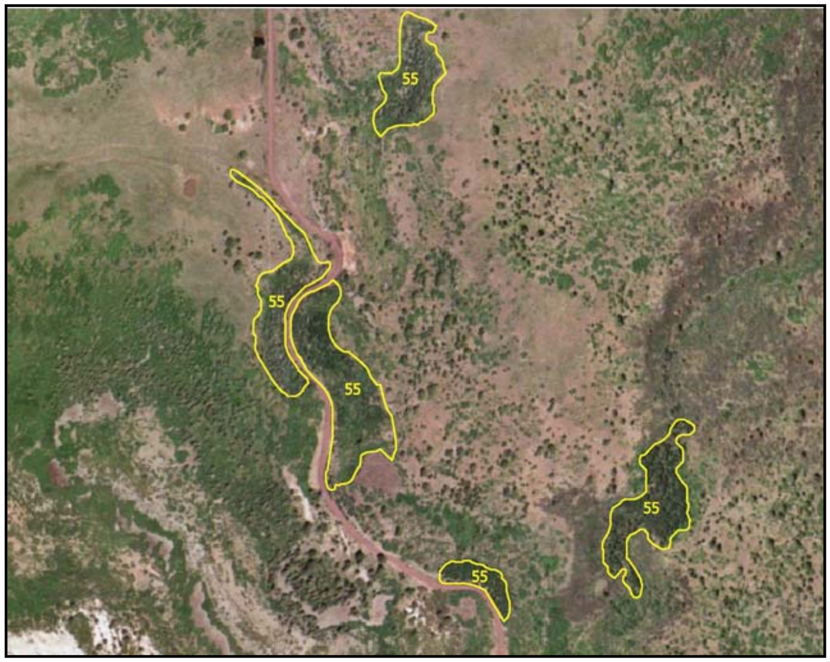
55 *Populus tremuloides* Forest Complex
Quaking Aspen Forest Complex

Associations:
-Populus tremuloides - Abies concolor / Symphoricarpos oreophilus Forest
-Populus tremuloides - Abies concolor / Poa pratensis Forest
-Populus tremuloides / Symphoricarpos oreophilus / Tall Forbs Forest
-Populus tremuloides / Quercus gambelii / Symphoricarpos oreophilus Forest

Common species:
Abies concolor
Populus tremuloides
Acer grandidentatum
Symphoricarpos oreophilus
Poa pratensis
Achillea millefolium
Vicia americana

Project Specifics:
Frequency = 482 total polygons
99 polygons ZION, 383 polygons Environs
Area = 2,693 total acres
297 acres ZION, 2,396 acres Environs
Average Size = 6 acres

Photo Signature Example



Description:
This map class is fairly common in the northern portions of the project area in cool, moist areas. Quaking aspen occurs in many different forms including old, decadent stands, lush post-burn suckers, and thick pole-sized clumps. The appearance of the aspen on the aerial photos was characterized by a smooth, dark green color and white trunks (if the canopy was open). This map class intermingled with various other montane forest and woodland types, including white fire and gambel oak.

Ground Photos

Coniferous Woodlands

56 *Juniperus spp. / Artemisia tridentata* Woodland Complex
Juniper / Big Sagebrush Woodland Complex

Associations:
-Juniperus osteosperma / Artemisia tridentata Woodland
-Pinus edulis - Juniperus spp. / Artemisia tridentata Woodland
-Pinus monophylla - Juniperus osteosperma / Artemisia tridentata Woodland

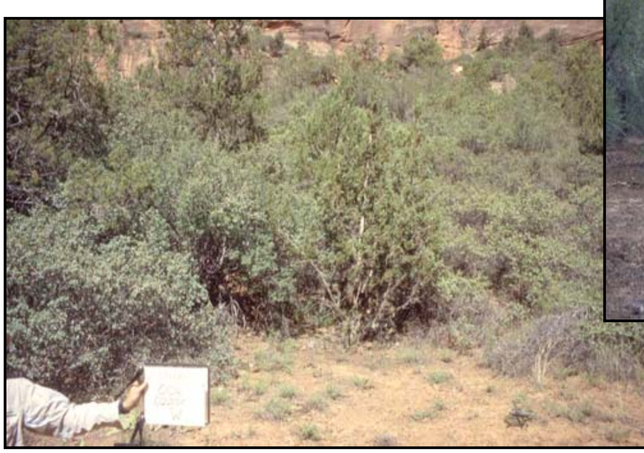
Common species:
Juniperus osteosperma
Artemisia tridentata
Ephedra nevadensis
Gutierrezia sarothrae
Opuntia macrorhiza

Project Specifics:
Frequency = 624 total polygons
203 polygons ZION, 421 polygons Environs
Area = 6216 total acres
2,298 acres ZION, 3,918 acres Environs
Average Size = 10 acres

Photo Signature Example

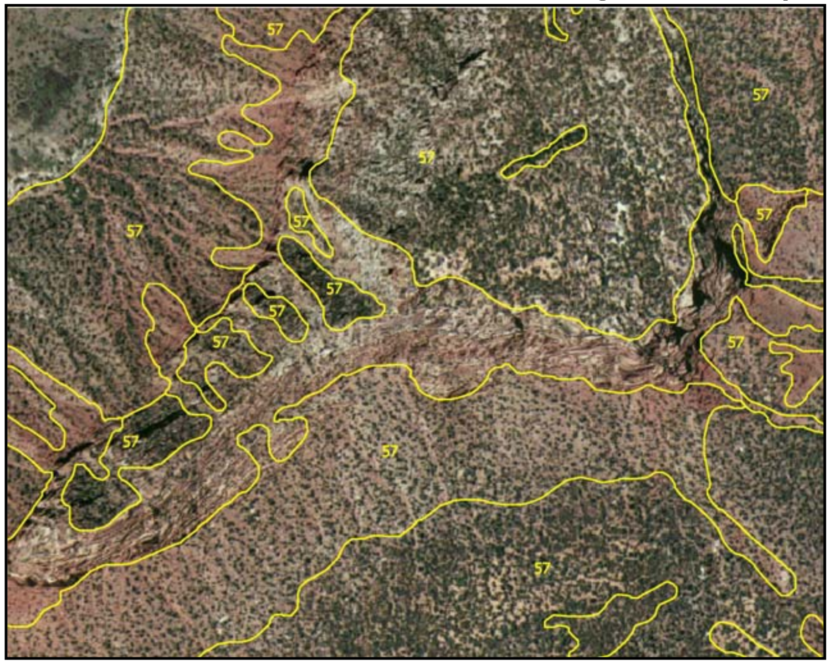
Description:
This map class is common in the southern regions of the project area where the pinyon pine tends to be less abundant, likely a result of drier conditions. *Juniperus osteosperma* is usually less than 25% cover in and will range between 5-10 m in height. The herbaceous layer is absent or very sparse. The presence of big sagebrush in the understory was a diagnostic characteristic on the aerial photographs. This map class may intermingle and be confused with the other pinyon – juniper map classes especially if shrubs other than big sagebrush are prominent.

Ground Photos



57 *Pinus* spp. - *Juniperus* spp. Woodland Complex
Pinyon - Juniper Woodland Complex

Photo Signature Example



Associations:
-*Pinus edulis - Juniperus osteosperma / Cercocarpus intricatus* Woodland
-*Pinus edulis - Juniperus osteosperma / Purshia stansburiana* Woodland
-*Pinus edulis - Juniperus osteosperma / Arctostaphylos patula* Woodland
-*Pinus edulis - Juniperus osteosperma / Cercocarpus montanus* Woodland
-*Pinus edulis - Juniperus osteosperma / Cercocarpus ledifolius* Woodland
-*Pinus monophylla - Juniperus osteosperma / Artemisia nova* Woodland
-*Pinus monophylla - Juniperus osteosperma / Quercus turbinella* Woodland
-*Pinus monophylla - Juniperus osteosperma / (Shepherdia rotundifolia Amelanchier utahensis)* Woodland
-*Pinus monophylla - Juniperus osteosperma / Cercocarpus montanus - Quercus gambelii* Woodland
-*Pinus monophylla - Juniperus osteosperma / Gutierrezia sarothrae* Woodland
-*Pinus monophylla - Juniperus osteosperma / Pleuraphis jamesii* Woodland
-*Pinus monophylla - Juniperus osteosperma / Coleogyne ramosissima* Woodland

Ground Photos

Common species:
Amelanchier utahensis
Arctostaphylos patula
Cercocarpus montanus
Cercocarpus intricatus
Purshia stansburiana
Cercocarpus ledifolius
Quercus turbinella
Shepherdia rotundifolia
Gutierrezia sarothrae
Pleuraphis jamesii
Coleogyne ramosissima

Project Specifics:
Frequency = 2,379 total polygons
1,594 polygons ZION, 785 polygons Environs
Area = 55,995 total acres
34,323 acres ZION, 21,672 acres Environs
Average Size = 24 acres

Description:

This is the largest map unit at ZION coving over 20% of the project area. Many of the polygons represent differences in density due to changes in soils, moisture levels, and slope/aspect. This class constitutes the majority of the pinyon pine and juniper associations found at ZION. Due to the similar growth patterns and hybridizing between the two pine species it was impossible to sort *Pinus monophylla* from *P. edulis* on the aerial photos. Throughout most of the Park, this map class intermingles and can be confused with similar ponderosa pine map classes, especially if the ponderosa trees are small and grow at the same height as the pinyon pines and junipers. Both pinyon-juniper and ponderosa pine map classes can share the same understory species.

58 *Pinus spp. - Juniperus spp. / Quercus gambelii* Woodland Complex
Pinyon - Juniper / Gamble Oak Woodland Complex

Associations:
-Juniperus scopulorum - Quercus gambelii Woodland
-Pinus edulis - Juniperus spp. / Quercus gambelii Woodland

Common species:
Juniperus osteosperma
Pinus edulis
Amelanchier utahensis
Arctostaphylos patula
Cercocarpus montanus
Quercus gambelii
Poa fendleriana

Project Specifics:
Frequency = 1,875 total polygons
1,084 polygons ZION, 791 polygons Environs
Area = 14,786 total acres
7,112 acres ZION, 7,674 acres Environs
Average Size = 8 acres

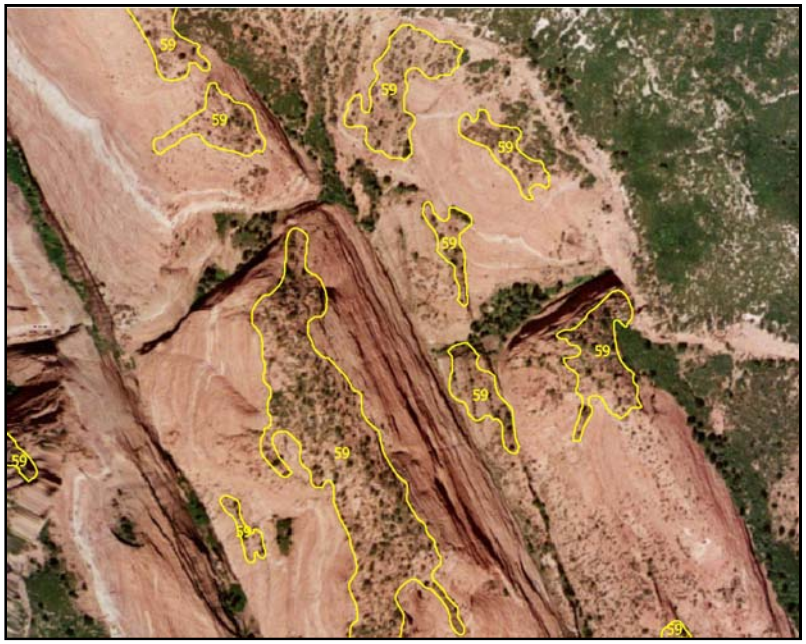
Photo Signature Example

Description:
This is a fairly common map unit at ZION representing situations were pinyon-juniper woodlands have substantial cover of gambel oak in the understory. Most stands are fairly large and occur on flat to moderately steep slopes of mesas and across large plateaus. The aspects of these slopes are generally eastern to southern, and occasionally western. When the amount of pinyon-juniper is low this type may be confused with other gambel oak map classes and when gambel oak is reduced it may appear as other pinyon-juniper woodlands.

Ground Photos

59 *Pinus ponderosa* Slickrock Sparse Vegetation
Ponderosa Pine Slickrock Sparse Vegetation

Photo Signature Example



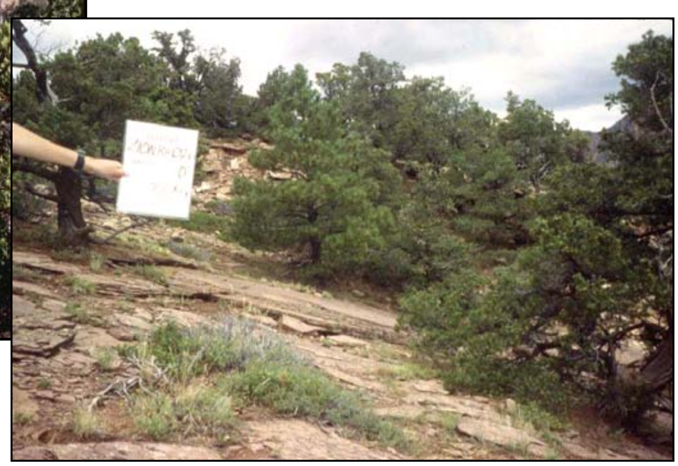
Association:
-*Pinus ponderosa* Slickrock Sparse Vegetation

Common species:
Pinus ponderosa
Pinus monophylla
Amelanchier utahensis
Arctostaphylos patula
Cercocarpus intricatus
Aristida purpurea
Poa fendleriana
Sporobolus cryptandrus
Comandra umbellate
Heterotheca villosa
Phlox austromontana
Stephanomeria spp.

Project Specifics:
Frequency = 816 total polygons
746 polygons ZION, 70 polygons Environs
Area = 5,726 total acres
4,922 acres ZION, 804 acres Environs
Average Size = 7 acres

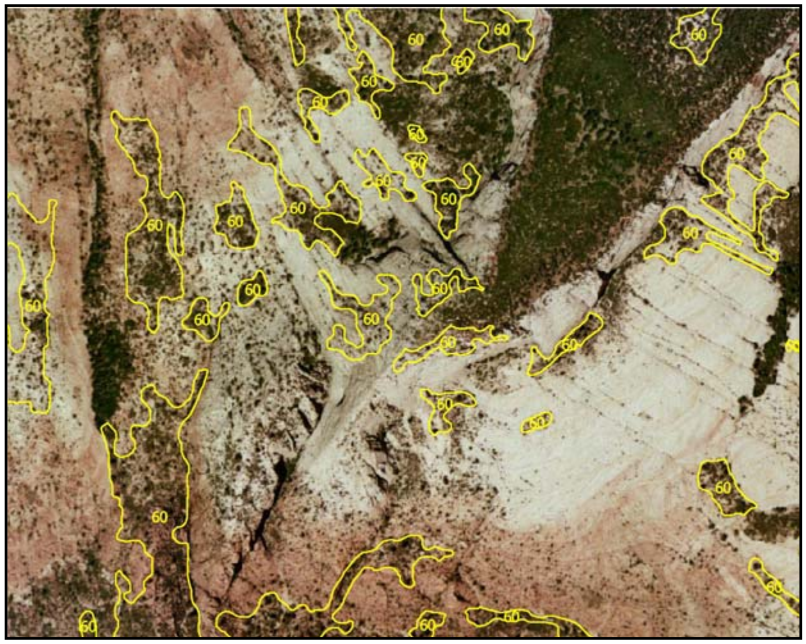
Description:
This association occurs on steep Navajo sandstone slopes above 6000 feet elevation. Sandy soils accumulate in rock crevices to support opportunistic vegetation. There is high cover of exposed bedrock with occasional manzanita and mountain mahogany shrubs. This map class is usually in close proximity to the barren Navajo map class and if the ponderosa pine is extremely low in cover may be confused with other slickrock sparse shrub types. In some areas with shadows and/or poor light this map class may appear very similar on aerial photos to the *Pinus ponderosa / Arctostaphylos patula* Woodland class.

Ground Photos



60 *Pinus ponderosa / Arctostaphylos patula* Woodland
Ponderosa Pine / Greenleaf Manzanita Woodland

Photo Signature Example



Association:
-Pinus ponderosa / Arctostaphylos patula Woodland

Common species:
Juniperus osteosperma
Pinus edulis, Pinus ponderosa
Amelanchier utahensis
Arctostaphylos patula
Cercocarpus montanus
Purshia tridentate
Quercus gambelii
Quercus turbinella

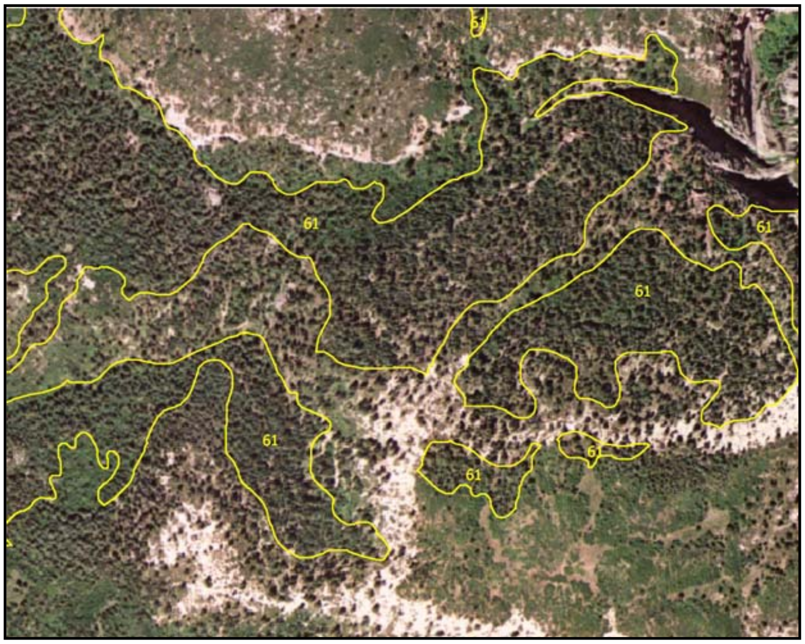
Project Specifics:
Frequency = 2,434 total polygons
1,979 polygons ZION, 455 polygons Environs
Area = 21,531 total acres
15,744 acres ZION, 5,787 acres Environs
Average Size = 9 acres

Description:
This map class is widespread throughout ZION occurring on gentle to moderate slopes of various aspects at elevations between 5600 and 8000 feet. It is found on high mesa tops, plateaus and Navajo sandstone formation benches and basins. The photo signature for this class is distinct due to the open canopy of the ponderosa pine trees and the olive-green color of the manzanita. This type may intermingle with other manzanita and sparse shrub types common on slickrock and Navajo sandstone formations.

Ground Photos

61 *Pinus ponderosa / Quercus gambelii* Woodland Complex
Ponderosa Pine / Gambel Oak Woodland Complex

Photo Signature Example



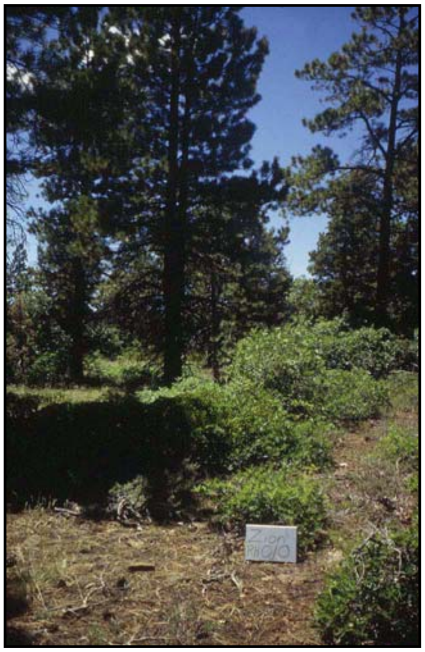
Associations:
-Pinus ponderosa / Quercus gambelii Woodland
-Pinus ponderosa / Pteridium aquilinum Woodland [Provisional]

Common species:
Juniperus scopulorum
Pinus ponderosa
Arctostaphylos patula
Quercus gambelii
Pteridium aquilinum

Project Specifics:
Frequency = 2,185 total polygons
1,730 polygons ZION, 455 polygons Environs
Area = 12,438 total acres
8,763 acres ZION, 3,675 acres Environs
Average Size = 6 acres

Description:
This is a widespread woodland type at ZION. The vast majority of this type represents *Pinus ponderosa / Quercus gambelii* Woodland association with a prominent gambel oak understory that appears bright green on the aerial photos. In some limited situations a dense understory of bracken fern gives the same aerial photo signature. This occurs primarily across the Pine Valley and Pocket Mesa areas. This class is rather unique and usually occurs adjacent to other gambel oak types.

Ground Photos



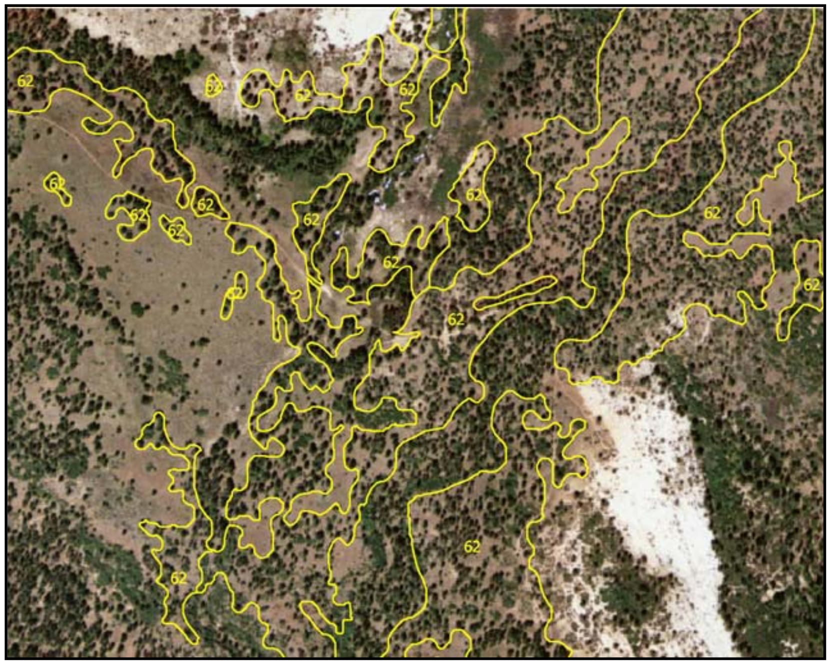
62 *Pinus ponderosa* / Mixed Herbaceous Woodland Complex
Ponderosa Pine / Mixed Herbaceous Woodland Complex

Associations:
-Pinus ponderosa / Bromus inermis Semi-natural Woodland
-Pinus ponderosa / Artemisia nova Woodland

Common species:
Pinus ponderosa
Quercus gambelii
Artemisia nova
Carex rossii
Elymus elymoides
Poa secunda
Bromus inermis
Heterotheca villosa
Lupinus argenteus
Lotus utahensis
Achillea millefolium

Project Specifics:
Frequency = 177 total polygons
113 polygons ZION, 64 polygons Environs
Area = 926 total acres
608 acres ZION, 317 acres Environs
Average Size = 5 acres

Photo Signature Example



Description:
This map class is fairly rare in the project area but can be locally abundant in recently burned or disturbed areas. *Pinus ponderosa* dominates this association with rather low cover (10-30%). The understory on the aerial photos appears devoid of shrubs although when *Artemisia nova* is over 20% cover it may appear slightly gray. The understory is usually evenly distributed in the stand. Specifically in Corral Hollow the spring snowmelt provides seasonally saturated soils that favor *Bromus inermis* and *Poa pratensis*.

Ground Photos

Coniferous Forests

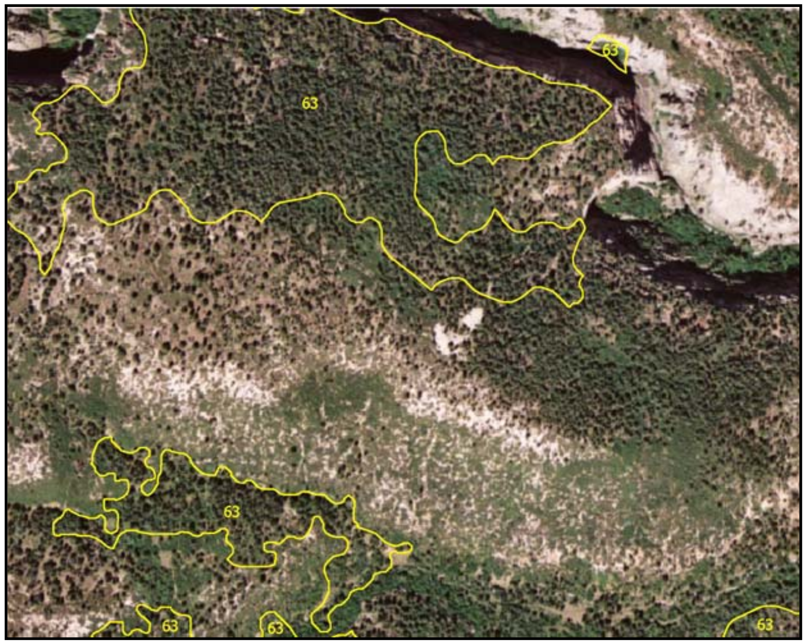
63 *Pinus ponderosa* Forest (Closed Canopy)
Ponderosa Pine Forest (Closed Canopy)

Associations:
(none; map class cannot be classified to the association level)

Common species:
Pinus ponderosa

Project Specifics:
Frequency = 43 total polygons
26 polygons ZION, 17 polygons Environs
Area = 628 total acres
242 acres ZION, 386 acres Environs
Average Size = 15 acres

Photo Signature Example

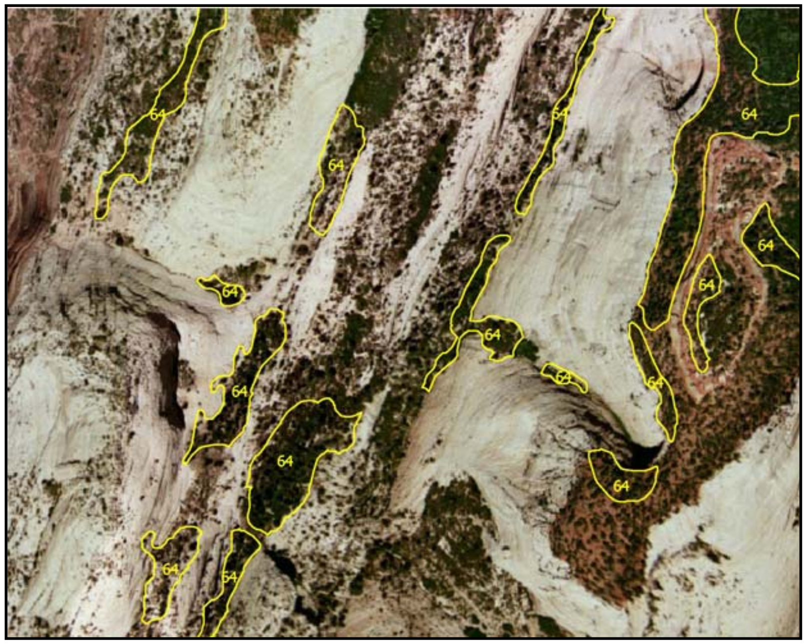


Description:
This map class is fairly rare at ZION and occurs mainly on well developed soils in remote areas of the Park. In these situations the pine trees grow close together forming thick, dog-hair stands. Since the canopy is tight, understory species can not be determined from the aerial photos. On the ground, the understory is also usually sparse or absent. Often a thick layer of needles is present. This map class may be similar to other thick ponderosa pine types.

Ground Photos

64 *Pseudotsuga menziesii* Forest Alliance
Douglas-fir Forest Alliance

Photo Signature Example



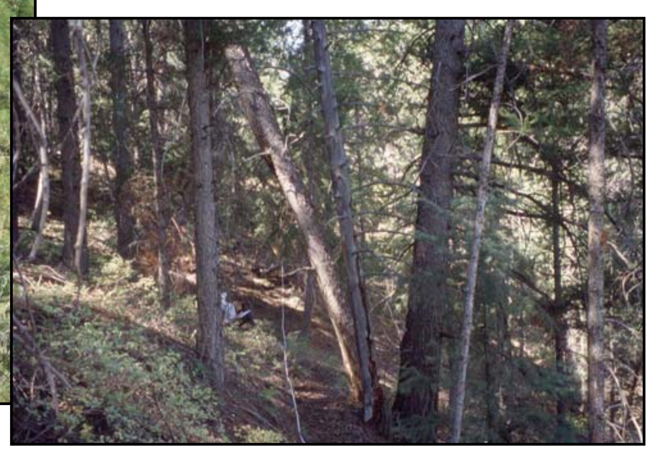
Associations:
-Pseudotsuga menziesii / Quercus gambelii Forest
-Pseudotsuga menziesii / Symphoricarpos oreophilus Forest
-Pseudotsuga menziesii / Acer grandidentatum Forest

Common species:
Pseudotsuga menziesii
Acer grandidentatum
Quercus gambelii
Mahonia repens
Paxistima myrsinites
Maianthemum stellatum
Thalictrum fendleri
Pinus ponderosa
Amelanchier utahensis
Symphoricarpos oreophilus

Project Specifics:
Frequency = 600 total polygons
552 polygons ZION, 48 polygons Environs
Area = 1,849 total acres
1,718 acres ZION, 131 acres Environs
Average Size = 3 acres

Description:
This map class is dominated by mature *Pseudotsuga menziesii* common in moist valleys, ravines and slot canyons. Occasional stands may also exist in cool floodplains and on elevated canyon shelves and ridges. *Pinus ponderosa* and/or *Abies concolor* are occasionally present and may replace *Pseudotsuga menziesii* as the local dominant. The indicator shrub *Symphoricarpos oreophilus* is at least present, but with insignificant cover. *Amelanchier utahensis* is usually present in the shrub layer. Herbaceous species are diverse and contribute minimal cover. Mature *Juniperus scopulorum* and *Quercus gambelii* may also be present or represented in the subcanopy by young trees and seedlings. This class is easily confused with the *Abies concolor* Forest Alliance due to the similar growth habits of the dominant conifers.

Ground Photos



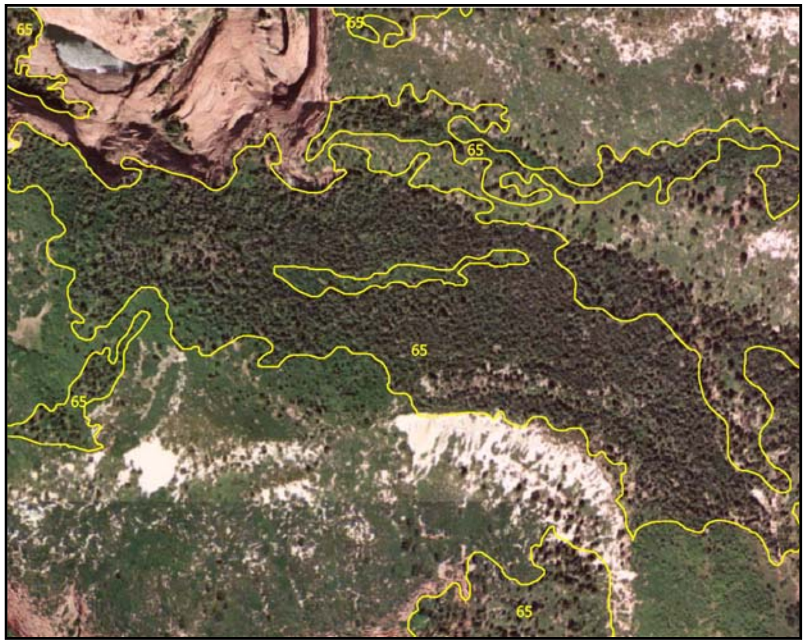
65 *Abies concolor* Forest Alliance
White Fir Forest Alliance

Photo Signature Example

Associations:
-*Abies concolor / Acer grandidentatum*
-*Abies concolor / Quercus gambelii* Forest
-*Abies concolor / Symphoricarpos oreophilus* Forest

Common species:
Abies concolor
Pseudotsuga menziesii
Acer grandidentatum
Quercus gambelii.
Pinus strobiformis,
Pinus ponderosa
Juniper spp.
Amelanchier alnifolius,
Symphoricarpos oreophilus,
Populus tremuloides

Project Specifics:
Frequency = 451 total polygons
290 polygons ZION, 161 polygons Environs
Area = 5,194 total acres
2,333 acres ZION, 2,861 acres Environs
Average Size = 12 acres



Description:
This map class is widespread at ZION and occurs in two distinct habitats. In cool, wet canyons it appears as linear patches, often replacing Douglas fir as the dominant. Throughout the higher elevations this type occurs on cool, dry middle and lower slopes and on all aspects except south and southwestern. Stands transition to the Pinus *ponderosa / Quercus gambelii* Forest in dryer sites. Large stands in the Northwest intermingle with *Populus tremuloides*.

Ground Photos