Vegetation Sampling and Mapping – Doyle-Loyalton Study Area Report

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Cover Photo (by Brian Kreb): Taken from the Diamond Mountains looking north toward Susanville, showing an assortment of wildflowers including: *Agastache, Monardella, Veratrum, Mertensia*, *Lupinus*, and *Penstemon* with *Abies concolor* in the background.

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A special thank you to the Department of Fish and Wildlife's Vegetation Classification and Mapping Program (VegCAMP) team, who assisted in surveying, classification, and scoring of the map's accuracy assessment. We would also like to thank all of the major land holders who permitted us to access their land holdings including: United States Bureau of Land Management, California Department of Fish and Wildlife, California State Lands Commission, United States Forest Service, The Nature Conservancy, California Department of Parks and Recreation, California State Parks, United States Army Corps of Engineers, and Sierra Pacific Industries.

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Contents

Abstract

The purpose of this project was to collect vegetation surveys to contribute to the state-wide vegetation classification and to create a comprehensive digital map of vegetation communities within the Doyle and Loyalton deer herds ranges. Creation of this map has multiple purposes, including but not limited to the following: assisting land managers in decision making, fire and fuel management, protecting endangered species and habitats, protecting cultural and natural resources, habitat connectivity, habitat restoration, conservation prioritization, and informed development. This map is part of the greater collaborative effort to create a comprehensive vegetation map for all of California. This project resulted in the collection of 434 Rapid Assessment and Releve vegetation surveys. The completed map covers a surface area of 1,598,627 acres and has a total of 80,592 polygons with 107 mapping units.

Introduction

The Geographical Information Center (GIC) was contracted by the California Department of Fish and Wildlife (CDFW) to collect vegetation surveys to contribute to the regional and state-wide vegetation classification, and to create a fine-scale vegetation map following the Survey of California Vegetation (SCV) standards for a study area of 1,598,627 acres from the western edge of Lake Tahoe north to Honey Lake and from the crest of the Sierra Nevada Mountain Range east to the Nevada border (Figure 1). The following ecoregion subsections were used to guide the extent of the study area for this project: Honey Lake Basin, Diamond Mountains - Crystal Peak, Frenchman, Sierra Valley, and Tahoe - Truckee, with a few inclusions of Nevada ecoregion subsections of Fort Sage Mountains - Lemmon Valley, and the Carson Range (Cleland 2007). This area has been identified by the CDFW Wildlife Branch as a high priority area for assessing habitat and connectivity for the Doyle and Loyalton deer herds (CDFW 2020). A small disjunct portion in the Pit River Valley subsection was added to the study area to fill in a gap surrounded by a previous mapping effort in Modoc and Lassen counties. The previous mapping in this area was a two-part effort resulting in two datasets that can be downloaded here: https://wildlife.ca.gov/Data/GIS/Vegetation-Data

- Modoc Plateau: Shinn, Likely, and Snowstorm Mountains (CDFW) (zip)
- Modoc Plateau: Devil's Garden, Adin Mountains, Jess Valley (CDFW) (zip)

The vegetation classification used for mapping followed the guidelines set forth by the National Vegetation Classification System (USNVC 2019) and A Manual of California Vegetation (CNPS 2020). The map is generally at the alliance level, yet photo-interpreters attempted to identify the more specific association level when possible. Group levels were utilized when vegetation communities were difficult to determine at the alliance level, such as herbaceous types. The digital map can be found on the Biogeographic Information and Observation System (BIOS) website or by following the link here: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=211201

The scope of this project includes a comprehensive field sampling effort to characterize the vegetation communities within the study area, creation of a digital vegetation map using ERSI software following the SCV standards, vegetation map accuracy assessment surveys, scoring of the accuracy assessment surveys (by CDFW), and a final summary report.

FIGURE 1. DOYLE – LOYALTON STUDY AREA

This figure shows the ecoregion subsections that reside within the study area for this project: Honey Lake Basin, Diamond Mountains - Crystal Peak, Frenchman, Sierra Valley, and Tahoe - Truckee, with a few inclusions of Nevada ecoregion subsections of Fort Sage Mountains - Lemmon Valley, and the Carson Range (Cleland 2007). A small disjunct portion in the Pit River Valley subsection was added to the study area to fill in a gap surrounded by a previous mapping effort in Modoc and Lassen counties. The study area extends from the crest of the Sierra Nevada Mountain Range in the west to the Nevada border in the east, from Susanville and Honey Lake to the north, south to the west shore of Lake Tahoe.

Methods

Sample Allocation

Prior to field sampling, CDFW's Vegetation Classification and Mapping Program (VegCAMP) conducted a sample allocation to direct sampling using a Generalized Random Tessellation Stratified (GRTS) survey design to generate a target sample point allocation using GIS and R software (ESRI 2011, R Core Team 2021). The allocation approach attempted to balance three goals: 1) generate a target number of samples based on workload predictions for staff conducting the field surveys; 2) distribute samples among the vegetation types so that both rare and common types are represented; and 3) facilitate access to sites based on land ownership and proximity to roads or trails. This approach, in combination with manual photo-interpreted sample allocation and subjective identification of stands across a landscape through reconnaissance, maximized efficiencies that enabled more samples to be collected while also increasing the diversity of vegetation types sampled.

The GRTS survey design used the Calveg vegetation dataset (Calveg 2002) and the National Wetlands Inventory (NWI) (USFWS 2016) dataset to stratify the allocation of sample target points. Footprints of fires since the year 2000 from the CalFire dataset (FRAP 2019) were used to further constrain the allocation so that proportionally fewer points were allocated in recently burned areas. The allocation area was bounded within 500m of roads (some digitized) that occurred within parcels found in the 2018 California Protected Areas Database (CPAD) – www.calands.org (2019). Stratification was based on unique cover type combinations between CalVeg, NWI, and CalFire layers across the study area. The GRTS module in the R statistical package (R Core Team 2013) was employed to assign 181 target points. Additionally, imagery was used by VegCAMP ecologists to identify unique signatures for a total of 194 additional potential targets for sampling.

The target sample points were used to direct exploration at the allocated point and surrounding area for homogeneous stands of vegetation to sample, rather than a fixed sampling location. More than one vegetation type could be sampled in the area surrounding the target sample point if the sampling locations were greater than 1000m apart to control for autocorrelation. More than one type could be sampled in closer proximity to each other if they were distinctly different stands, such as a riparian shub stand versus an upland herbaceous stand. Field crews carried a list of potentially occurring vegetation types within the study area and kept a running tally of the number of samples collected for each type. This ensured that samples were distributed proportionally across all types and that as many types as possible were sampled.

Field Sampling

The initial field data collection strategy was designed to capture all of the existing vegetation communities that reside within the study area. The rugged rocky terrain, dense vegetation, slick clay soils, lost car keys, and decommissioned and washed out roads made for an adventurous but ultimately successful field season.

From June 3, 2019 to September 6, 2019, three GIC crews consisting of two people each collected vegetation surveys using the CNPS-CDFW Combined Vegetation Rapid Assessment and Relevé protocol for sampling. The field form and protocol can be found in Appendices C and D. For each survey, collected data include: location, date, surveyors, coordinates in UTMs, stand size, aspect, gradient, topography, geology, soil texture, surface substrate covers, bioturbation presence, fire evidence, disturbance codes (including evidence of grazing or off-road vehicles), tree average diameter at breast height, shrub height, herb height, field alliance, and species list. The site history, stand age, and any other pertinent information about the stand and its surroundings were also recorded in a comments section. Photos were taken in the four cardinal directions in the following order: North, East, South, and West. Additional photos were taken if the original four photos did not adequately capture the stand's vegetation. All photos were sorted by survey ID and archived with CDFW.

Once finalized, the field forms were scanned and then bookmarked in PDF format in Adobe Acrobat Pro. Field data were entered into a geospatially referenced Access database that was provided by CDFW. The database was checked for quality assurance by both the GIC and CDFW. The data was utilized by VegCAMP to create the classification and key to guide the mapping process.

Survey Equipment

Three crews of two utilized four-wheel drive vehicles to complete the field surveys, which were essential to navigate the rugged terrain of the study area. Three Dell Toughbooks (rugged laptops) with built-in GPS were used to collect/record field data and survey point locations. Rapid assessment and relevé data were more thoroughly recorded on "Rite in the Rain" paper and later scanned to digital format in the office. Bushnell rangefinders were used to estimate and record tree heights. Garmin compasses were used to record aspect and gradient. Small shovels were used for collecting soil samples. Photos were taken on either a Sony Cybershot camera or an iPhone. Some crews used the Theodolite application which allowed for labeling pictures in the field and also contains other labeled attributes such as coordinates, bearing, and elevation (precision was variable depending on cell service range). Shovels, fire extinguishers, water jugs, first aid kits, air compressors, and Garmin InReach GPS trackers were carried for safety purposes. Plant presses were used to preserve sample specimens. The Jepson Manual (Hickman, J. C., & Jepson, W. L. 2012) and Vern Oswald's Selected Plants of Northern California and Adjacent Nevada (Oswald, V. H., Janeway L. 2013) were used to identify and confirm the species of plant samples collected. *Note*: the same surveying equipment was utilized for the accuracy assessment surveys.

Mapping Classification

Along with pre-existing data for the project area, vegetation survey data were utilized by VegCAMP to create a vegetation classification for the project area, including corresponding descriptions and a field key to the alliance and associations (Ratchford et al. 2023). The

classification is based on the hierarchical National Vegetation Classification System (USNVC 2019). The hierarchical structure can be seen in Table 1. Refer to Appendix F for the floristic vegetation key.The classification report does not provide descriptions at the group level. Group level descriptions can be found using NatureServe Explorer (NatureServe 2022).

GIC photo-interpreters determined which types and which levels of the floristic classification could be mapped to develop a mapping classification of potential mapping units. Mapping units are primarily alliance level. When possible, photo-interpreters attempted to identify the more specific association level. Tree and shrub types are typically easier to identify on imagery and can be correctly interpreted at the alliance and association levels. However, some vegetation types are more difficult to photo-interpret to association or alliance level and are therefore mapped to the group level. Herbaceous types often are mapped at group level due to the challenge of differentiating and interpreting them correctly from imagery. Macrogroup level was utilized only for rock outcroppings. The mapping classification also contains non-vegetated mapping units that are not in the floristic classification. The mapping classification can be found in Table 3.

Table 1 shows the hierarchical structure for vegetation classification following the USNVC. The structure ranges from Formation Class at the most general level to Association, which is the most detailed level of the hierarchy.

TABLE 1. HIERARCHY STRUCTURE

Hierarchy Structure:
1. Formation Class
2. Formation Subclass
3. Formation
4. Division
5. Macrogroup
6. Group
7. Alliance
8. Association

Mapping

Trained GIC biologists/vegetation ecologists used manual photo interpretation (heads-up digitizing) of National Aerial Inventory Program (NAIP) imagery to determine delineation and attribution of vegetation stands to create a wall-to-wall vegetation map of the study area. Digitizing was done at an average scale of 1:2000. Both 2018 NAIP natural color and infrared imagery from the following counties were utilized for photo interpretation: Modoc, Lassen, Plumas, Sierra, Nevada, and Placer. Google Earth imagery was also heavily used as ancillary information to inform the photo interpretation process. Example imagery (photo signatures) for each mapping unit used in the map can be found in Appendix E. Field survey-point data were also utilized by the photo-interpreters for baseline known signatures to guide linework and

attribution. Slope, aspect, and hydrology all influence vegetation distribution and were considered while mapping. Survey data and field photos also assisted the photo-interpreters in their decision-making process. Mapping was completed in ESRI's ArcMap 10.8.1 using a file geodatabase for data storage.

Minimum Mapping Units

Minimum polygon size or minimum mapping unit (MMU) is important to consider when creating a map. Determining the MMU for a project can be influenced by time and budget constraints, the purpose of the map, and the clarity of the imagery. Also, the vegetation type itself can influence the MMU for a given type. For example, stands of special significance may have a smaller MMU.

- 1 acre for woody and herbaceous upland stands
- 0.25 acres for wetland and riparian
- No MMU for polygons on the border of the mapping boundary
- 1 acre for agriculture and urban
- 1 acre for water (with the exception of small earthen dams, which went down to .25 acres)
- Minimum width of linear polygons was generally 10 meters; exceptions were made for connecting two like polygons over a short distance

Vegetation Cover

Vegetation cover was estimated using a birds-eye view perspective, looking straight down on the vegetation, considering porosity (light passing through the canopy). Cover of trees and shrubs was estimated as whole integers, while herbaceous vegetation cover was estimated using the following cover class categories: <2%, 2-9%, 10-39%, 40-59%, >60%. When the overstory layer(s) were 40% absolute cover or greater, estimates of the understory were unreliable and therefore not given. Absolute percent cover - the actual percentage of ground covered by a vertical structure, taking into account porosity of the vegetation - was assigned to each strata layer. Vegetation porosity varies from species to species and community to community depending on multiple environmental factors; a combination of field data, imagery, and calibration between photo-interpreters were all utilized to guide photo-interpreters to determine absolute cover values.

Cover Class and Height Code Breaks

Adjacent polygons of the same vegetation type (typically alliance level) were separated if the overstory had a break in cover class and each polygon was at least 3 acres, or if the understory had a break in cover class and each polygon was at least 5 acres. The Braun-Blanquet cover classes (1932) used are as follows:

<1%, 1-5%, 6-15%, 16-25%, 26-50%, 51-75%, >75%

Adjacent polygons of the same alliance were also broken at 3 acres each when there was a change in the modal height of the overstory layer. Height classes are as follows:

<½ meter, ½-1 m, 1-2 m, 2-5 m, 5-10 m, 10-15 m, 15-20 m, 20-35 m, 35-50 m, >50 m

Map Attributes and Associated Rules

This portion of the report covers definitions of group, alliance, and association level; it also defines trees, shrubs and herbs and the associated values necessary to determine each type.

Group: The sixth level in the natural vegetation hierarchy, in which each vegetation unit is defined by a group of plant communities with a common set of growth forms and diagnostic species or taxa (including several characteristic species of the dominant growth forms), preferentially sharing a similar set of regional edaphic, topographic, and disturbance factors. (Jennings et al. 2006, FGDC 2008) This is the level in which most herbaceous types were mapped.

Alliance: A classification unit of vegetation containing one or more associations and defined by one or more diagnostic species, often of high cover, in the uppermost layer or the layer with the highest canopy cover. Alliances reflect the general form or appearance of the landscape as well as regional to sub-regional climates, substrates, hydrology, and disturbance regimes (Jennings et al. 2006, FGDC 2008). An alliance was assigned to each polygon and was the target classification level for this map. Group level (one level up in the hierarchy) was utilized when alliance level was not achievable.

Association: A classification unit of vegetation containing diagnostic species, usually from multiple growth forms or layers, which have similar composition that reflects topo-edaphic climate, substrates, hydrology, and disturbance regimes (Jennings et al. 2006, FGDC 2008). Association level was attempted, but not required, when photo-interpreters were confident to map to this level. The accuracy assessment (AA) showed that it is very challenging to map to this detail and several scores were below 80% accuracy.

Tree: A woody plant that generally has a single main stem and a more or less definite crown. In instances where growth form cannot be determined, woody plants equal to or greater than 5 m in height at maturity shall be considered trees (adapted from Federal Geographic Data Committee 1997). Tree stands must have at least 5% absolute cover of tree species to be determined a tree stand. An exception was made for mature juniper stands in rocky areas with young juniper recruitment, which could be a tree stand at 3% cover (from vegetation key, Appendix F). Percent of estimated absolute **tree cover** was entered as a real number for conifer and hardwoods and "0.2" was entered when tree cover was present but at <1%. Percent tree was entered as 333 for the non-vegetation mapping units: acriculture, urban, water impound features, and irrigated pastures which are already delineated and categorized to finer levels in other land use layers.

Shrub: A woody plant that generally has two to several stems from its base, giving it a broad crown, and is usually below 5 m in height. Includes dwarf shrubs and low or short woody vines (adapted from Federal Geographic Data Committee 1997). Shrub stands must have less than 5% tree cover and shrub cover must be >2% and evenly distributed. Riparian stands required 10% shrub cover to be determined a shrub stand. **Shrub cover** was recorded when tree cover was <40% and was entered as a real number for estimated absolute cover; "0.2" was entered when

shrub cover was present but at <1%. Percent shrub was entered as 333 for the non-vegetation mapping units: acriculture, urban, water impound features, and irrigated pastures which are already delineated and categorized to finer levels in other land use layers.

Herbaceous cover was estimated when total tree and shrub cover was <40% and recorded in the following classes:

<2%, 2-9%, 10-40%, >40% woody, >40%

Isolated tree was given a "Y" (yes) when tree cover was present but at less than 5% cover in the polygon.

Juniper Expansion was recorded to show the presence and cover of young junipers with less than 6 inches diameter at breast height. The cover categories are as follows:

None visible, .2-1%, 1-4%, and >4%

Clearing Disturbance was recorded based on the percentage of the polygon affected by noticeable clearing, scraping, or other obvious anthropogenic disturbance (other than buildings) and was recorded as follows:

None visible, Low <33%, Moderate 33-66%, High >66%

Roadedness was recorded based on the percentage of the polygon affected by roads fragmenting the polygon as follows:

None visible, Low (>66% is roadless), Moderate (33-66% is roadless), High (<33% is roadless)

Restoration was recorded when it was obvious to the photo-interpreter that restoration had occurred. The most obvious categories utilized were for juniper removal projects and thinning of pine and juniper. Juniper removal projects are implemented primarily to restore groundwater to areas where juniper has expanded due to fire suppression. All restoration categories are as follows:

None obvious, *Juniperus occidentalis* removal, grass/forb seeding, shrub/tree planting, thinning pine/juniper, other (see comments)

Development was recorded as a percentage of the polygon affected when it was obvious to the photo-interpreter that anthropogenic development was present in a polygon and was recorded as follows:

None visible, Low (<2%, scattered), Moderate (2-5%, multiple examples), High (>5%, multiple examples and evenly distributed)

Invasive species were recorded when it was obvious to the photo-interpreter that invasive species were present. Relative cover was used to determine the percentage of invasive species present. Relative cover always totals 100%, even when absolute cover is low, and is a measure of the cover of a species in relation to that of other species within a set area or sample of vegetation. Invasive species were calculated across all strata layers and were recorded as follows:

None obvious, Visible patches (<33%), Significant cover (33-66%), Stand characterized by exotics (>66%)

Comments are notes from the photo-interpreter pertinent to an individual polygon.

Further information describing attributes used can be found in the metadata of the map.

For more details, see Survey of California Vegetation Classification and Mapping Standards at:

https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=102342&inline

Non-vegetation Mapping Unit Descriptions

Several non-vegetation mapping units were utilized in this mapping effort and are described below:

Agriculture (within the current 5-year cycle) Mapping Unit: areas where the photo-interpreter could clearly determine from NAIP and/or Google Earth imagery that the land was currently agriculture or had been used for agriculture within the five years prior to the NAIP imagery

Alpine Permanent Snow Field/Glacier Mapping Unit: areas where snow, ice or glacier was remaining year-round as far as the photo-interpreter could tell.

Anthropogenic Areas of Little or No Vegetation Mapping Unit: ground is barren or nearly barren of vegetation and is the result of man-made disturbances such as plowing, disking, scraping, or mining.

Built-up & Urban Disturbance Mapping Unit: urban and semi-urban settings where dwellings and anthropogenic disturbance presence is visible.

Columbia Plateau Cliff, Scree and Rock Mapping Unit: rocky areas where there was little to no vegetation present, often in talus piles. It has a dark brown to black signature which is representative of the basalt volcanic rock. This mapping unit was utilized for Great Basin areas north of the Diamond Mountain Range found just south of Susanville.

Irrigated Pastures Mapping Unit: areas are typically wet late into the summer months and show signs of irrigation piping or canals. Livestock and grazing trails are typically present.

Non-woody Row and Field Agriculture Mapping Unit: agriculture areas where the photo-interpreter could determine that the crop type was non-woody, which was typically the case in the study area. *Note*: When quantifying agriculture for this project, both this mapping unit and *Agriculture (within the past 5-year cycle*) were used.

Perennial Stream Channel (Open Water) Mapping Unit: rivers and creeks that flow or retain water year-round.

Planted Trees and Shrubs Mapping Unit: utilized when the photo-interpreter could identify that non-native trees and/or shrubs were planted/present due to human activity. Often found near homes or old homesteads.

Small Earthen-dammed Ponds & Natural Lakes Mapping Unit: includes both natural and man-made dams and lakes of varying shapes and sizes.

Sparsely Vegetated Recently Burned Areas Mapping Unit: areas where there was very recent fire evidence and the photo-interpreters were not able to see enough vegetation to determine

a vegetation type. Dark charred soils were common in these areas. This mapping unit was primarily used in the area of the 2018 Stone Fire.

Water Impound Feature Mapping Unit: This mapping unit was utilized for man-made features designed to hold water, typically bound on all sides by berms and having a rectangular or square form. In this study area, this mapping unit can be found in duck club lands and a wastewater treatment facility.

Western North American Cliff, Scree, & Rock Vegetation Macrogroup: rocky areas where there was little to no vegetation present, often in talus piles. It has a variable signature, from dark brown to black for basalt volcanic rock and a much lighter white to gray for granitic outcrops. This macrogroup was used for the ecoregions that resided within the study area and were outside of the Great Basin Floristic Province.

Western North American Sparsely Vegetated Rivershore Mapping Unit: areas where there was no vegetation or very sparse vegetation along the margins of streams and other water bodies, or in the channels of dried-up seasonal waterways.

Accuracy Assessment

Sample Allocation

To validate the vegetation maps, an accuracy assessment (AA) was performed. To determine the polygons to be accuracy assessed, the mapping polygons were subset, removing those that had been sampled or recently burned at high severity (FRAP 2021, BAER 2021), and limiting the sample space to roadsides where the land use was private or within areas of the California Protected Areas Database. Additionally, the sample space was constrained by an area 750 m from roads using steep slopes as barriers to ensure that polygons could be reasonably accessed. Finally, a stratified random selection of polygons was performed that ensured no two polygons that were within 1000 meters of each other were selected. The final AA allocation contained 1040 polygons.

AA Data Collection

Due to the vast extent of the study area the accuracy assessment was performed over the course of two field seasons – the summers of 2021 and 2022. In 2021, two GIC crews of two people each collected AA surveys from July 12 to August 9. For each AA, field staff visited the allocated polygons without knowing any of the polygon's attributions and determined the vegetation type using the floristic vegetation key (Appendix F). Data was collected using the accuracy assessment field form and protocol provided by VegCAMP (Appendix A and B). The accuracy assessment data collected included the following: surveyors, date, location name, waypoint and polygon ID, GPS name, UTM's, camera name, photos, up to 12 species, notes, map unit, confidence level, record of any linework problems, notes if more than one mapping unit was present per polygon, percent cover per strata, tree height, tree diameter at breast height, invasive species, and percent of polygon viewed. AA data were entered into a

geospatially referenced Access database that was provided by CDFW. The database was checked for quality assurance by both the GIC and CDFW.

Avoiding Bias

In order to avoid any bias in this accuracy assessment process, the photo-interpreter who drew and attributed a polygon could not be the one to assess the polygon in the field. The surveyors were limited to the following layers to assist them in the field: allocations, roads, mapping boundary, and 2018 NAIP imagery. The vegetation map being assessed was not referenced at any time during the survey period.

Note: At the time the map was accuracy assessed the map was at 75% completion, with the remaining 25% completed post accuracy assessment.

AA Scoring Methods

VegCAMP staff reviewed the AA data for each polygon visitied, and removed from consideration those samples that had problems associated with access, vegetation identification, visibility, or significant changes in land use or vegetation since the date of the imagery on which the map was based. If the field crews could not identify the vegetation type based on the field key or incorrectly identified the type, a VegCAMP ecologist assigned the correct type based on the species presence and covers, additional notes taken during the AA survey, and field photos. All field calls were reviewed and a "final call" was recorded in the database.

The scoring process compared the vegetation type assigned to each polygon in the map (i.e., the photo-interpreted map unit attribute) with the “final call” for the polygon. Other attributes (cover, disturbance, height) were not scored, but results were provided to GIC so the photo-interpreters could correct any systematic errors.

A closeness-of-fit, or fuzzy logic, method was used to score each AA, rather than simply denoting if a sample was correct or incorrect (Gopal and Woodcock 1994; Congalton and Green 1999; Foody 2002; Hagen 2003; Metzler and Sader 2005). Each field-verified polygon was scored according to a set of decision rules (Table 2), with a total of five possible points for each polygon. Scores were summed for each vegetation type, then divided by the total possible score and multiplied by 100 for a percent accuracy. The scores and reviewers’ notes were provided to GIC so systematic errors could be corrected.

Corrections

Once the accuracy assessment scores were finalized, every polygon that was scored was reviewed by the GIC and necessary corrections were made to the map. All alliances that had a score lower than 80% were reevaluated and changed accordingly by the lead photo-interpreter. Photo-interpreters worked their way outward from the known points that were incorrect, looking for similar polygons that needed correcting in the same manner.

TABLE 2. ACCURACY ASSESSMENT SCORING RULES

Reason Code	Score	Explanation
A	5	Photo interpreter completely correct
B	4	Correct Group OR next level up in hierarchy
C	4	Based on close ecological similarity
D	3	Correct Macro Group OR next level up in hierarchy
E	3	Overlapping cover of significant and similar species
F	2	Correct Division
G	2	Correct at Lifeform and some floristic/hydrologic similarity
H	1	Correct only at Lifeform
I	0	No similarity above Formation and incorrect Lifeform
J	None	Survey removed because significant change in polygon since date of imagery
K	None	Survey removed if represents less than or equal to 10 percent of polygon
L	None	Survey removed because field data is incomplete, inadequate or confusing

Results

Rapid Assessment and Relevé Field Sampling

Once permitted, field sampling was performed on the following properties: United States Bureau of Land Management, California Department of Fish and Wildlife, California State Lands Commission, United States Forest Service, The Nature Conservancy, California Department of Parks and Recreation, California State Parks, United States Army Corps of Engineers, and Sierra Pacific Industries.

GIC staff collected 434 vegetation surveys within the project area during the field season. Of those surveys 111 were herbaceous relevé surveys. Location of the vegetation surveys is displayed in Figure 2. Challenges experienced during data collection included access restrictions due to fire (discussed in more detail later), road closures/locked gates, demolition of roads, and misplaced “no trespassing” signs on public lands.

Of the 434 vegetation surveys, 143 were tree types, 182 were shrub types, and 110 were herbaceous types. We were able to survey at or near 353 of the allocated sample locations and 81 were opportunistic samples. Of the 434 vegetation surveys, 108 were in the Diamond Mountains – Crystal Peak subsection, 25 in the Honey Lake Basin subsection, 75 in the Frenchman subsection, 7 in the Sierra Valley subsection, 21 in the Fort Sage Mountains – Lemmon Valley subsection, 4 in the Carson Range subsection, and 191 in the Tahoe – Truckee subsection, and 2 surveys resided just outside of the study area.

Approximately 930 different plant species, subspecies, and varietals were recorded during this survey effort. Eleven collected plant specimens were pressed and submitted to the Chico State Herbarium for accession. Following are the species submitted: *Alisma triviale, Artemisia arbuscula* ssp. *longiloba* (n=2), *Artemisia spiciformis* (n=2), *Bromus inermis, Calamagrostis canadensis* ssp. *langsdorffii, Carex haydeniana, Carex infirminervia, Carex petasata, Carex*

scopulorum, Carex subfusca, Carex vesicaria, Ivesia sericoleuca, and *Muhlenbergia filiformis.* Seven rare plant species (CNPS 1B, 2B) were identified in our surveys: *Ivesia sericoleuca, Balsamorhiza lanata, Carex davyi, Silene oregana, Astragalus austiniae, Perideridia parishii* ssp. *parishii,* and *Carex petasata*. Seven plants of limited distribution (CNPS 4) were identified during our surveys: *Senecio hydrophiloides, Hesperocyparis bakeri, Carex geyeri, Pedicularis howellii, Eleocharis parvula, Cryptantha glomeriflora,* and *Antennaria pulchella*.

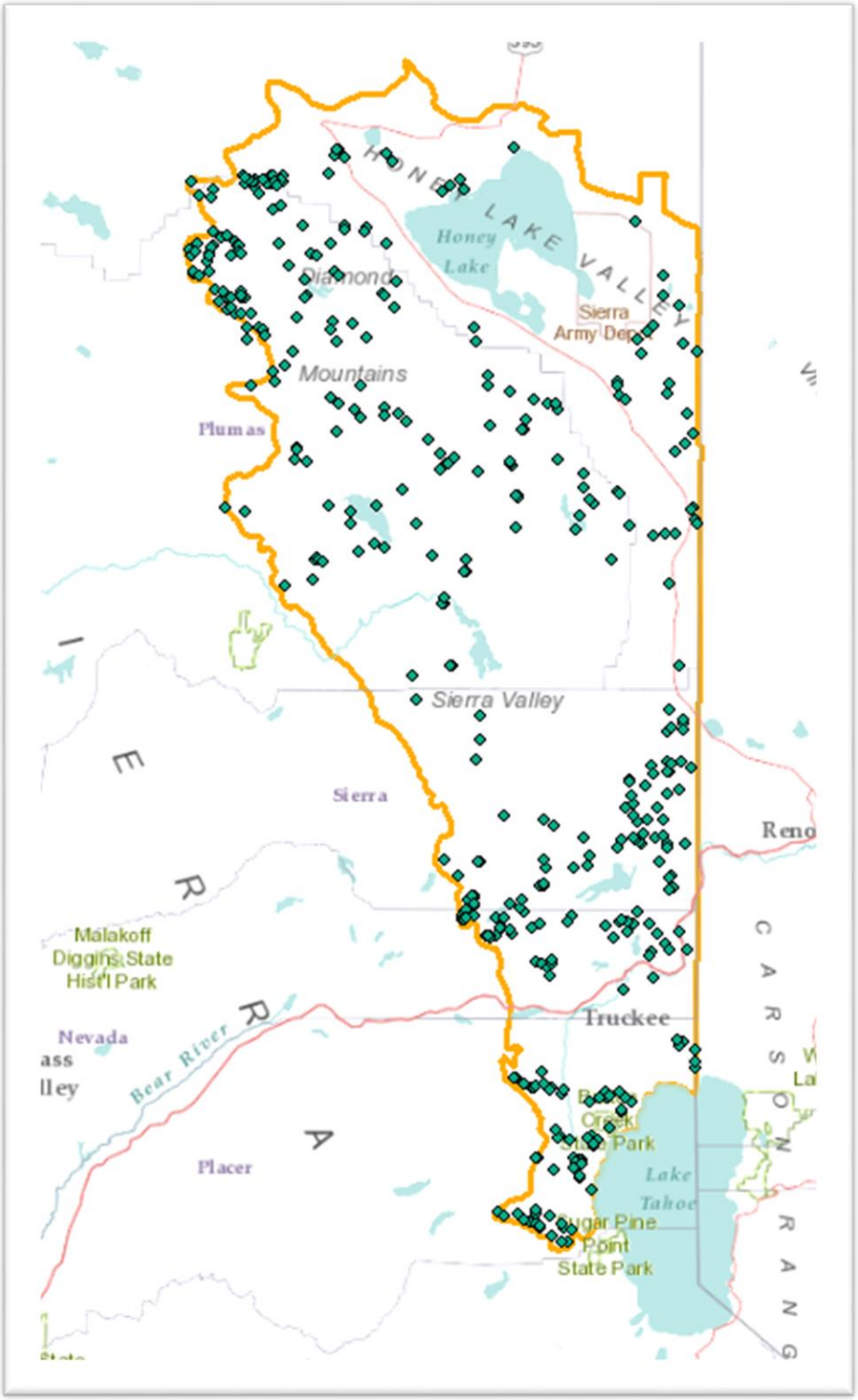


FIGURE 2. RAPID ASSESSMENT AND RELEVÉ SURVEYS

Locations of rapid assessment and relevé surveys collected by the GIC for the classification effort during the summer of 2019.

Mapping

The GIC mapped a total of 1,598,627 acres with a total 80,592 polygons. A total of 107 mapping units were utilized by photo-interpreters which included 58 alliances, 24 associations, 9 groups, 2 macrogroups, and 14 miscellaneous mapping units, all of which are all listed in Table 3.

TABLE 3. SUMMARY OF MAPPING UNITS

Mapping units used including count, average acres, and sum of acres for each unit mapped.

Map Class	Count	Avg Acres	Sum Acres
Abies concolor - Pinus lambertiana Alliance	353	25	8832
Abies concolor - Pseudotsuga menziesii Alliance	65	18	1146
Abies concolor Alliance	2718	20	53638
Abies magnifica Alliance	1931	27	52824
Acer glabrum Alliance	9	2	22
Agriculture (w/in current 5year cycle) Mapping Unit	163	325	52949
Alnus incana Association	1123	3	3391
Alpine Permanent Snowfield/Glacier Mapping Unit	1	4	4
Amelanchier utahensis Association	25	12	288
Anthropogenic Areas of Little or No Vegetation Mapping Unit	127	9	1145
Arctostaphylos nevadensis Association	538	3	1677
Arctostaphylos patula - Arctostaphylos nevadensis Shrubland Alliance	100	9	898
Arctostaphylos patula - Ceanothus velutinus - Ceanothus prostratus Association	1451	14	20938
Arctostaphylos patula Association	1491	10	15328
Arid West Interior Freshwater Marsh Group	95	28	2614
Artemisia arbuscula Alliance	1820	12	22123
Artemisia cana Alliance	716	17	12099
Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Association	1264	25	31626
Artemisia tridentata Alliance	5254	20	104018
Artemisia tridentata ssp. vaseyana Alliance	3836	9	36241
Atriplex canescens Alliance	1	7	7
Atriplex confertifolia Alliance	469	18	8423
Bromus tectorum - Taeniatherum caput-medusae Alliance	1690	15	24892

Built-up and Urban Disturbance Mapping Unit	910	50	45945
Carex utriculata - Calamagrostis canadensis Alliance	7	6	42
Ceanothus cordulatus - Ceanothus integerrimus Shrubland Alliance	35	6	214
Ceanothus cordulatus Association	897	10	9305
Ceanothus cuneatus Alliance	3	7	22
Ceanothus integerrimus Association	28	12	342
Ceanothus velutinus - Prunus emarginata - Artemisia tridentata Association	837	11	9534
Ceanothus velutinus Association	1775	12	22055
Cercocarpus ledifolius Alliance	1724	8	14639
Chrysolepis sempervirens Association	19	2	39
Chrysothamnus viscidiflorus Alliance	134	16	2130
Cistanthe (umbellata) - Gayophytum (diffusum) Alliance	52	4	185
Columbia Plateau Cliff, Scree and Rock Mapping Unit	170	5	807
Cornus sericea - Rosa woodsii - Ribes spp. Alliance	24	3	69
Danthonia californica - Deschampsia cespitosa - Camassia quamash Alliance	6	4	23
Distichlis spicata Alliance	77	29	2206
Elymus cinereus - Elymus triticoides Alliance	84	25	2121
Ephedra viridis Alliance	96	32	3119
Ericameria nauseosa Alliance	870	10	8869
Eriogonum spp. / Poa secunda Alliance	707	4	2744
Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis Alliance	15	13	191
Festuca idahoensis - Pseudoroegneria spicata - Poa secunda Alliance	3305	7	23813
Hesperocyparis bakeri / Arctostaphylos patula Association	4	9	36
Intermountain Semi-Desert Grassland Group	9	5	48
Irrigated Pastures Mapping Unit	77	522	40182
Juncus arcticus (var. balticus, mexicanus) Alliance	31	11	330
Juniperus grandis Alliance	263	8	2181
Juniperus occidentalis - (Pinus jeffreyi - Pinus ponderosa) / Cercocarpus ledifolius Association	935	15	14274

Juniperus occidentalis / (Poa secunda - Festuca idahoensis - Pseudoroegneria spicata) Association	5	7	36
Juniperus occidentalis / Artemisia arbuscula / Poa secunda Association	59	14	854
Juniperus occidentalis / Artemisia tridentata - Purshia tridentata Association	272	18	4935
Juniperus occidentalis Alliance	388	16	6116
Juniperus osteosperma Alliance	227	32	7207
Krascheninnikovia lanata Alliance	13	22	284
Oregon-Washington-British Columbia Vernal Pool Group	378	22	8432
Penstemon newberryi Alliance	15	2	23
Perrenial Stream Channel (Open Water) Mapping Unit	116	10	1106
Phlox covillei - Ericameria discoidea Alliance	2	1	3
Pinus (ponderosa, jeffreyi) - (Ceanothus prostratus - Purshia tridentata) Association	1731	17	28752
Pinus contorta ssp. murrayana Alliance	1624	13	20965
Pinus jeffreyi - Abies concolor Association	3386	30	99937
Pinus jeffreyi Alliance	5460	23	127789
Pinus monticola Alliance	196	11	2209
Pinus ponderosa - Calocedrus decurrens - Pseudotsuga menziesii Alliance	2209	50	109474
Pinus ponderosa / Shrub Understory Alliance	5595	28	156037
Poa secunda - Muhlenbergia richardsonis - Carex douglasii Alliance	50	4	219
Populus tremuloides Alliance	1070	4	4470
Populus trichocarpa Alliance	294	6	1628
Prunus emarginata - Holodiscus discolor Shrubland Alliance	388	5	1885
Prunus emarginata Association	442	5	2089
Prunus virginiana Alliance	77	4	313
Pseudotsuga menziesii Provisional Association	5	16	79
Purshia tridentata - Artemisia tridentata Alliance	3146	20	63068
Quercus chrysolepis (tree) Alliance	49	17	811
Quercus kelloggii Alliance	1040	26	27125
Quercus vacciniifolia - Chrysolepis sempervirens Shrubland Alliance	80	13	1021

Quercus vacciniifolia / Arctostaphylos patula Association	703	5	3854
Quercus vacciniifolia Association	119	5	592
Rocky Mountain-Sierran Alpine Turf and Fell-field Group	340	4	1456
Rocky Mountain Alkaline Fen Group	35	2	70
Salix boothii - Salix geyeriana - Salix lutea Montane Wet Shrubland Alliance	186	3	560
Salix eastwoodiae - Salix lemmonii Alliance	1601	4	6463
Salix exigua Alliance	531	6	3095
Salix lasiolepis Alliance	95	3	283
Salix scouleriana Alliance	980	7	6728
Sarcobatus vermiculatus Intermountain Wet Shrubland Alliance	1523	47	71165
Small-Earthen Dammed Ponds and Natural Lakes Mapping Unit	262	263	68926
Sparsely Vegetated Burn Areas Mapping Unit	21	39	817
Sparsely vegetated playa Mapping Unit	156	14	2156
Symphoricarpos oreophilus Association	192	9	1762
Tamarix spp. Alliance	3	7	20
Tree Developed Vegetation Mapping Unit	82	4	312
Tsuga mertensiana - Pinus monticola Association	83	13	1071
Tsuga mertensiana Alliance	378	16	6112
Vancouverian-Rocky Mountain Montane Wet Meadow and Marsh Group	3281	10	31734
Water Impound Features Mapping Unit	30	29	859
Western North American Cliff, Scree and Rock Vegetation Macrogroup	874	4	3467
Western North American Interior Ruderal Grassland and Shrubland Group	497	45	22163
Western North American Montane Scrub Group	123	9	1163
Western North American Ruderal Marsh, Wet Meadow and Shrubland Group	486	32	15606
Western North American Sparsely Vegetated Rivershore Mapping Unit	113	43	4840
Western North American Temperate Freshwater Aquatic Vegetation Group	20	3	70

Western North American Vernal Pool Macrogroup	28	6	175
Wyethia mollis - Balsamorhiza sagittata Association	1199	5	5650

Accuracy Assessment

Field Sampling

In 2021, GIC collected 118 surveys. CDFW's VegCAMP contributed six surveys for a total of 124 surveys collected in 2021. Unfortunately, extensive smoke and forest closures from the Dixie and Caldor fires put an early end to the 2021 field season. In 2022, GIC collected 526 AA surveys and VegCAMP collected an additional 29 AA surveys. A total of 679 AA surveys were collected across the two seasons. The locations of the accuracy assessment surveys are displayed in Figure 3, and Figure 4 shows the relationship of the accuracy assessment locations to the fire perimeters.

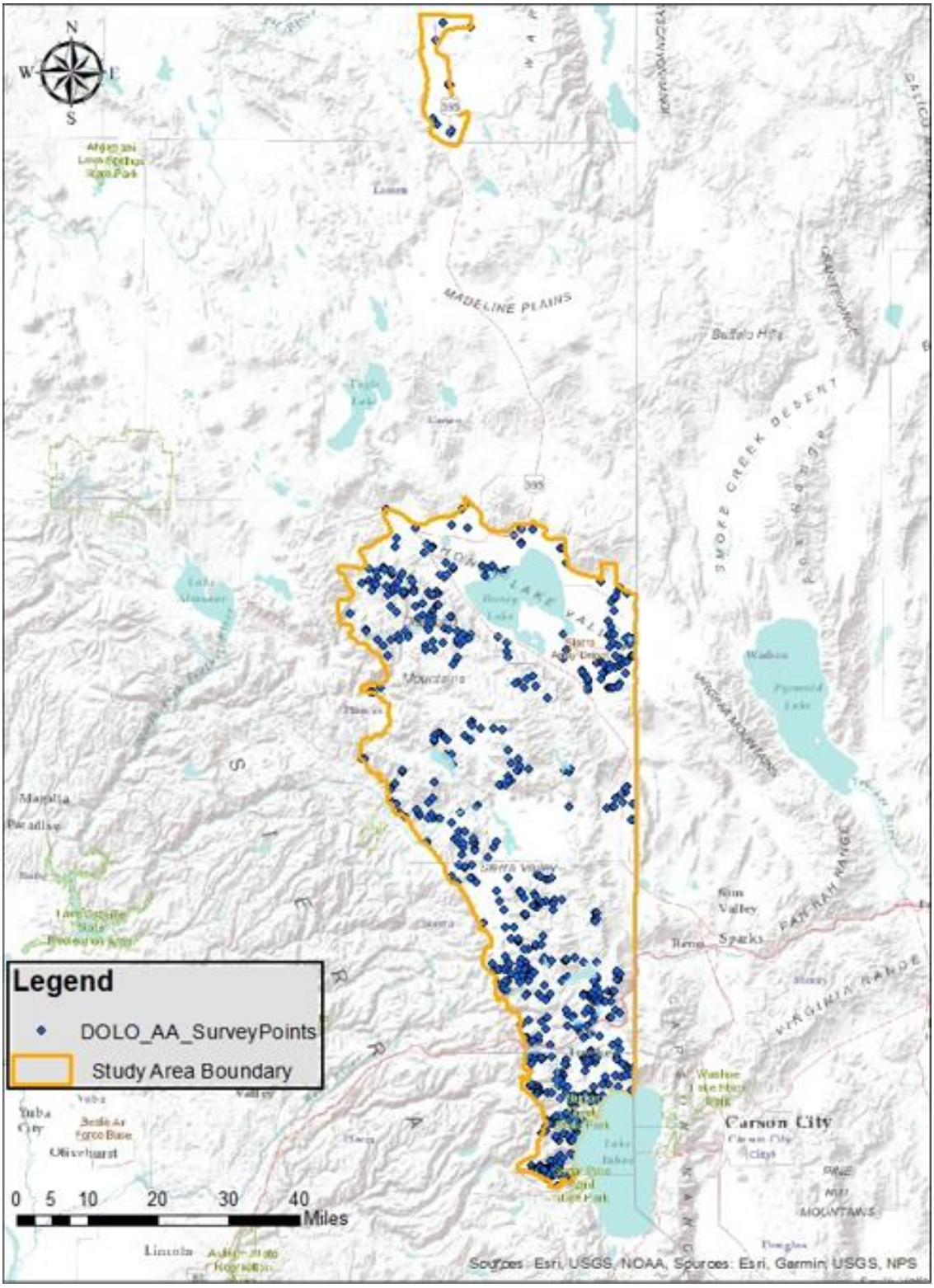


FIGURE 3. ACCURACY ASSESSMENT SURVEY POINTS

Locations of accuracy assessment survey points collected during the summers of 2021-22.

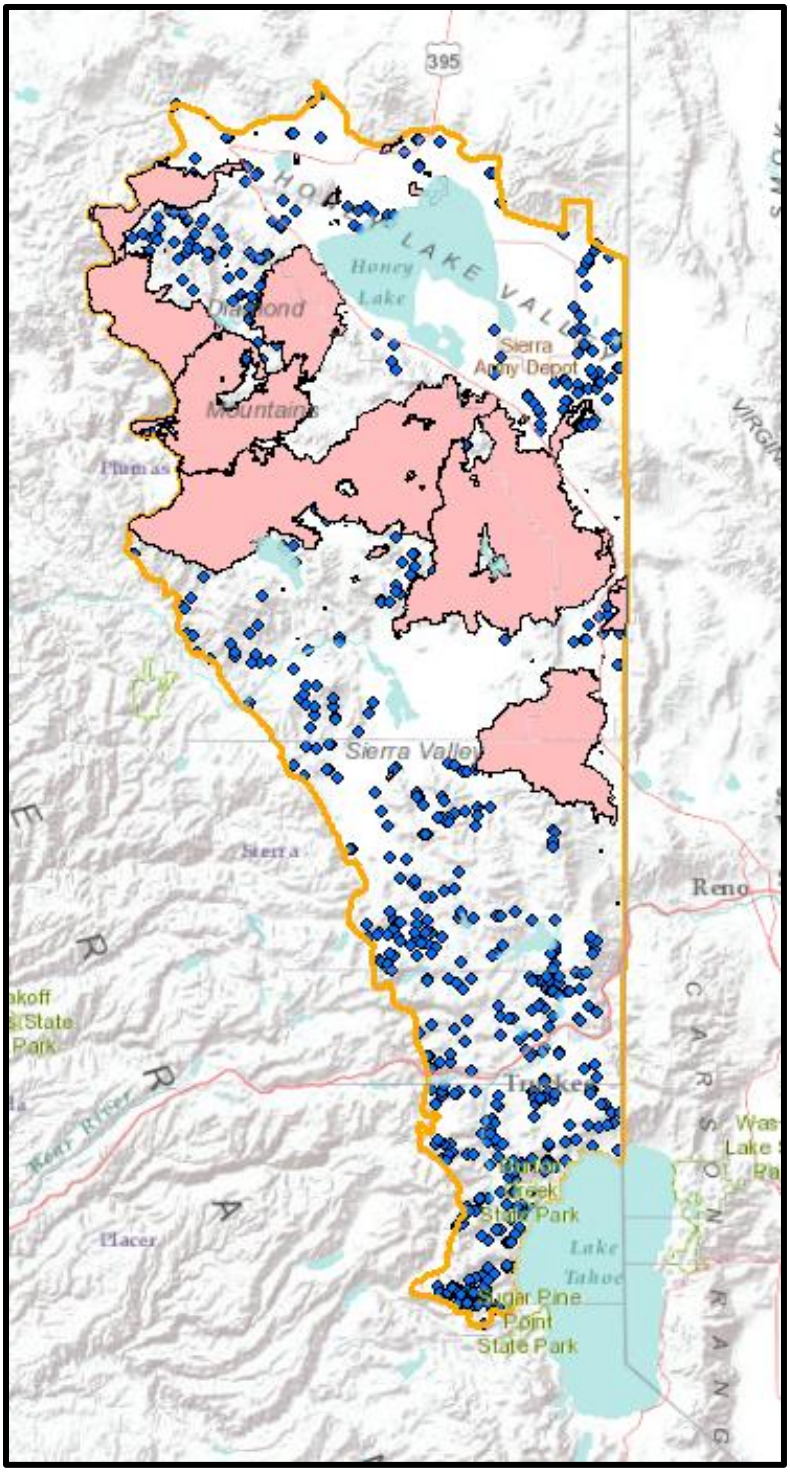


FIGURE 4. ACCURACY ASSESSMENT SURVEY POINTS AND FIRE PERIMETERS

Shows the relationship between the accuracy assessment survey points and the fire perimeters. The fire layer used in this figure was from the National Interagency Fire Center and called the Inter Agency Fire Perimeter History All Years. The Dixie fire was still burning when the layer was last updated and the Dixie fire perimeter was replaced with the final fire perimeter.

Limitations Due to Wildfires

Wildfires can impact vegetation surveying and mapping in a few ways. They can keep us from doing our initial rapid assessment and relevé surveys as well as our accuracy assessment surveys. They can also significantly alter the landscape after we have mapped an area to a particular year in time, such as in this project using 2018 NAIP. This imagery was flown in linear strips over a period of time ranging from July 21 to September 27, 2018. Between this time period and the start of the accuracy assessment in 2022, 524,937 acres of the 1.6 million acres study area burned. This is almost one third of the mapping area that was altered by fire and could not be accuracy assessed. No fires occurred in the disjunct northern portion of the mapping area during this same time period.

AA Scoring

The AA field data was analyzed by CDFW'sVegCAMP to verify the accuracy of the map. Of the 679 AA surveys, 37 were removed from scoring due to significant changes in vegetation since the imagery was taken or an inadequate portion of the polygon that was viewed. The overall Fuzzy Accuracy Assessment of the map is 81.8%. Table 2 provides User's and Producer's accuracy scores for each mapping unit scored. User's accuracy provides an estimate of the commission error, or how well the map data represents what is found on the ground. In other words, when a user goes to a location mapped as a certain type, how likely is it that the vegetation on the ground will be what was mapped. The producer's accuracy provides an estimate of the omission error, or the probability a given mapping unit in the field is mapped as that type. The producer's accuracy may inform the photointerpreters how well a mapping unit can be detected (Story and Congalton 1986, Lea and Curtis 2010).

A contingency table (or confusion matrix) is provided in Table 5. This table displays the field-assessed mapping units for polygons (Final Call) in columns with the photo-interpreted mapping unit in rows. The number in the cells indicates the number of polygons for each combination. Values in the diagonal cells indicate correctly mapped polygons.

TABLE 4. ACCURACY ASSESSMENT SCORES BASED ON FIELD SURVEYS FOR EACH VEGETATION MAPPING UNIT (ARRANGED HIERARCHICALLY)

Map Unit	Producer's Accuracy (%)	Producer's Count	User's Accuracy (%)	User's Count
Quercus kelloggii Alliance	100.00	5	100.00	5
Pinus ponderosa / Shrub Understory Alliance	82.86	14	82.86	14
Populus tremuloides Alliance	92.50	8	72.73	11
Juniperus osteosperma Alliance	93.33	9	88.89	9
Juniperus occidentalis Alliance	82.86	7	100.00	1

Juniperus occidentalis / Artemisia arbuscula / Poa secunda Association	93.33	3	100.00	2
Juniperus occidentalis / Artemisia tridentata - Purshia tridentata Association	90.00	4	90.00	6
Juniperus occidentalis - (Pinus jeffreyi - Pinus ponderosa) / Cercocarpus ledifolius Association	90.00	4	87.50	8
Cercocarpus ledifolius Alliance	93.33	6	100.00	5
Pinus ponderosa - Calocedrus decurrens - Pseudotsuga menziesii Alliance	88.57	14	96.00	10
Pinus jeffreyi Alliance	87.50	16	72.59	27
Abies concolor Alliance	85.00	8	80.00	18
Abies concolor - Pseudotsuga menziesii Alliance	96.67	6	96.67	6
Abies concolor - Pinus lambertiana Alliance	90.00	12	88.00	10
Juniperus grandis Alliance	83.75	16	90.00	10
Tsuga mertensiana Alliance	87.62	21	100.00	14
Abies magnifica Alliance	85.00	16	86.67	27
Pinus monticola Alliance	76.36	11	100.00	2
Pinus contorta ssp. murrayana Alliance	93.60	25	99.13	23
Populus trichocarpa Alliance	100.00	12	100.00	12
Festuca idahoensis - Pseudoroegneria spicata - Poa secunda Alliance	60.00	11	64.00	10
Western North American Interior Ruderal Grassland & Shrubland Group	36.67	6	40.00	1
Ceanothus cordulatus - Ceanothus integerrimus Alliance	80.00	2		0
Ceanothus cordulatus Association	93.33	12	93.33	12
Prunus emarginata - Holodiscus discolor Alliance	67.27	11	68.57	14
Arctostaphylos patula - Arctostaphylos nevadensis Allaince	80.00	4		0

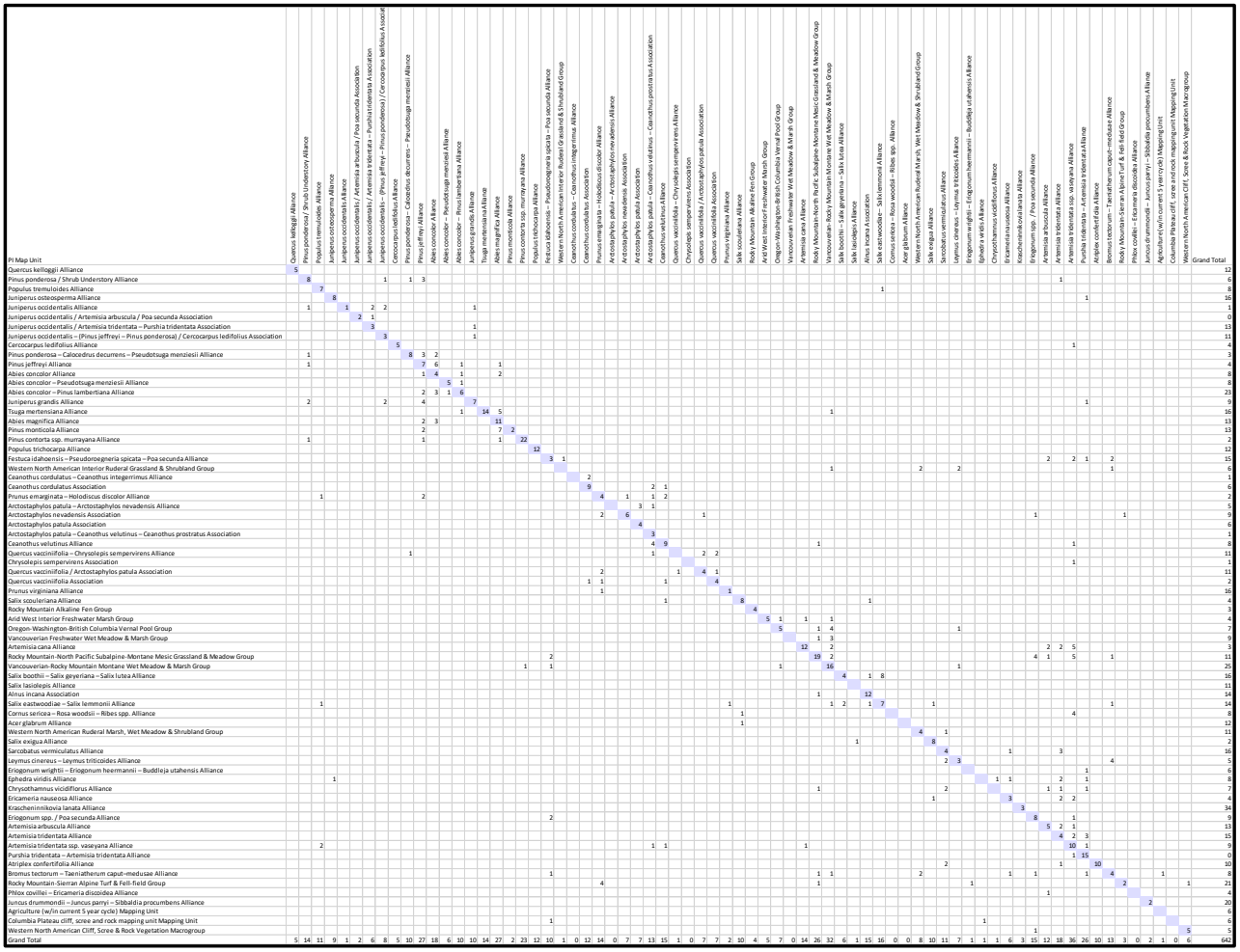
Arctostaphylos nevadensis Association	81.82	11	97.14	7
Arctostaphylos patula Association	100.00	4	91.43	7
Arctostaphylos patula - Ceanothus velutinus - Ceanothus prostratus Association	100.00	3	78.46	13
Ceanothus velutinus Alliance	86.67	15	85.33	15
Quercus vacciniifolia - Chrysolepis sempervirens Alliance	76.67	6	80.00	1
Chrysolepis sempervirens Association	20.00	1		0
Quercus vacciniifolia / Arctostaphylos patula Association	85.00	8	88.57	7
Quercus vacciniifolia Association	82.86	7	91.43	7
Prunus virginiana Alliance	90.00	2	80.00	2
Salix scouleriana Alliance	92.00	10	86.00	10
Rocky Mountain Alkaline Fen Group	100.00	4	100.00	4
Arid West Interior Freshwater Marsh Group	87.50	8	100.00	5
Oregon-Washington-British Columbia Vernal Pool Group	74.55	11	88.57	7
Vancouverian Freshwater Wet Meadow & Marsh Group	50.00	4		0
Artemisia cana Alliance	71.30	23	90.00	14
Rocky Mountain-North Pacific Subalpine-Montane Mesic Grassland & Meadow Group	75.88	34	81.54	26
Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group	90.00	20	75.63	32
Salix boothii - Salix geyeriana - Salix lutea Alliance	84.62	13	93.33	6
Salix lasiolepis Alliance		0	60.00	1
Alnus incana Association	95.38	13	90.67	15
Salix eastwoodiae - Salix lemmonii Alliance	80.00	15	86.25	16

Cornus sericea - Rosa woodsii - Ribes spp. Alliance	40.00	5		0
Acer glabrum Alliance	20.00	1		0
Western North American Ruderal Marsh, Wet Meadow & Shrubland Group	88.00	5	77.50	8
Salix exigua Alliance	95.56	9	90.00	10
Sarcobatus vermiculatus Alliance	65.00	8	67.27	11
Leymus cinereus - Leymus triticoides Alliance	68.89	9	60.00	7
Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis Alliance	40.00	1	60.00	1
Ephedra viridis Alliance	43.33	6	80.00	1
Chrysothamnus vicidiflorus Alliance	40.00	6	80.00	1
Ericameria nauseosa Alliance	62.50	8	73.33	6
Krascheninnikovia lanata Alliance	100.00	3	100.00	3
Eriogonum spp. / Poa secunda Alliance	89.09	11	72.00	15
Artemisia arbuscula Alliance	85.00	8	71.67	12
Artemisia tridentata Alliance	88.89	9	56.67	18
Artemisia tridentata ssp. vaseyana Alliance	76.25	16	61.11	36
Purshia tridentata - Artemisia tridentata Alliance	98.75	16	77.69	26
Atriplex confertifolia Alliance	92.31	13	100.00	10
Bromus tectorum - Taeniatherum caput-medusae Alliance	52.31	13	58.46	13
Rocky Mountain-Sierran Alpine Turf & Fell-field Group	64.44	9	93.33	3
Phlox covillei - Ericameria discoidea Alliance	20.00	1		0
Juncus drummondii - Juncus parryi - Sibbaldia procumbens Alliance	100.00	2	100.00	2

Agriculture (w/in current 5-year cycle) Mapping Unit		0	20.00	1
Columbia Plateau cliff, scree and rock mapping unit Mapping Unit	80.00	2		0
Western North American Cliff, Scree & Rock Vegetation Macrogroup	83.33	6	96.67	6
Overall Average Score: 4.09				
Overall Average Score (%): 81.81%				
Total # of points included in Overall Average Score: 642				

TABLE 5. CONFUSION MATRIX

The Confusion Matrix displays all of the surveys as whole numbers representing both the producer's accuracy (photo interpreted call) and the user's accuracy (final call). This matrix can be viewed in greater detail using the zoom tool, or can be accessed at the following link: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=211258



Discussion of Low Scores

Acer glabrum Alliance - this alliance was rarely mapped and scored low in the accuracy assessment for a few reasons. First, it was rarely observed in the field and is thought to be uncommon in the study area. Secondly, stands that were observed were typically very small and had a signature similar to *Prunus virginiana*. Only one of these polygons was accuracy assessed and was determined to be *Salix scouleriana*.

Artemisia cana Alliance - this alliance scored low in the accuracy assessment for a few reasons. One is that *Artemisia cana* can grow in similar environments to *Artemisia tridentata* and *Artemisia arbuscula*, and can be mistaken for either one. It can also mix with these two *Artemisia* species, making it hard to tell what percentage of each species is present to

determine the correct alliance. Typically, areas that are flat and wet, often with clay or alkali soils, indicate the environments *Artemisia cana* can be found in.

Bromus tectorum - Taeniatherum caput-medusae Alliance - this alliance (and all other herbaceous mapping units) is difficult to map. The reasoning for scoring low in this category is due to the difficulty of differentiating it from native and other weedy mapping units. Only 10% nativity is all that is required for the stand to be called a native type. This alliance was mistaken for five different herbaceous categories, two shrubs types, and one polygon was determined to be agriculture.

Chrysolepis sempervirens Association - only one polygon of this alliance was surveyed during the accuracy assessment and was determined to be the *Artemisia tridentata* ssp. *vaseyana* Alliance. *Chrysolepis* typically grows in small patches, often mixing with similarly colored shrub species.

Chrysothamnus viscidiflorus Alliance - this alliance was fairly uncommon and difficult to differentiate from other shrub types in the study area. It was mistaken for two shrub types that have a similar signature on infrared imagery and another two that have a similar signature on NAIP imagery. One was determined to be a grassland with not enough shrubs to be called a shrub stand.

Cornus sericea - Rosa woodsii - Ribes spp. Alliance - the reasoning for the low score in this alliance was mostly due to miscommunication between the GIC and DFW on how to map *Ribes* species. This alliance was supposed to be used for riparian settings where one or more of the named species is present. The GIC used this type to map disturbed stands at high elevations, which were often dominated by *Ribes* species and *Symphoricarpos rotundifolius*. Four of the five surveys scored were determined to be the *Symphoricarpos oreophila* Association (which includes *Ribes* spp. in its description) under the *Artemisia tridentata* ssp. *vaseyana* Alliance.

Elymus cinereus - Elymus triticoides Alliance - another herbaceous alliance that is difficult to map correctly due to its variable signature which can easily be mistaken for other herbaceous alliances. Four of the accuracy assessed polygons were determined to be *Bromus tectorum - Taeniatherum caput-medusae* Alliance. The other two were called the *Sarcobatus vermiculatus* Alliance, which grows in the same alkali environments as *Elymus cinereus*.

Ephedra viridis Alliance - true stands of this alliance were not encountered at all during the accuracy assessment process. All five of the assessed polygons turned out to be other shrub types. *Ephedra viridis* can take an alliance with sub-dominant presence. It often mixes with other shrubs and it is difficult to determine if enough *E. viridis* is present to take the alliance. This alliance was encountered in the eastern portion of the study area.

Phlox covillei - Ericameria discoidea Alliance - this alliance was fairly uncommon and was only found at the higher elevations. The low score in this alliance was due to only one polygon being surveyed, which was determined to be *Artemisia arbuscula*.

Ericameria nauseosa Alliance - this alliance was common in disturbed areas and typically grows with or near *Artemisia tridentata*. It can have a variable signature and can sometimes look like *Artemisia tridentata*, which is what four of the accuracy assessments were called.

Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis Alliance - this alliance was rare in the study area and was restricted to the Fort Sage OHV park near Doyle. *Eriogonum wrightii* was the target species mapped in this alliance and its common name is "Bastard Sage", meaning it looks a lot like *Artemisia* species. Only one polygon from this alliance was accuracy assessed and it was determined to be the *Purshia tridentata - Artemisia tridentata* Alliance.

Festuca idahoensis - Pseudoroegneria spicata - Poa secunda Alliance - this native herbaceous alliance was common in the study area. In the accuracy assessment it was mistaken for other grassland alliances twice, and four other surveys were determined to be shrub alliances. In certain circumstances shrub stands can take an alliance at very low cover, as long as they are evenly distributed. Oftentimes sparse shrubs were not detected in the imagery by the photo-interpreters.

Oregon-Washington-British Columbia Vernal Pool Group - this wet group with vernal pool species was fairly common in the study area, with some large stands in the Sierra Valley area. During the accuracy assessment it was found four times to be the very similar group called the Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group. This group is often found adjacent to the Oregon-Washington-British Columbia Vernal Pool Group with some overlap and mixing of species from each group. There were two other surveys that were determined to be other herbaceous groups.

Penstemon newberryi Alliance - this alliance grows in very small and sparse patches that were rarely mapped without the assistance of field surveys. It grows in extreme rocky conditions that are often hard to reach to complete an accuracy assessment. No polygons from this alliance were surveyed during the accuracy assessment.

Pinus monticola Alliance - this high-elevation alliance was commonly mistaken for *Abies magnifica,* which has a similar signature, grows at a similar elevation, and often mixes with *Pinus monticola*. Seven of the accuracy assessments were determined to be *Abies magnifica*. Two surveys were determined to be *Pinus jeffreyi*, which can also have a similar appearance and grows at similar elevations.

Prunus emarginata - Holodiscus discolor Shrubland Alliance - this alliance was typically found on north-facing rocky slopes at mid to high elevations. It commonly mixes with other shrubs and was mistaken for three other shrub types in the accuracy assessment. Two of the surveys determined that there was enough *Pinus jeffreyi* present to call it this alliance. This could possibly be due to growth that occurred between the time the NAIP imagery was flown and the time of the accuracy assessment, which was a four-year lapse.

Quercus vacciniifolia - Chrysolepis sempervirens Shrubland Alliance - the majority of these stands that were surveyed during the accuracy assessment were found to be a finer association

level of the *Quercus vacciniifolia - Chrysolepis sempervirens* Alliance, which photo-interpreters were not expected to map to. One survey was determined to have enough tree cover to be called a *Pinus ponderosa - Calocedrus decurrens - Pseudotsuga menziesii* Alliance. This could possibly be due to growth that occurred between the time the NAIP imagery was flown and the time of the accuracy assessment, which was a four-year lapse. One stand was determined to be the mixed shrub type *Arctostaphylos patula - Ceanothus velutinus - Ceanothus prostratus* Association.

Rocky Mountain-North Pacific Subalpine-Montane Mesic Grassland & Meadow Group - this group was confused with several other shrub and herbaceous groups and alliances. This alliance is found at high elevations and is often rocky and sparse, with stunted and scattered low-density shrubs. These factors make it challenging to map correctly, for sparse low-growing shrubs can be mistaken for rocks on imagery. Other native and non-native herbaceous types also grow at similar elevations. One survey was found to be the *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Alliance, one was the *Bromus tectorum - Taeniatherum caput-medusae* Alliance, and the most common alliance determined by the accuracy assessment was the *Artemisia tridentata* ssp. *vaseyana* Alliance, which can be found at these higher elevations as sparse rocky stands.

Rocky Mountain-Sierran Alpine Turf & Fell-field Group - this group was found at high elevations, typically in areas around talus piles and receding snow packs. Stands were typically sparse and diverse. Three of the accuracy assessed stands were found to be the *Prunus emarginata - Holodiscus discolor* Shrubland Alliance, which are commonly found in the same rocky high-elevation areas. One stand was found to be the *Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis* Alliance, another was found to be *Penstemon newberryi*, and one was called the Western North American Cliff, Scree & Rock Vegetation Macrogroup.

Salix lasiolepis Alliance - no polygons from this alliance were surveyed during the accuracy assessment.

Sarcobatus vermiculatus Intermountain Wet Shrubland Alliance - this alliance was found in the eastern arid portion of the study area where it commonly mixed with *Artemisia tridentata*. *Sarcobatus vermiculatus* can take an alliance even when sub-dominant to other shrubs. A minimum sub-dominance threshold was never communicated in the key. Photo-interpreters may have been calling out this alliance when there was a very small amount of *Sarcobatus* present. Four of the accuracy assessments were determined to be the *Artemisia tridentata* Alliance and one was the *Ericameria nauseosa* Alliance.

Vancouverian Freshwater Wet Meadow & Marsh Group - the low score in this group was due to the photo-interpreters accidentally selecting this group instead of the very similarly named Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group. Three of the four polygons assessed were determined to be the similarly named marsh group and one was found to be the higher-elevation Rocky Mountain-North Pacific Subalpine-Montane Mesic Grassland & Meadow Group. All polygons of this mapping unit were cross-walked to the similarly named

group during the post accuracy assessment map correction process, with the exception of polygons that were mapped based on field surveys.

Western North American Interior Ruderal Grassland & Shrubland Group - the low score in this group was partially due to the photo-interpreters selecting this group instead of the very similarly named Western North American Ruderal Marsh, Wet Meadow & Shrubland Group, which two of the accuracy assessments were determined to be. It was also mistaken for three other native and non-native herbaceous groups/alliances, including one Vancouverian - Rocky Mountain Montane Wet Meadow & Marsh Group, one *Elymus cinereus* - *Elymus triticoides* Alliance, and one *Bromus tectorum* - *Taeniatherum caput-medusae* Alliance

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Appendix A: Accuracy Assessment Field Form

Accuracy Assessment: Doyle - Loyalton (4/8/2021)

Surveyor:	**Other Surveyors:**	**Date:**
Location Name:		
Waypoint ID: **Polygon UID:**	**GPS Name** _____ **Projected? Yes / No / Base** If Yes, enter: **Bearing (°):** _____ **Distance (m):** _____ **Inclination (°):** _____ If Yes, enter: **Base Waypoint ID:** _____ Record either UTMs or Decimal Degrees **Base** UTMs / **Projected** UTMs (circle one) GPS error: **ft / m / PDOP** ____ **UTME** ___ ___ ___ ___ ___ ___ **UTMN** ___ ___ ___ ___ ___ ___ ___ Decimal degrees: **LAT** __ __ . __ __ __ __ __ __ **LONG** __ __ __ . __ __ __ __ __ __	
Camera name:	**Photo #s:**	

Strata	Species	% cover	C	Strata	Species	% cover	C

Notes:

Map Unit Name:		Secondary:	
Confidence in map unit ID: L M H Explain:			
Describe above:	Linework problems ☐	More than 1 vegetation type in this polygon ☐	Vegetation change since imagery taken ☐
Conifer Cover: _____	Hardwood Cover: _____	Total Tree Cover: _____	Shrub Cover: _____
Herb Cover Class	<2%	2–9%	10–40% >40%
Tree Height	<0.5m	0.5-1m 1-2m 2-5m 5-10m 10-15m 15-20m 20-35m 35-50m >50 m NA	
Tree DBH	<1"	1-6" >6-11" >11-24" >24"	
Exotics (relative cover)	None or not visible	<33% 33-66% >66%	
Estimated % of polygon viewed _____	Is this a multiple point assessment? No / Yes If "Yes," point _____ of _____		

Appendix B: Accuracy Assessment Protocol for Data Collection Surveys 2021-22

This protocol describes accuracy assessment data collection procedures. The primary purpose of the AA fieldwork is to supply data to test the accuracy of a specific vegetation map. The information collected can also contribute additional data for the classification of vegetation communities. The primary sampling units are the vegetation polygons delineated by photo-interpreters in the creation of the vegetation map.

If an entire AA polygon cannot be fully investigated due to terrain or other reasons, as much of the polygon as can be evaluated should be assessed.

Note that a delineated polygon may differ from the conventional definition of a stand of vegetation. A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some stands of vegetation are very small while some may be several square kilometers in size. A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.

2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes, but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous.

A properly delineated polygon may contain more than one stand. One example is a stand that is below the minimum mapping unit (MMU) of 1 acre or ¼ acres for special stands; it cannot be mapped separately and will be absorbed into the surrounding vegetation type. Another example is vegetation that is difficult to identify accurately on photo imagery. Several similar-looking stands may be grouped into one polygon and assigned a vegetation type at a high level, such as Group.

Selecting a location to sample within a polygon (for subsamples only):

If assessing a large polygon, it may be difficult to summarize the species composition, cover, and structure of the entire area. We are also usually trying to capture the most information as efficiently as possible. Thus, we may be forced to select a representative portion to sample.

When taking a subsample, the main point to remember is to select an area that, in as many ways possible, is representative of that polygon. This means that you are not randomly selecting a sample location; on the contrary, you are actively using your own best judgment to find a representative example of the polygon.

Selecting an assessment site requires that you see enough of the polygon you are sampling to feel comfortable in choosing a representative sample location. If possible, take a brief walk through the polygon and figure out where the boundary lines are drawn. Look for variations in species composition and in stand structure. In the process, decide whether the polygon includes more than one mappable vegetation type or if the stand boundaries do not seem to match up with the polygon delineation. If more than one vegetation type is present, fill out an AA form for each type ONLY IF each type is mappable (i.e., it is large enough to meet MMU and can be delineated without creating unreasonably shaped polygons). Small variations in vegetation that are repeated throughout the polygon should be included in your subsample. Once you assess the variation within the polygon, attempt to find an area that captures the stand's species composition and structural condition to sample.

How to enter fields on the form:

Recorder: The full name of the recorder should be provided for the first field form for the day. On successive forms, initials can be recorded.

Other Surveyors: The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded.

Date: The date the AA point was sampled. Use the standard U.S. format of "month-day-year" or use letters to write out the month.

Waypoint ID: Use the Polygon UID for the Waypoint ID. If more than one point is taken in a polygon (e.g. photo point, multiple vegetation types in a polygon) follow the Polygon UID by an underscore and a sequential number (e.g. _1, _2, etc.)

Note that the GPS point should be taken away from the edge of the polygon, and near the center of the polygon or subsample (if one is used).

Polygon UID: The unique identifier (UID) assigned to each polygon, displayed in the GPS data and on paper maps.

Location Name: The name of the property, park, or the location within large holdings (like USFS or BLM properties). If the survey is taken on private property, the name of the owner could be used.

GPS name: The name/number assigned to the GPS unit.

Projected? Yes / No/ Base/ Digitized: Circle the appropriate option

> **Yes** - The point is a projected, or offset point. The surveyors used a bearing, distance, and inclination to project the point into the polygon they are describing.
>
> **No** - The surveyor is within the boundary of the polygon being assessed and the point is where the observer was standing for photographs. This location can also be used as a base location for an offset survey.

Base - Base point only. This is where a surveyor was standing when taking an offset survey to describe vegetation not at that point. No plant data or vegetation descriptions are associated with this location. However, cardinal photos taken at this point will be stored in a directory of this name.

Digitized - An offset point was created on the GPS unit without taking bearing and distance readings. This option should only be used when the imagery on the GPS unit is unique and unmistakable.

If Projected = Yes

Bearing (°): The compass bearing from the Base point to the Projected point.

Distance (m): The distance in meters from the Base point to the Projected point, determined by use of a range finder.

Inclination (°): The vertical offset from the Base point to the Projected point.

If Projected = Yes or Digitized

Base Waypoint ID: "B_Waypoint ID". This is the location where the surveyor was standing when the information was collected. Cardinal photographs will be taken at this point and will be stored on the computer under this ID. Take at least one photo that represents the vegetation in the polygon. This photo(s) will be stored on the computer under the Projected point's ID.

Base UTMs / Projected UTMs: If the point is projected or digitized, circle whether the UTM coordinates of the base point or the projected point have been recorded. These will generally be for the base point.

UTM coordinates: Easting (**UTME**) and Northing (**UTMN**) location coordinates using the Universal Transverse Mercator (UTM) grid. Record this information from a GPS unit.

PDOP: The accuracy of the GPS location, when taking the UTM field reading using positional dilution of precision (PDOP). It is typical for commercial GPS units to be accurate with a PDOP value of 1 to 5. The lower the error number, the more accurate the GPS reading.

Note: if your GPS device does not report accuracy in PDOP, cross this out and record the accuracy value and unit instead, e.g. "5m".

Decimal degrees: *Use this only if your GPS unit will not record UTM coordinates.* Latitude-Longitude reading in decimal degrees. Record the information from your GPS unit.

Camera name / Photo #s: Write the name or the camera, JPG numbers of each photo, and direction of photos. *Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the GPS location.* This symbol can be used to indicate the cardinal photos: 

Make sure to take additional photos of the general composition of the stand if the cardinal photos do not do an adequate job; note the JPG numbers and a description and direction of each additional photo. If you take photos from anywhere in the stand other than the waypoint location taken for this survey, take addition "photo points" to associate with the photos. Photo points will be recorded as Field Markers (Survey type) and the waypoint ID could be the

Waypoint ID of the polygon it is associated with followed by "_f" and a sequential number (e.g. _f1, _f2, etc.). Include all appropriate information pertaining to the photo points in this field or in the Notes field.

Species list and coverage

List up to twelve species that are dominant or that are characteristically consistent throughout the stand. These species may or may not be abundant, but they should be constant representatives in the survey. When different layers of vegetation occur in the stand, make sure to list species from each stratum. As a general guide, make sure to list at least 1-2 of the most abundant species per stratum.

Strata:

T = Overstory tree. A woody perennial plant that has a single trunk.

A = SApling. 1" - <6" dbh and young in age, OR small trees that are <1" dbh, are clearly of appreciable age, and are kept short by repeated browsing, burning, or other disturbance or environmental conditions. Includes trees that are re-sprouting from roots or stumps following fire, logging or other disturbance. These re-sprouts may exhibit a shrubby form, with multiple small trunks, but are species that are generally considered trees. If a majority of the trunks are >6" dbh, then the re-sprouts would be recorded under the "Tree" stratum.

E = SEedling. A tree species clearly of a very young age that is <1" dbh or has not reached breast height. Applies only to trees propagating from seed; re-sprouts are not recorded here even if they meet the size requirements.

S = Shrub A perennial, woody plant that is multi-branched and doesn't die back to the ground every year.

H = Herb An annual or perennial that dies down to ground level every year.

N = Non-vascular Includes mosses, liverworts, hornworts, and algae.

Species: Use Jepson Manual nomenclature. When uncertain of an identification use parentheses to indicate what part of the determination needs to be confirmed. For example, you could write out *Brassica* (*nigra*) if you are sure it is a *Brassica* but you need further clarification on the specific epithet. Collect samples of unknow plants for identification later. The dominant and/or most characteristic species must be identified to species whether in the field or collected and identified later. If phenology does not allow for identification, make a note of that in the Notes section.

% cover: provide the % absolute aerial cover for each species listed. All species percent covers may total over 100% because of overlap.

C: If a species collection is made, it should be indicated with a "C" (for collected). If the species is later keyed out, cross out the species name or description and write the keyed species name in pen on the data sheet. Do not erase what was written in the field, because this information can be used if specimens get mixed up later. If the specimen is then thrown out, add a "T" to the "C" in that column (CT = thrown out after confirmation) or cross out the "C". If the specimen is kept but is still not confidently identified, add a "U" to the "C" (CU = collected and

unconfirmed). In this case the unconfirmed species epithet should be put in parentheses [e.g *Hordeum (murinum)*]. If the specimen is kept and is confidently identified, add a "C" to the existing "C" (CC = collected and confirmed). If the specimen is later deposited in an herbarium, add a "D" to the existing "C" (CD = collected and deposited) and note the receiving herbarium.

Notes: Describe the stand age or seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors. Include recommendations for line-work revision, discernibility of the vegetation based on season and topography, problems with classification interpretation, homogeneity of vegetation, and unusual sightings of plants or animals.

Map Unit Name: Enter the vegetation type name here**.** Refer to the Vegetation Key to identify the type to the finest level possible. If the vegetation in this polygon does not exactly match the descriptions in the key, enter the best-fitting vegetation type here and the second-best type in the next field. For further verification of the vegetation, refer to the Stand Tables.

Secondary (Optional): Assign a second best-fitting name for the vegetation within the polygon. Assign a secondary code **only** if there is some ambiguity in assigning the polygon to a primary vegetation. Note the reason for assigning a secondary call within the "*Confidence in map unit ID"* field below.

Confidence in map unit ID? L M H Explain: Note the level of confidence you feel in the map unit identification by circling **L**ow, **M**oderate, or **H**igh. This is an area to describe how well the stand characteristics match the Vegetation Key. Are all diagnostic species present in proper proportions? If not, how do they differ? If a secondary type is identified, what made the stand type ambiguous? ***Note that if you choose low or moderate confidence, you should have a secondary call, as an alternative way to classify the vegetation.***

Linework problems: Check the box if the polygon boundary line does not surround a distinct vegetation type. Examples for which you would check the box include situations where there is more than one type of mappable vegetation within the polygon, when a portion of the boundary includes part of an adjacent stand, or when the stand continues beyond the polygon boundary. *If checked, provide comments in the Notes section to explain.*

More than 1 vegetation type in this polygon: Check if there is more than one vegetation type within the polygon. If the polygon includes more than one type, take a separate GPS point and fill out an AA form for each ***mappable*** vegetation type. Be sure to describe the location and extent of each vegetation type in the Notes section. If these other types are smaller than the MMU, and therefore would not be expected to be mapped, just note the additional vegetation types in the Notes section.

Vegetation change since imagery taken: Check the box if the vegetation in the polygon has changed since the aerial imagery used as the base of the vegetation map was taken. If yes, provide a description in the Notes section of how the vegetation has changed (for example: burned, developed, visible dominance changes over time).

Conifer Cover: The total foliar cover (considering porosity) of all live conifer trees, disregarding overlap of individual trees.

Hardwood Cover: The total foliar cover (considering porosity) of all live hardwood trees, disregarding overlap of individual trees.

Total Tree Cover: The total foliar cover (considering porosity) of all live tree species, disregarding overlap of individual trees. This value may be less than the sum of the conifer and hardwood covers due to overlap.

Shrub Cover: The total foliar cover (considering porosity) of all live shrubs, disregarding overlap.

Herb Cover Class: The total cover (considering porosity) of all herbaceous species, disregarding overlap. Circle the appropriate cover class range.

Tree Height: Circle the height range of the modal tree height.

Tree DBH: Circle one of the tree size classes provided. Size class is based on the average diameter at breast height (dbh) of each trunk (standard breast height is 4.5ft or 137cm). When marking the main size class, make sure to estimate the mean diameter of all trees over the entire stand, and weight the mean toward the larger tree dbh's.

Exotics: Circle the appropriate level:

None or not visible
1 = Light, less than 33% of total cover is non-native
2 = Moderate, between 33% and 66% of total cover is non-native
3 = Heavy, more than 66% of total cover is non-native
Not Applicable

Estimated % of polygon viewed:

Enter an estimate of the **percent of the polygon** that you were able to assess from your point AND any additional area that you were able to view while driving or walking around or through the polygon. Explain in the Notes section any reasons for not viewing entire polygon.

Is this a "multiple" point assessment?:

Circle **NO** or **YES**. If Yes, fill in the sequence and total number of points for this polygon (e.g., 1 of 2 points for this polygon).

Appendix C: Field Form for Rapid Assessment and Relevé Surveys

Combined Vegetation Rapid Assessment and Relevé Field Form
(Revised May 20, 2019 for the Doyle/Loyalton project)

For Office Use:	Final database #:	Final vegetation type:	Alliance_____ Association

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION — circle: **Relevé or RA**

Database #:	Date:	Name of recorder:	
		Other surveyors:	☐
	UID:	Location Name:	☐

GPS name: _____ For Relevé only: **Bearing°**, left axis at ID point____ **of Long / Short** side ☐

UTME ___ ___ ___ ___ ___ ___ UTMN ___ ___ ___ ___ ___ ___ ___ **Zone: 10 NAD83** GPS error: **ft./ m./ PDOP** ____

Decimal degrees: **LAT** ___ ___ . ___ ___ ___ ___ ___ ___ **LONG** ___ ___ ___ . ___ ___ ___ ___ ___ ___

GPS within stand? Yes / No If No, cite from GPS to stand: distance (m) ____ bearing ° ____ inclination ° ____ ☐

and record: **Base point ID** _____ **Projected UTMs: UTME** ___ ___ ___ ___ ___ ___ **UTMN** ___ ___ ___ ___ ___ ___ ___ ☐

Camera Name: **Cardinal photos at ID point:** ☐

Other photos:

Stand Size (acres): <1, 1-5, >5 | **Plot Area (m²): 100 / _____** | **Plot Dimensions ____ x____ m** | **RA Radius____ m** ☐

Exposure, Actual °: _____ NE NW SE SW Flat Variable | **Steepness, Actual °: _____ 0° 1-5° > 5-25° > 25** ☐

Topography: Macro: top upper mid lower bottom | **Micro: convex flat concave undulating** ☐

Geology code: _____ Soil Texture code: _____ | **Upland** or **Wetland/Riparian** (circle one) ☐

Restoration code: 1-None obvious 2-Juniper removal 3-Grass/forbs seeding 4-Shrub/tree planting 5-Thinning (pine, juniper) 6-Other

% Surface cover: (Incl. outcrops) (>60cm diam) (25-60cm) (7.5-25cm) (2mm-7.5cm) (Incl sand, mud) ☐

H_20: BA Stems: Litter: Bedrock: Boulder: Stone: Cobble: Gravel: Fines: =100%

% Current year bioturbation _____ Past bioturbation present? Yes / No | **% Hoof punch _____** ☐

Fire evidence: Yes / No (circle one) If yes, describe in Site history section, including date of fire, if known. ☐

Site history, stand age, comments: ☐

Disturbance code / Intensity (L,M,H): ____/___ ____/___ ____/___ ____/___ ____/___ **"Other"** _____/___ ☐

II. HABITAT DESCRIPTION

Tree DBH : T1 (<1" dbh), **T2** (1-6" dbh), **T3** (6-11" dbh), **T4** (11-24" dbh), **T5** (>24" dbh), **T6** multi-layered (T3 or T4 layer under T5, >60% cover) ☐

Shrub: S1 seedling (<3 yr. old), **S2** young (<1% dead), **S3** mature (1-25% dead), **S4** decadent (>25% dead) ☐

Herbaceous: H1 (<12" plant ht.), **H2** (>12" ht.) ☐

III. INTERPRETATION OF STAND

Field-assessed vegetation Alliance name: _____ ☐

Field-assessed Association name (optional): _____ ☐

Adjacent Alliances/direction: _____/_____, _____/_____ ☐

Confidence in Alliance identification: L M H Explain: _____ ☐

Phenology (E,P,L): Herb____ Shrub____ Tree____ Other identification or mapping information: ☐

Combined Vegetation Rapid Assessment and Relevé Field Form

(Revised May 20, 2019 for the Doyle/Loyalton project)

Database #: __________ SPECIES SHEET

IV. VEGETATION DESCRIPTION

% NonVasc cover:____ Total % Vasc Veg cover:_____

% Cover - **Conifer tree / Hardwood tree:** _____/_____ **Regenerating Tree:** _____ **Shrub:** _____ **Herbaceous:** _____

Height Class - **Conifer tree / Hardwood tree:** _____/_____ **Regenerating Tree:** _____ **Shrub:** _____ **Herbaceous:** _____

Height classes: 1=<1/2m, 2=1/2-1m, 3=1-2m, 4=2-5m, 5=5-10m, 6=10-15m, 7=15-20m, 8=20-35m, 9=35-50m, 10=>50m

Stratum categories: T=Tree, A = SApling, E = SEedling, S = Shrub, H= Herb, N= Non-vascular

% Cover Intervals for reference: r = trace, + = <1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%

Stratum	Species	% cover	C	Final species determination

Unusual species: ____

Appendix D: Protocol for Rapid Assessment and Relevé Surveys
CDFW-CNPS Protocol for the
Combined Vegetation Rapid Assessment and Relevé Field Form

Doyle-Loyalton

(May 20, 2019)

Introduction

This protocol describes the methodology for both the Relevé and Rapid assessment (RA) vegetation sampling techniques as recorded in the Combined Vegetation Rapid assessment and Relevé Field Form. The same environmental data are collected for both techniques. However, the relevé sample is a plot demarcated with a measuring tape, and each species in the plot is recorded along with its cover. The Rapid assessment sample is not based on a taped plot, but is based on a visually estimated, usually circular area within a representative portion of the entire stand, with up to 20 of the dominant or characteristic species and their cover values recorded.

For this project, collect rapid assessments in woody vegetation and relevés in herbaceous vegetation. Some parts of this project area have not been sampled before, so RAs in woody vegetation may list more than 20 species.

Defining a Stand

A stand is the basic physical unit of vegetation in a landscape. It has no set size. Some vegetation stands are very small, such as a portion of a vernal pool, and some may be several square kilometers in size, such as a forest type. All samples should be in stands that meet the minimum mapping unit of 1 acre for upland and 0.5 acre for special stands such as small wetlands, riparian and serpentine barrens.

A stand is defined by two main unifying characteristics:

1) It has compositional integrity. Throughout the site, the combination of species is similar. The stand is differentiated from adjacent stands by a discernable boundary that may be abrupt or indistinct.
2) It has structural integrity. It has a similar history or environmental setting that affords relatively similar horizontal and vertical spacing of plant species. For example, a hillside forest originally dominated by the same species that burned on the upper part of the slopes but not the lower, would be divided into two stands. Likewise, sparse woodland occupying a slope with very shallow rocky soils would be considered a different stand from an adjacent slope with deeper, moister soil and a denser woodland or forest of the same species.

The structural and compositional features of a stand are often combined into a term called homogeneity. For an area of vegetated ground to meet the requirements of a stand, it must be homogeneous (uniform in structure and composition throughout).

Selecting a bounded plot (relevé) or representative area (rapid assessment) to sample within a stand

Stands to be sampled may be selected by evaluation prior to a site visit (e.g., from aerial photos) or they may be selected on site during reconnaissance to determine extent and boundaries, location of other similar stands, etc.

Because many stands are large, it may be difficult to summarize the species composition, cover, and structure of an entire stand. We are usually trying to capture the most information as efficiently as possible. Thus, we are typically forced to select a representative portion to sample.

When sampling a stand of vegetation, the main point is to select a sample that, in as many ways possible, is representative of that stand. This means that you are not randomly selecting a plot; on the contrary, you are actively using your own best judgment to find a representative example of the stand.

Selecting a relevé plot or RA area requires that you see enough of the stand you are sampling to feel comfortable in choosing a representative plot location. Take a brief walk through the stand and look for variations in species composition and in stand structure. In hilly or mountainous terrain, look for a vantage point from which you can get a representative view of the whole stand. Variations in vegetation that are repeated throughout the stand should be included in your plot. Once you assess the variation within the stand, attempt to find an area that captures the stand's common species composition and structural condition to sample.

Tracking sampled vegetation types

For large projects, the number of samples should be tracked daily or weekly by field-assessed Alliance type so that samples are spread as evenly as possible over types and time is not wasted collecting excessive numbers of samples of certain types. When multiple teams are in the field in the same week, daily communication between teams about alliances sampled can ensure even sampling. *Prior to selecting a stand to sample, determine if what you are going to sample is needed based on this alliance tracking.*

Selecting plots to avoid spatial autocorrelation

In no case should you sample the same stand more than once. For large projects, select sample locations to limit spatial autocorrelation. When possible, do not sample adjacent stands. Do not take a sample within 1000 meters of a survey of the same vegetation type. Exceptions can be made due to limited access to private lands. For example, samples taken from different formations, subclasses, or classes (e.g., wetlands vs. uplands, lithomorphic vs. mesomorphic) adjacent to one-another have a lower probability of sharing a number of species and may be sampled within 1000 meters of each other. However, avoid sampling adjacent stands that tend to have more species overlap even if they are technically different formations, such as a grassland adjacent to an open woodland.

Plot Size

For this project, the herbaceous relevé plot size is 100 m^2. In a very few cases, such as vernal pools, the plot size can be less (10 m^2).

Plot Shape

A relevé has no fixed shape, though plot shape should reflect the character of the stand and is either a square or a rectangle. Adjust the orientation and dimensions of the plot to incorporate the best approximation of stand homogeneity. If the stand is about the same size as a Relevé, the plot boundaries may be similar to that of the entire stand. If we are sampling streamside riparian or other linear communities, our plot dimensions should not go beyond the community's natural ecological boundaries. Thus, a relatively long, narrow plot capturing the vegetation within the stand, but not outside it, would be appropriate. Species present along the edges of the plot that are clearly part of the adjacent stand should be excluded from the plot.

Location of GPS Points

For relevés, one point will be considered the plot identifier (ID point) and should be in the SW corner of a rectangular or square plot, if possible, or in the center of a circular plot. If it is taken in another location, this should be noted in the Site History section.

Definitions of fields in the Field Form

I. LOCATIONAL/ENVIRONMENTAL DESCRIPTION

Relevé or RA: Circle the appropriate survey type.

Database #: This is the unique ID number for relevés and rapid assessments, in the form of PPPPxxxx, where PPPP is the 4-character project code and xxxx is a unique 4-digit number (e.g. MOLA0001 for Modoc-Lassen sample #1). If this is a long-term plot, a character from A to Z can be added to the unique ID for each re-sampling survey; so the first re-sample for MOLA0001 would be MOLA0001A.

Base Points: For a projected RA (GPS within stand = No), a Base Point will be taken where the surveyors are standing and a separate point will be projected into the stand. The ID of the basepoint is B_*PPPPxxxx*, i.e. B_MOLA0001.

Photo Points: Occasionally, stand photos will be taken from a vantage point outside the stand, or in a place other than the survey point. The ID for this point is *PPPPxxxx*_P#, i.e. the first Photo Point for MOLA0001 will be MOLA0001_P1.

Date: Date of the sampling.

Name of recorder: The full name of the recorder should be provided for the first field form for the day. On successive forms, initials can be recorded.

Other Surveyors: The full names of each person assisting should be provided for the first field form for the day. On successive forms, initials of each person assisting can be recorded.

UID: The ID of a previously assigned point that was created to suggest survey locations. You can find this ID on the field map or the GPS device map.

Location Name: The name of the property or park, or the location within large holdings (like USFS or BLM properties).

GPS name: The name/number assigned to each GPS unit. This can be the serial number if another number is not assigned.

Bearing°, left axis at ID point of Long / Short side: Fill this in for relevés only. For square or rectangular plots: from the ID Point, looking towards the plot, record the bearing of the axis to your left. If the plot is a rectangle, indicate whether the left side of the plot is the long or short side of the rectangle by circling "long" or "short" side (no need to circle anything for square plots). If there are no stand constraints, set up the plot with boundaries running in the cardinal directions and place the ID Point in the SW corner.

UTM coordinates: Easting (**UTME**) and northing (**UTMN**) location coordinates using the Universal Transverse Mercator (UTM) grid. Record the information from your GPS unit. These coordinates are always the base point of the survey. Soil samples and photos are taken from this point, and exposure, steepness, topography, etc. are measured here. If the GPS is not within the stand (i.e., the point is projected), these are the UTMs of the base point. Important: a projected point or a point digitized in the field must always have a base point associated with it (projected surveys are preferred). A base point can serve as the base for several distance surveys.

For Relevé plots, take the GPS point in the southwest corner of the plot whenever possible or in the center of a circular plot.

Zone: Universal Transverse Mercator zone. Zone 10 is for California west of the 120th longitude; zone 11 is for California east of 120th longitude. The UTM Zone is 10 for this project.

NAD83: This is the default GPS datum. If you use a different one, cross this out and write in the correct datum.

GPS error: ft./ m./ PDOP: Circle the appropriate unit of measure and record the error reading from the GPS unit.

Decimal degrees: *Use this only if your GPS unit will not record UTM coordinates.* Latitude-Longitude reading in decimal degrees. Record the information from your GPS unit. These coordinates are always the base point of the survey. Soil samples and photos are taken from this point, and exposure, steepness, topography, etc. are measured here.
For Relevé plots, take the waypoint in the southwest corner of the plot whenever possible or in the center of a circular plot.

GPS within stand? Yes / No: Circle "Yes" to denote that the GPS waypoint was taken directly within or at the edge of the stand being assessed for a rapid assessment, or circle "No" if the waypoint was taken at a distance from the stand (such as with a binocular view of the stand). If the point is taken at the edge of the stand, note the direction to the stand.

> **If No, cite from GPS to stand: distance (m), bearing°, inclination°:** From the base GPS point, measure the distance to the projected point using a range finder. Record the compass bearing from the base point to the projected point; record the inclination if the base and projected points are not at the same elevation.
> **and record Base point ID:** This is the ID of the base GPS point, where the surveyors were standing to record the distance survey. This is required for both projected points and points digitized in the field (gathering projection data is preferred).
> **and Projected UTMs:** These are the coordinates of the projected point, the point being surveyed. They are generated in the field if the GPS units have the ability to calculate projected points. If the GPS unit does not have this capability, make a note to that effect and leave these fields blank. Note that a digitized point, e.g., using your finger to plunk the location that you are surveying in Collector, is NOT a projected point.

Camera Name: Write the camera name.

Cardinal photos at ID point: Take four photos in the main cardinal directions (N, E, S, W) clockwise from the north, from the ID Point, and record the jpeg numbers here. Try to include the horizon in at least some of these photos. If this is a distance survey to a projected point, take the four cardinal photos at the base point and at least one photo of the stand. A digital camera with a minimum 10-megapixel resolution must be used.

Other photos: This may include cardinal photos at additional corners or other relevant photos. Notes regarding photo locations or subjects can go here.

Stand Size: Estimate the size of the entire stand in which the sample is taken. As a measure, one acre is about 4,000 square meters (approximately 64 x 64 m), or 208 feet by 208 feet. One acre is similar in size to a football field.

Plot Size: If this is a Relevé, circle "100" for a 100m^2 plot, or record the plot size.

Plot Dimensions: Record the length and width of the Relevé plot in meters.

RA Radius: Enter the radius in meters of the visually estimated sample area for rapid assessments (should be a 20-meter radius at minimum). For a large stand, this limits the area covered by the RA. If you can see and assess the entire stand, the length and width should be recorded. If it is a long, narrow stand, note the width of the stand at your location. If your point is on the edge of the stand, record the

radius into the stand, but note your location and the direction to which the RA Radius applies in the Site History section.

Exposure: (Enter Actual º and circle general category): While facing in the general downhill direction, read degrees of the compass for the aspect or the direction you are standing, using degrees from north, adjusted for declination. Average the reading over the entire stand, even if you are sampling a Relevé plot, since your plot is representative of the stand. If estimating the exposure, write "N/A" for the actual degrees, and circle the general category chosen. "Variable" may be selected if the same, homogenous stand of vegetation occurs across a varied range of slope exposures.

Steepness: (Enter Actual º and circle general category): Read degree slope from your compass. If estimating, write "N/A" for the actual degrees, and circle the general category chosen. Make sure to average the reading across the entire stand even if you are sampling in a Relevé plot.

Topography: First assess the broad (**Macro**) topographic feature or general position of the stand relative to the immediately surrounding landscape. This attribute does not refer to the watershed as a whole, but to a cross section of the topography at the location of your stand. For instance, if your stand is located along a small creek in a narrow, v-shaped canyon, your position would be at the "Bottom," even if the canyon itself slopes downward. Since stands can occupy more than just a single slope position, **circle all the positions that apply**.

Then assess the local (**Micro**) topographic features or the lay of the area (e.g., surface is flat or concave). **Circle only *one* of the microtopographic descriptors**.

Geology code: Geological parent material of stand. If exact type is unknown, use a more general category (e.g., igneous, metamorphic, sedimentary). *See code list for types*.

Soil Texture code: Record soil texture that is characteristic of the plot (*e.g.,* coarse loamy sand, sandy clay loam). *See soil texture key for types.*

Upland or Wetland/Riparian: Indicate if the stand is in upland or wetland/riparian setting. (Wetland and riparian are one category.) Note that a site need not be officially delineated (as in the Army Corps of Engineer's wetland delineation protocols) as a wetland to qualify as such in this context (e.g., seasonally wet meadow).

Restoration Code: Circle the appropriate code. If you observe more than one type of restoration, circle all codes that apply. "6-Other" should only be used if the restoration type is not described by codes 2-5. Describe the type of restoration for code 6 in the Site History.

% Surface cover: The abiotic substrates of the plot. The total should sum to 100%. It is helpful to imagine "mowing off" all of the live vegetation at the base of the plants and removing it - you will be estimating what is left covering the surface. Note that non-vascular cover (lichens, mosses, cryptobiotic crusts) is not estimated in this section.

H_2O:	Percent surface cover of running or standing water, ignoring the substrate below the water.
BA Stems:	Percent surface cover of the basal area of stems at the ground surface. For most vegetation types, BA is 1-3% cover.
Litter:	Percent surface cover of litter, duff, or wood on the ground.
Bedrock:	Percent surface cover of bedrock, including outcrops.
Boulder:	Percent surface cover of rocks >60 cm in the longest dimension.
Stone:	Percent surface cover of rocks >25-60 cm in the longest dimension.
Cobble:	Percent surface cover of rocks >7.5-25 cm in the longest dimension.

Gravel: Percent surface cover of rocks 2 mm-7.5 cm in the longest dimension.

Fines: Percent surface cover of bare ground and fine sediment <2 mm in the longest dimension (*e.g.,* dirt, sand).

% Current year bioturbation: Estimate the percent of the plot exhibiting soil disturbance by any organism that lives underground. Do not include disturbance by ungulates. Note that this is a separate estimation from surface cover.

Past bioturbation present? Circle Yes if there is evidence of bioturbation from previous years in the plot.

% Hoof punch: Note the percent of the plot surface that has been punched down by hooves (cattle or native grazers) in wet soil. Depressions must be >2 cm deep.

Fire Evidence: Circle Yes if there is visible evidence of fire within the stand, and note the type of evidence in the "Site history, stand age, comments section," for example, "charred dead stems of *Quercus berberidifolia* extending 2 feet above resprouting shrubs." If you are certain of the year of the fire, put this in the Site history section. You may also record more general historic information if you lack the precise date of a fire (such as most recent fire appears to be 10-20 years ago).

Site history, stand age, comments: Briefly describe the stand age/seral stage, disturbance history, nature and extent of land use, and other site environmental and vegetation factors, such as distribution of species. Examples of disturbance history: fire, landslides, avalanching, drought, flood, animal burrowing, or pest outbreak. Also, try to estimate year or frequency of disturbance. Examples of land use: grazing, timber harvest, or mining. Examples of other site factors: exposed rocks, soil with fine-textured sediments, high litter/duff build-up, multi-storied vegetation structure, or other stand dynamics.

Disturbance code / Intensity (L, M, H): List codes for potential or existing impacts on the stability of the plant community. See code list for impacts and definitions of levels of disturbance. Characterize each impact each as **L** (=Light), **M** (=Moderate), or **H** (=Heavy). Disturbance is evaluated on a stand basis.

II. HABITAT AND VEGETATION DESCRIPTION

California Wildlife Habitat Relationships (CWHR)

For CWHR, identify the size/height class of the plot using the following tree, shrub, and/or herbaceous categories. These categories are based on functional life forms.

Tree DBH: Circle one of the tree size classes provided when the tree canopy closure exceeds 10% of the total cover, or if young tree density indicates imminent tree dominance. Size class is based on the average diameter at breast height (dbh) of each trunk (standard breast height is 4.5ft or 137cm). When marking the main size class, make sure to estimate the mean diameter of all trees over the entire stand, and weight the mean toward the larger tree dbh's. The "**T6 multi-layered**" dbh size class signifies a multi-layered tree canopy (with a size class T3 and/or T4 layer growing under a T5 layer and a distinct height separation between the classes) exceeding 60% total cover. Stands in the T6 class need also to contain at least 10% cover of size class 5 (>24" dbh) trees growing over a distinct layer with at least 10% combined cover of trees in size classes 3 (>6-11" dbh) or 4 (>11-24" dbh).

Shrub: Circle one of the shrub size classes provided when shrub canopy closure exceeds 10% (except in desert types) by recording which class is predominant in the survey. Shrub size class is based on the average amount of crown decadence (dead standing vegetation on live shrubs when looking across the crowns of the shrubs).

Herbaceous: Circle one of the herb height classes when herbaceous cover exceeds 2% by recording the predominant class in the survey. Note*: This height class is based on the average plant height at maturity, not necessarily at the time of observation.*

III. INTERPRETATION OF STAND

Field-assessed vegetation Alliance name: Enter the name of the Alliance following the Manual of California Vegetation Online. Please use scientific nomenclature, *e.g., Quercus agrifolia* forest. An Alliance is based on the dominant or diagnostic species of the stand, and usually reflects the uppermost and/or dominant height stratum. A dominant species covers the greatest area. A diagnostic species is consistently found in some vegetation types but not others.

The field-assessed Alliance name may not exist in the present classification, in which case you can provide a new Alliance name in this field. If this is the case, also make sure to state that it is not in the MCV under "Explain" below.

Field-assessed Association name (optional): Enter the name of the species in the Alliance and additional dominant/diagnostic species from any strata. In following naming conventions, species in differing strata are separated with a slash, and species in the uppermost stratum are listed first (*e.g., Quercus douglasii / Toxicodendron diversilobum*). Species in the same stratum are separated with a dash (*e.g., Quercus lobata - Quercus douglasii)*.

The field-assessed Association name may not exist in the present classification, in which you can provide a new Association name in this field.

Adjacent Alliances/direction: Identify other vegetation types that are directly adjacent to the stand being assessed by noting the dominant species (or known type). Also note the distance in meters from the GPS waypoint and the direction in degrees that the adjacent alliance is found (*e.g., Amsinckia tessellata* / 50m, 360° N or *Eriogonum fasciculatum* / 100m, 110°).

Confidence in Alliance identification: (L, M, H) With respect to the "Field-assessed Alliance name," note whether you have L (=Low), M (=Moderate), or H (=High) confidence in the interpretation of this Alliance name.

Explain: Please elaborate if your "Confidence in Alliance identification" is low or moderate. Low confidence can occur from such things as a poor view of the stand, an unusual mix of species that does not meet the criteria of any described Alliance, or a low confidence in your ability to identify species that are significant members of the stand.

Phenology: Indicate early (E), peak (P), or late (L) phenology for each of the strata. For herbs, this generally indicates if species are in flower and/or fruit and are therefore identifiable. For shrubs and trees, this attribute generally refers to cover, e.g., a tree that is fully leafed out will be considered peak (P) even if it is not in flower. Phenology is useful for cover estimation and species identification issues, and should be elaborated upon in the next field.

Other identification or mapping information: Discuss any further problems with the identification of the assessment or issues that may be of interest to mappers. Note if this sample represents a type that is likely too small to map.

IV. VEGETATION DESCRIPTION

Database #: Copy the database # from Page 1.

Overall Cover of Vegetation

Provide an estimate of cover for the life-form categories below. Record a specific number for the total aerial cover or "bird's-eye view" looking from above for each category, estimating cover for the living plants only. Litter/duff should not be included in these estimates.

The *porosity* of the vegetation should be taken into consideration when estimating percent foliar cover for all categories below: consider how much of the sky you can see when you are standing under the canopy of a tree, or how much light passes through the canopy of the shrub layer to help you estimate foliar cover.

% NonVasc cover: The total cover of all lichens, bryophytes (mosses, liverworts, hornworts), and cryptogamic crust on substrate surfaces including downed logs, rocks and soil, but not on standing or inclined trees or vertical rock surfaces.

Total % Vasc Veg cover: The total cover of all vascular vegetation taking into consideration the porosity, or the holes, in the vegetation, and disregarding overlap[1] of the various tree, shrub, and/or herbaceous layers and species.

% Cover by Layer

Conifer Tree /Hardwood Tree: The total foliar cover (considering porosity) of all live tree species, disregarding overlap[1] of individual trees. Estimate conifer and hardwood covers separately. **Please note:** These cover values should not include the coverage of regenerating tree species (i.e., tree seedlings and saplings).

Regenerating Tree: The total foliar cover of seedlings and saplings, disregarding overlap[1] of individual recruits. See seedling and sapling definitions below.

Shrub: The total foliar cover (considering porosity) of all live shrub species disregarding overlap[1] of individual shrubs.

Herbaceous: The total cover (considering porosity) of all herbaceous species, disregarding overlap[1] of individual herbs.

Height Class by Layer

Modal height for conifer tree / hardwood tree, regenerating tree, shrub, and herbaceous categories. Record an average height value for each category by estimating the mean height for each group. Please use the following height intervals to record a height class: 1 = <1/2 m, 2 = 1/2-1 m, 3 = 1-2 m, 4 = 2-5 m, 5 = 5-10 m, 6 = 10-15 m, 7 = 15-20 m, 8 = 20-35 m, 9 = 35-50 m, 10 => 50 m.

Note: For the herbaceous layer height, this height class is based on the average plant height at the time of observation, as opposed to how this is recorded in the CWHR section (at maturity).

Species List and Coverage

For rapid assessments: List up to 20 species that are dominant or that are characteristically consistent within the assessment area. These species may or may not be abundant, but they should be constant representatives in the survey. When different layers of vegetation occur, make sure to list species from each stratum. As a general guide, make sure to list at least 1-2 of the most abundant species per stratum. There is a heavy line on the form under the 20th line to limit the RA section of the species list.

[1] Porosity reduces the total cover of the canopy. Overlapping strata should not be included in the total cover percent; for instance, if a shrub is growing under a tree, only the cover of the tree will be added into the total; the cover of the shrub will be disregarded, except for the amount by which it fills in the porosity of the tree canopy.

Note: If constant, diagnostic, or interesting species occur outside the assessment area but in the stand, list the species and estimated stand cover in the Site History section.

For relevés: list all species present in the plot, using a second species list page if necessary.
** If using a second species list page, note "Continued" on the bottom of the first page and be sure to note the **Database #** on the second page.

For both sample types, provide the stratum:

T = Tree. A woody perennial plant that has a single trunk.

A = SApling. 1" - <6" dbh and young in age, OR small trees that are <1" dbh, are clearly of appreciable age, and are kept short by repeated browsing, burning, or other disturbance. Includes trees that are re-sprouting from roots or stumps following fire, logging or other disturbance. These re-sprouts may exhibit a shrubby form, with multiple small trunks, but are species that are generally considered trees. If a majority of the trunks are >6" dbh, then the re-sprouts would be recorded under the "Tree" stratum.

E = SEedling. A tree species clearly of a very young age that is <1" dbh or has not reached breast height. Applies only to trees propagating from seed; resprouts are not recorded here even if they meet the size requirements.

S = Shrub. A perennial, woody plant, that is multi-branched and doesn't die back to the ground every year.

H = Herb. An annual or perennial that dies down to ground level every year.

N = Non-vascular. Includes moss, lichen, liverworts, hornworts, cryptogammic crust, and algae.

Be consistent and don't break up a single species into two separate strata. The only time it would be appropriate to do so is when one or more tree species are regenerating, in which case the SEedling and/or SApling strata should be recorded for that species. These may be noted on the same line, *e.g.:*

Strata	Species	%Cover	C
T/A/E	*Quercus douglasii*	40/<1/<1	

In some cases, the stratum of a particular species might not be obvious. Some examples are *Juniperus californica,* which has the size and growth habit of a shrub, but it is considered a tree, and mistletoe, which is considered a shrub. It is useful to have a list of species with ambiguous strata for each project. Consult the MCV or contact VegCAMP if you are unsure.

C. If a species collection is made, it should be indicated in the collection column with a "C" (for collected). If the species is later keyed out, cross out the species name or description and write the keyed species name in pen on the data sheet. Do not erase what was written in the field, because this information can be used if specimens get mixed up later. If the specimen is then thrown out, add a "T" to the "C" in the collection column (CT = thrown out after confirmation) or cross out the "C". If the specimen is kept but is still not confidently identified, add a "U" to the "C" in the collection column (CU = collected and unconfirmed). In this case the unconfirmed species epithet should be put in parentheses [*e.g., Hordeum (murinum)*]. If the specimen is kept and is confidently identified, add a "C" to the existing "C" in the collection column (CC = collected and confirmed). If the specimen is later deposited in an herbarium, add a "D" to the existing "C" in the collection column (CD = collected and deposited) and note the receiving herbarium.

Use Jepson Manual nomenclature. Write out the genus and species of the plant. Do not abbreviate except for dominant species that do not have ambiguous codes. If you aren't sure there aren't duplicate

codes, don't use a code. When uncertain of an identification (which you intend to confirm later) use parentheses to indicate what part of the determination needs to be confirmed. For example, you could write out *Brassica* (*nigra*) if you are sure it is a *Brassica* but you need further clarification on the specific epithet.

Provide the % absolute foliar cover for each species listed, considering porosity. When estimating, it is often helpful to think of coverage in terms of the following cover intervals at first:

<1%, 1-5%, >5-15%, >15-25%, >25-50%, >50-75%, >75%.

Keeping these classes in mind, refine your estimate to a specific percentage. All species percent covers may total over 100% because of overlap.
Include the percent cover of snags (standing dead) of trees and shrubs. Use the code "SNAG." Note their species, if known, in the "Species" column (i.e. SNAG - *Quercus wislizeni*).

For rapid assessments, make sure that the major non-native species occurring in the stand also are listed in the space provided in the species list with their strata and % cover.

For relevés, all non-native species should be included in the species list.

Also for relevés, record the <1% cover in one of two categories: "r" for trace (i.e., rare in plot, or solitary individuals) and "+" for <1% but not rare or solitary individuals.

Unusual species: List species that are locally or regionally rare, endangered, or atypical (e.g., range extension or range limit) within the stand. This field will be useful to the Program for obtaining data on regionally or locally significant populations of plants.

Note: Field forms are generally filled out in pencil, so that changes may be made easily while working in the plot or stand. Once out of the stand, however, entries on the field form should not be erased, but should be crossed out and corrected in a different-colored ink.

Appendix E: Imagery for each Mapping Unit Mapped

This appendix provides all of the mapping units, in alphabetical order, that were utilized in producing the map. For each mapping unit the classification level (Group, Alliance, Association) associated with each map unit is provided along with a description of the photo interpretation signature (color, tone, texture, pattern, etc.) commonly seen in the imagery, how it might be distinguished from other mapping units, and a generalization of where it was found. Examples of NAIP 2018 are provided followed by Google Earth imagery (various years). Infrared NAIP imagery (not provided) was used to show species that stood out more on infrared than on natural color imagery.

Abies concolor Dry Forest & Woodland Alliance

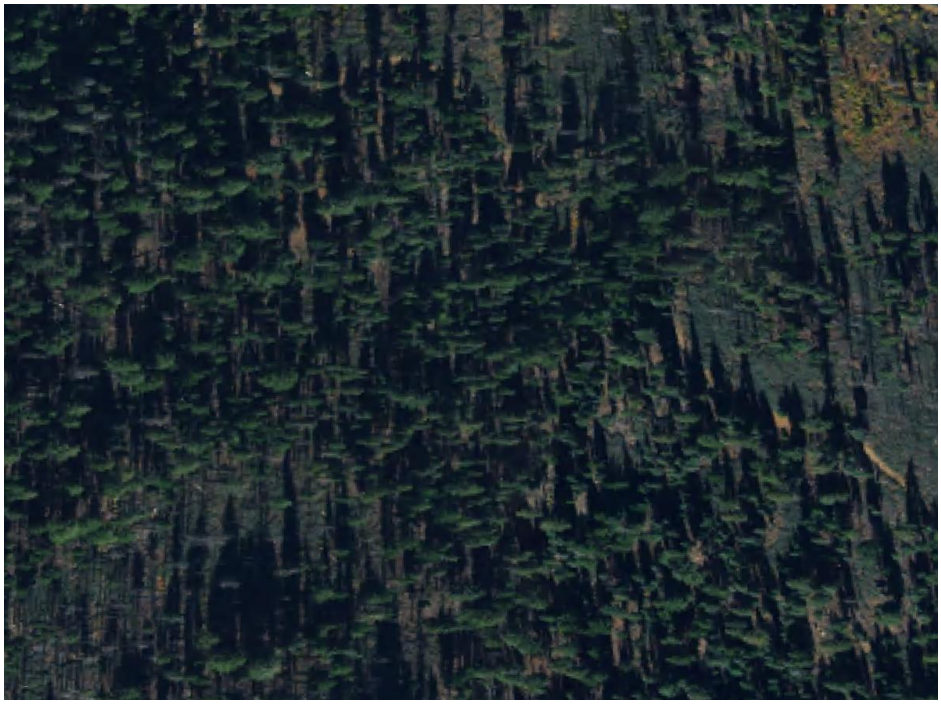
Abies concolor has a green to blue-green appearance and has a compact upright-branching structure. Pointy crowns and low branching near the ground can often be seen in the shadows and differentiate it from *Pinus jeffreyi* or *Pinus ponderosa,* which commonly drop lower branches with age. It can be found at higher elevations (generally between 5,000 and 7,000 feet) and often prefers northern, cooler aspects.

***Abies concolor* - *Pinus lambertiana* Alliance**

Abies concolor has a blue-green hue to it and has compact branching. *Pinus lambertiana* can be distinguished by its long, linear, sweeping branches which extend out further than most species. This alliance mostly occurred in the Diamond Mountains portion of the study area, with general elevation levels from 4,750 to 5,800 feet.

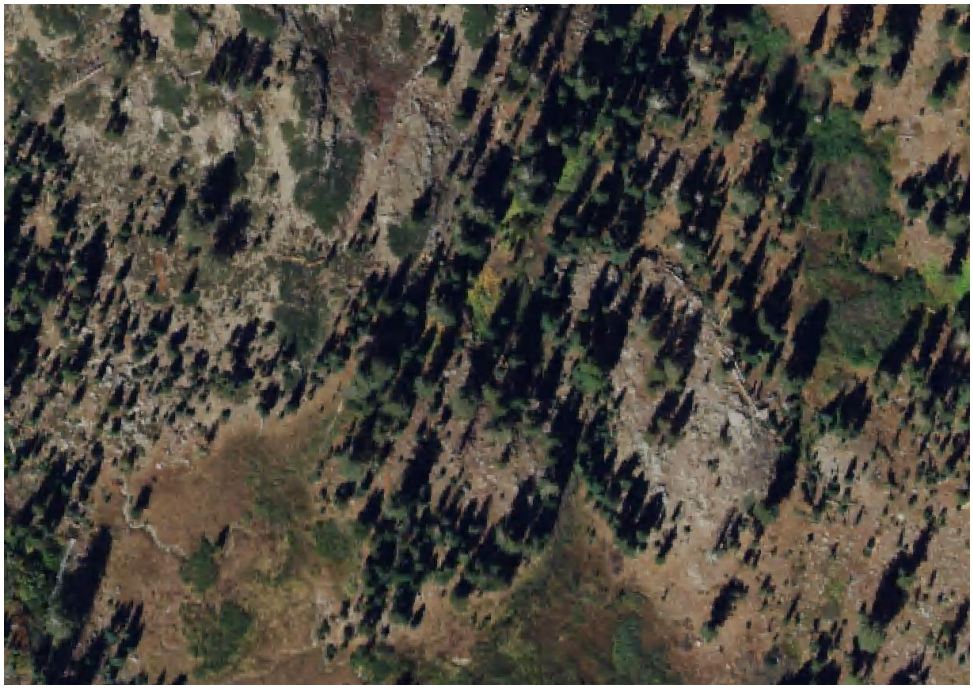
***Abies concolor - Pseudotsuga menziesii* Alliance**

Abies concolor has a blue-green hue to it and has compact branching. *Pseudotsuga menziesii* has a scraggly appearance, deep green in color, and has distinct branching similar to *Pinus lambertiana,* where individual outward-sweeping branching is a distinguishable characteristic. *P. menziesii* can be distinguished from *P. lambertiana* by its shorter branches which twist more than the linear branches of *P. lambertiana.* Occurrences were in the western portion of the study area, at an elevation range generally from 4,000 to 6,000 feet.



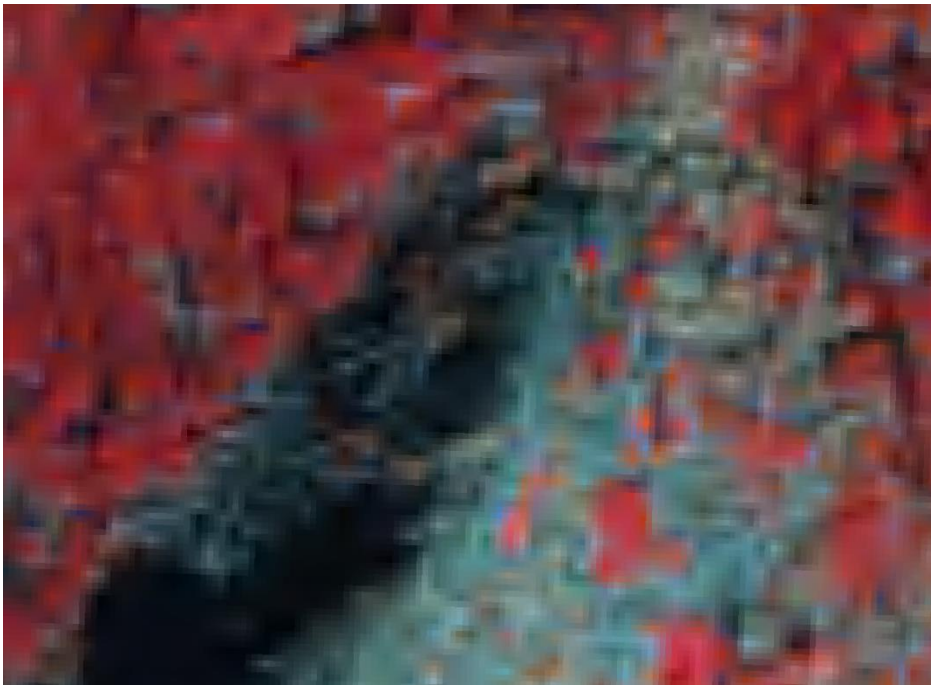
Abies magnifica Alliance

Abies magnifica is distinguishable by its large size and in some years its large white cones are visible on Google Earth. It often has dead or dying trees due to drought and climate change. It can be difficult to distinguish from *Pinus jeffreyi* when growing together, however *A. magnifica* has a denser branching structure and holds it lower branches longer as it matures. It was observed mostly in the western and southern portions of the study area and occurred generally between 6,700 and 8,600 feet elevation.



***Acer glabrum* Alliance**

Acer glabrum was rare in the study area, but can be seen here in the northwest portion of the rock outcropping. In the Google Earth image it has a signature similar to *Ceanothus velutinus,* which it is surround by in this image, but can be distinguished from *C. velutinus* by its brown-red hue on the infrared imagery. It would most likely be mistaken for a *Prunus* or *Alnus* species. It was surveyed in the study area from 6,500 to 7,200 feet elevation.



Agriculture (within the current 5-year cycle) Mapping Unit

This mapping unit was utilized when the photo-interpreter could see that the land was currently agriculture or had been used for agricultural production within the past five years of the imagery used. Sometimes these areas combined agriculture and grazing.

Alnus incana Association

Alnus incana has a deep rich green color and forms dense, continuous stands with a homogenous clumpy signature. It occurred in the study area in wet areas, oftentimes mixing with *Salix* species, from 6,600 to 7,400 feet elevation.

Amelanchier utahensis Association

Amelanchier utahensis has a fairly unique signature with consistent mounding and spacing, with a brown-green hue on NAIP imagery, which could potentially be mistaken for *Cercocarpus, Symphoricarpos,* or *Arctostaphylos*. The signature on Google Earth has a blue-green hue and has a consistent rough texture. Occurrences were on the east-facing slopes just west of Beckworth, from 4,900 to 5,400 feet elevation.

Alpine Permanent Snowfield/Glacier Mapping Unit

Areas where snow, ice or glacier was remaining year-round as far as the photo-interpreter could tell. The only occurrence in the study area was on the north face of Mount Lola at 9,000 feet elevation.

Anthropogenic Areas of Little or No Vegetation Mapping Unit

Ground is barren or nearly barren of vegetation and is the result of man-made disturbances such as plowing, disking, scraping, or mining.

***Arctostaphylos patula - Arctostaphylos nevadensis* Alliance**

***Arctostaphylos nevadensis* Association**

Arctostaphylos nevadensis is a low-growing shrub typically less than ½ meter in height that forms thick mats and has a darker army green hue. This alliance is found at higher elevations and occurred from 7,000 to 7,900 feet in the study area.

Arctostaphylos patula Shrubland Association

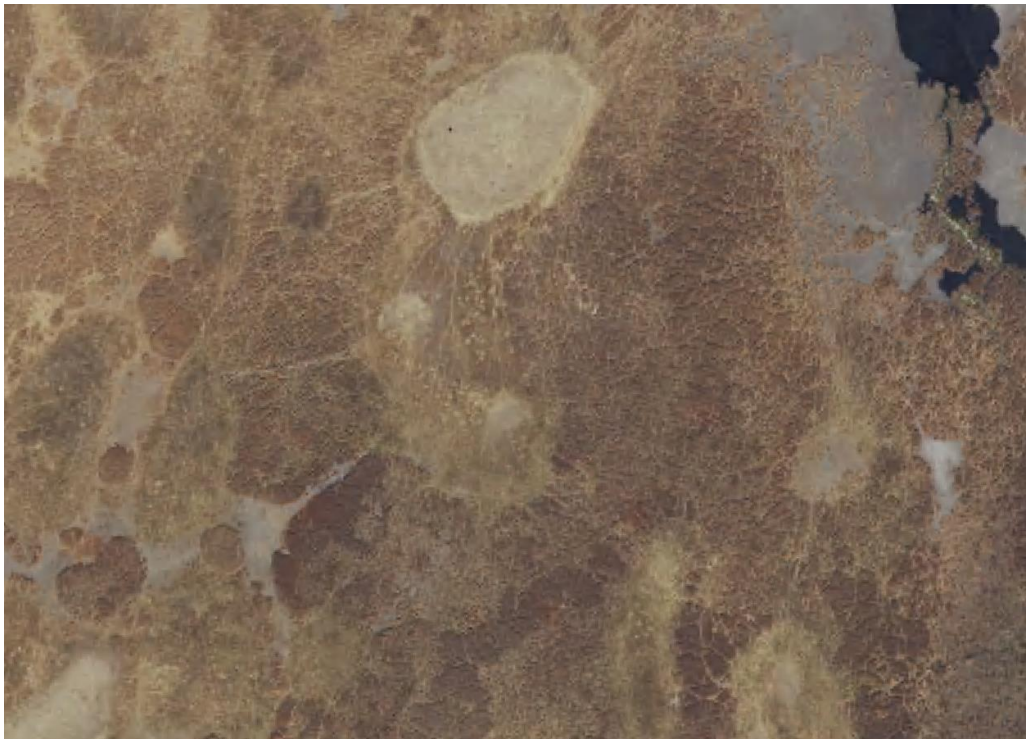
Arctostaphylos patula is a common mid-sized shrub, typically in the 1 to 2-meter height range and has an army-green to brownish-green appearance. Dead grey branches can often be spotted on the imagery, especially in decadent stands. This species can easily be mistaken for *Ceanothus velutinus,* which has a similar signature and often grows together with *Arctostaphylos*.

Arctostaphylos patula - Ceanothus velutinus - Ceanothus prostratus Association

This signature is very similar to the above association, with an army-green to brown-green appearance. When these two species mix, the stands typically become denser with a more closed-off canopy. All three of these species are pyrophytic and regenerate quickly post-fire.

Arid West Interior Freshwater Marsh Group

This group was used to map wet areas with emergent vegetation such as *Typha* spp. and *Schoenoplectus* spp. It has a highly variable signature depending on time of year and moisture presence. Typically, the *Schoenoplectus* is dark in color, ranging from a mid-brown to a dark brown verging on black. *Typha* is most often lighter in color, but can range from mid-brown to tan in the drier seasons. Similar signatures can be seen on both NAIP and Google Earth.



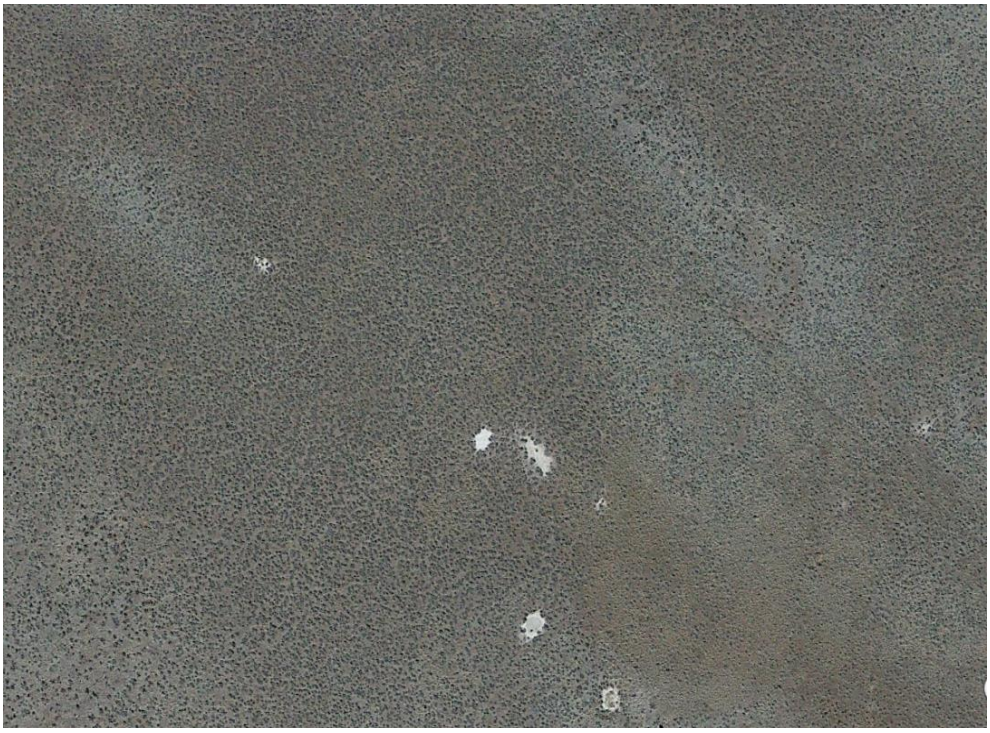
***Artemisia arbuscula* Steppe & Shrubland Alliance**

***Artemisia arbuscula / Poa secunda* Association**

Artemisia arbuscula is a shrub which does not exceed ½ meter in height. It grows well in thin clay soils and prefers flat to moderately sloped terrain. It has a dull grey to light blue-grey appearance on imagery and is often only visible on Google Earth.

Artemisia cana Mesic-Riparian Shrubland Alliance

Artemisia cana prefers flat low-lying areas that are commonly seasonally inundated with water and have thick deep-cracking clay soils. It is larger than *A. arbuscula* but often found adjacent to it, and has a slightly more blue-green hue than *A. arbuscula* and *A. tridentata*. Alkalinity is common in the soils (indicated by the white scalds) and the herbaceous layer is often sparse with vernal pool species present.



***Artemisia tridentata* Shrubland Alliance**

***Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum* Association**

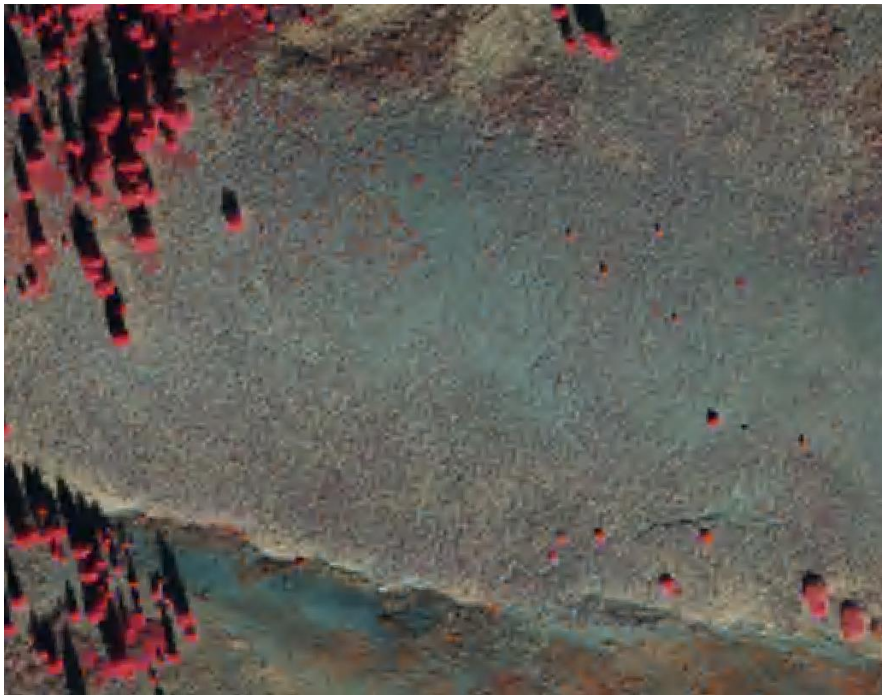
Artemisia tridentata is the largest of the *Artemisia* species in the study area and can reach heights over 2 meters. It can have a variable signature depending on growing conditions, but is generally robust with a grey-green to blue-green appearance on imagery. This association was commonly found in disturbed areas such as roadsides or near agriculture.

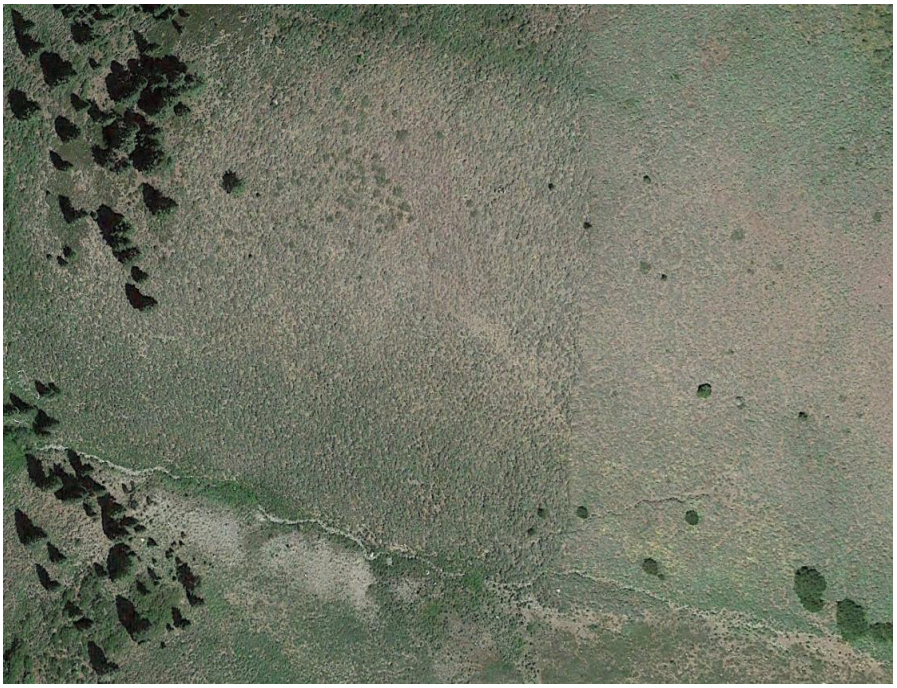
Artemisia tridentata Association

This association has high relative nativity and signs of disturbance are minimal. *Artemisia tridentata* is one of the most commonly found shrubs in the study area and can be found on a wide variety of slopes, aspects and soil conditions. It is typically blue-grey to blue-green.

***Artemisia tridentata ssp. vaseyana* Mixed Steppe & Shrubland Alliance**

Artemisia tridentata ssp. vaseyana starts near 5,000 feet elevation and above in the study area. It occurs in cold environments where there is moderate to deep winter snow accumulation. This subspecies can be identified by its blue-purple hue using the infrared NAIP imagery.



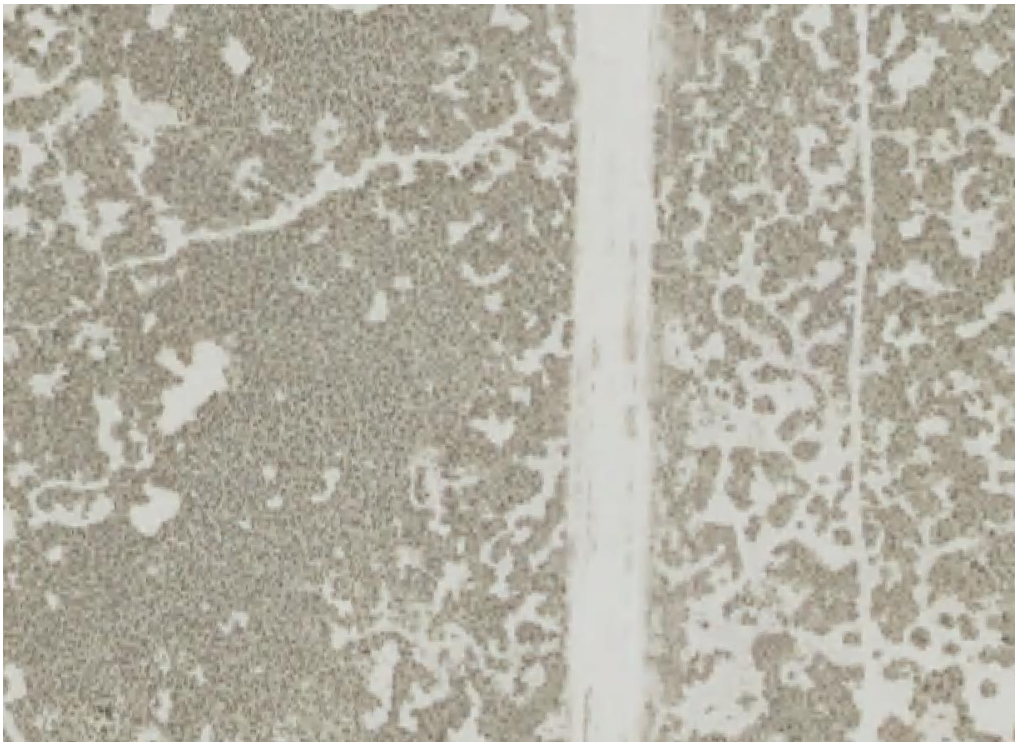


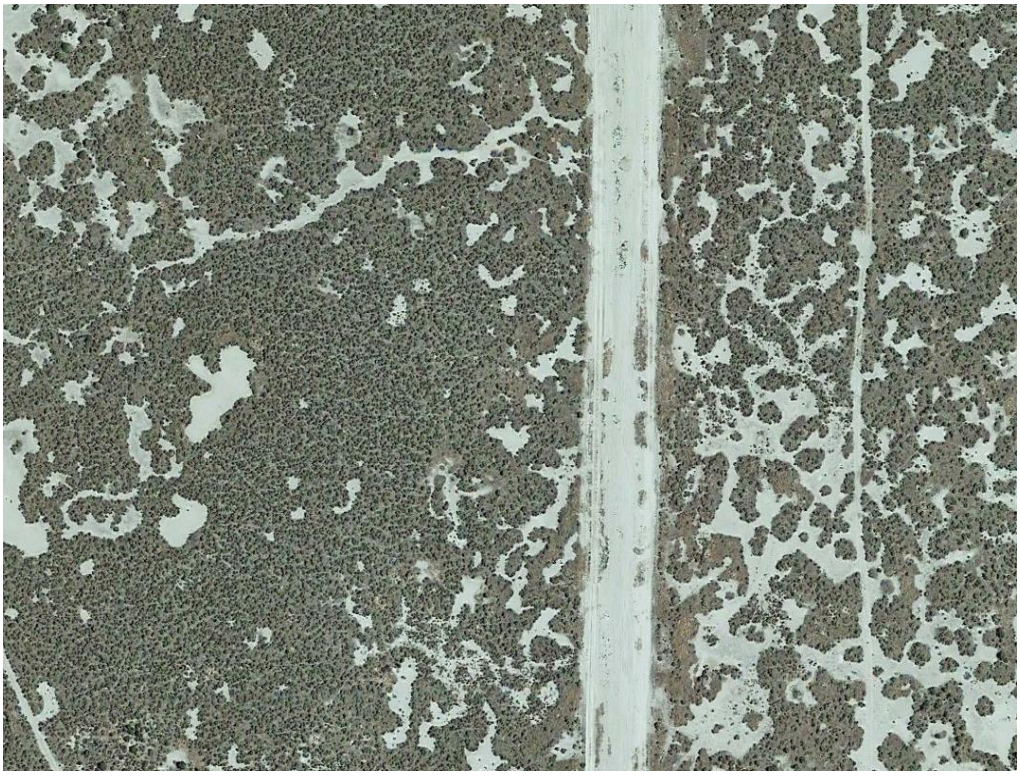
***Atriplex canescens* Alliance**

Atriplex canescens is found in arid areas and can be seen here in infrared imagery popping out as a maroon hue. It is much more difficult to differentiate on Google Earth and was rarely mapped in the study area.

Atriplex confertifolia Alliance

Atriplex confertifolia is found in arid areas near Doyle on the eastern side of the study area. It is often found mixing with and adjacent to *Sarcobatus vermiculatus* stands where alkali scalds are common. It has a compact uniform structure and a grey-green hue.

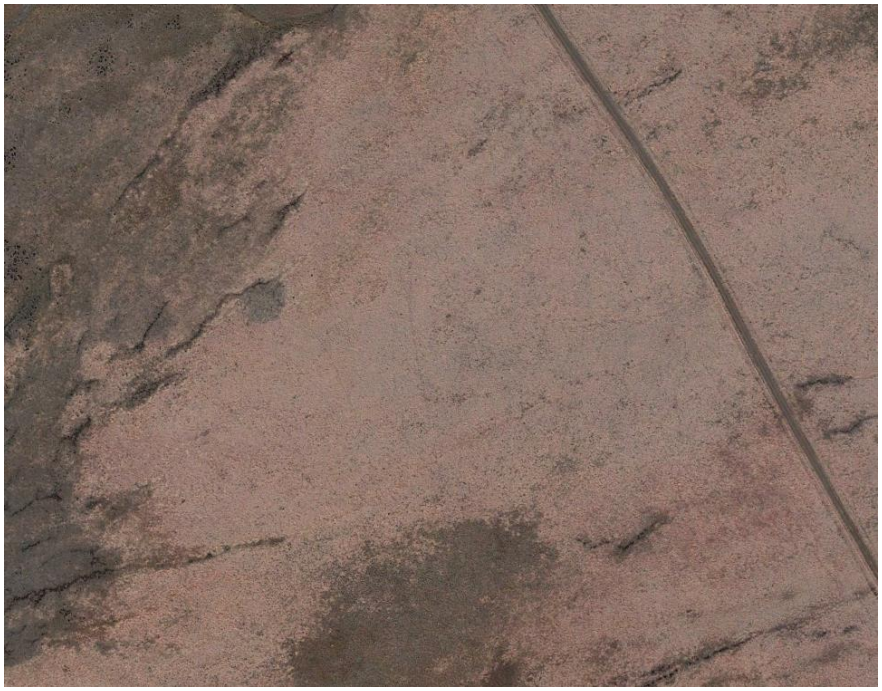




***Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance (The following three Associations were mapped at the alliance level and are included here to show signatures)**

***Bromus tectorum* Association**

Bromus tectorum typically shows up as a bright yellow to white signature on NAIP imagery and commonly has a red hue to it on Google Earth imagery. It was commonly found in our study area in disturbed areas post-fire or in juniper removal areas.

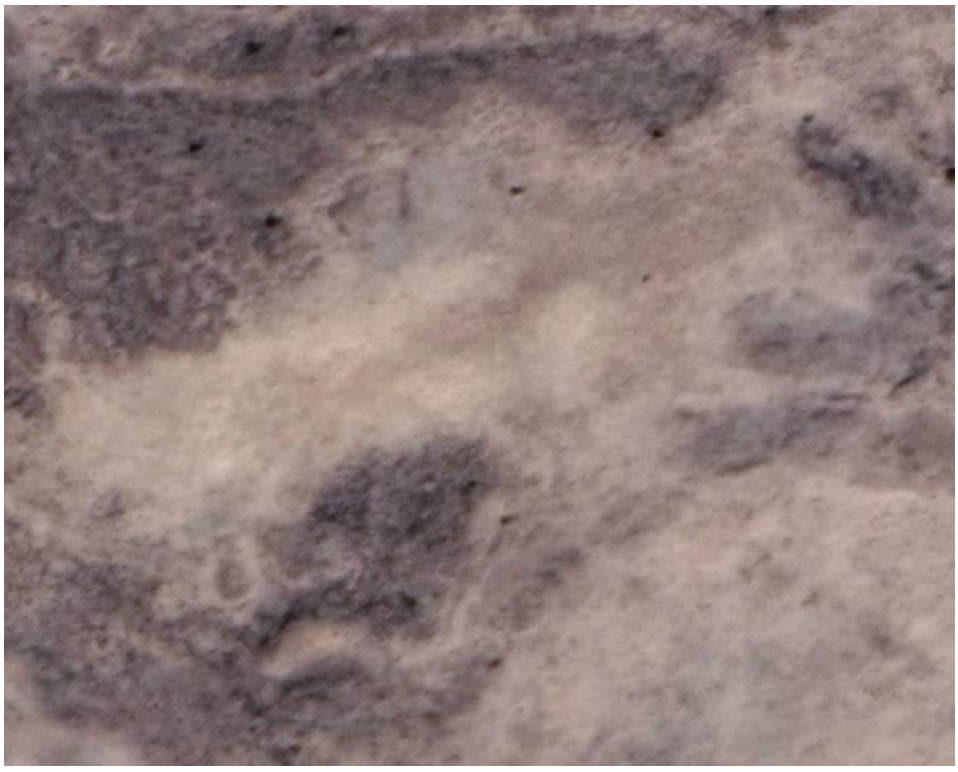


Taeniatherum caput-medusae Provisional Association

This association was common in the study area. *Taeniatherum caput-medusae* can create thick monocultures as well as mix with other weedy grasses and native herbs. Its signature can often be identified by the clumpy thatch piles from the previous year's dead vegetation mixing with the current year's growth. This can best be seen in the second Google Earth image.

Ventenata dubia Association

Ventenata dubia was most commonly found in the northernmost portions of the study area (generally north of Alturas, CA). It grows well in volcanic clay soils of variable depths and is a quick successor of large areas post-fire. It commonly has a light yellow to white signature.



Built-up & Urban Disturbance Mapping Unit

This mapping unit was used for urban and semi-urban settings where dwellings and anthropogenic disturbance was present.

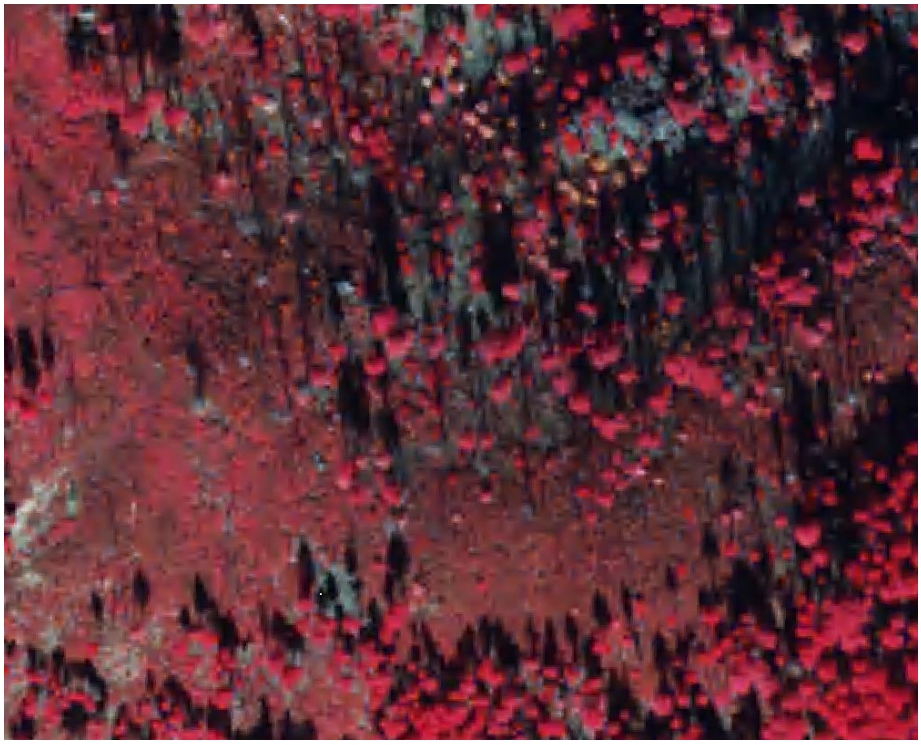
***Ceanothus cordulatus - Ceanothus integerrimus* Shrubland Alliance**

***Ceanothus cordulatus* Association**

Ceanothus cordulatus is a low-growing shrub that quickly regenerates post-fire, often creating large monocultures. It has a blue-green hue and was most commonly found in the western portion of the study area in the mid-to-upper elevations from 4,000 to over 8,500 feet.

Ceanothus integerrimus Association

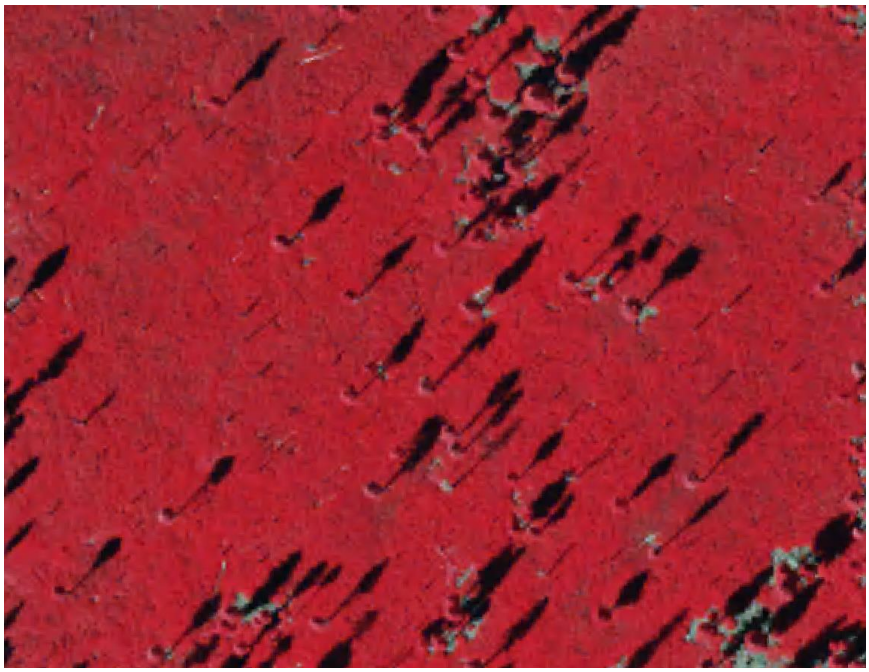
Ceanothus integerrimus is a mid-sized shrub that is quick to follow fires and is often found mixing with and adjacent to *C. cordulatus* stands. *C. integerrimus* can be seen on the infrared imagery in the darker maroon hue and *C. cordulatus* (on the left side) is a much brighter pink-red. On Google imagery *C. integerrimus* is a lush green where *C. cordulatus* is much more blue-green.

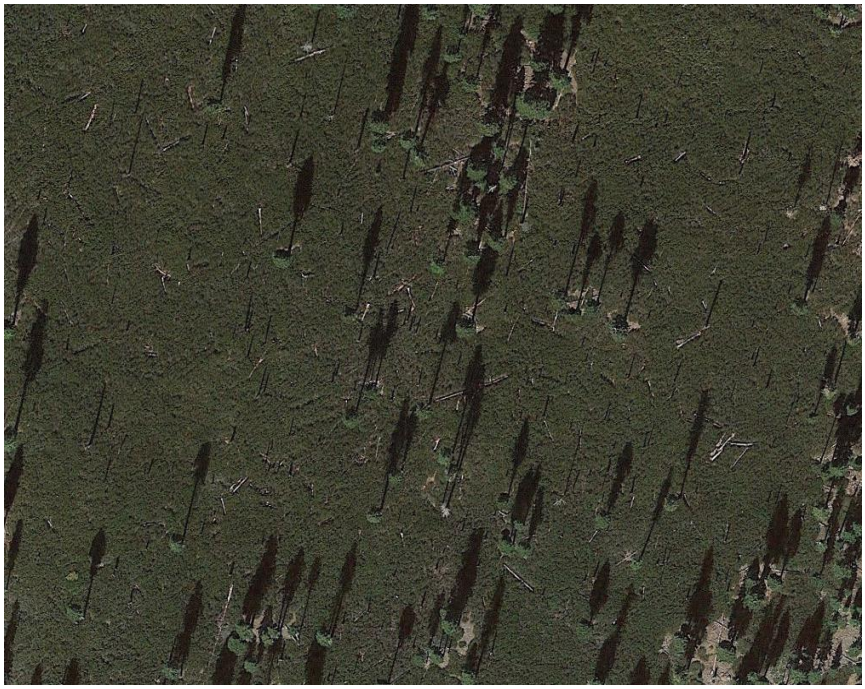


***Ceanothus velutinus* Alliance**

***Ceanothus velutinus* Association**

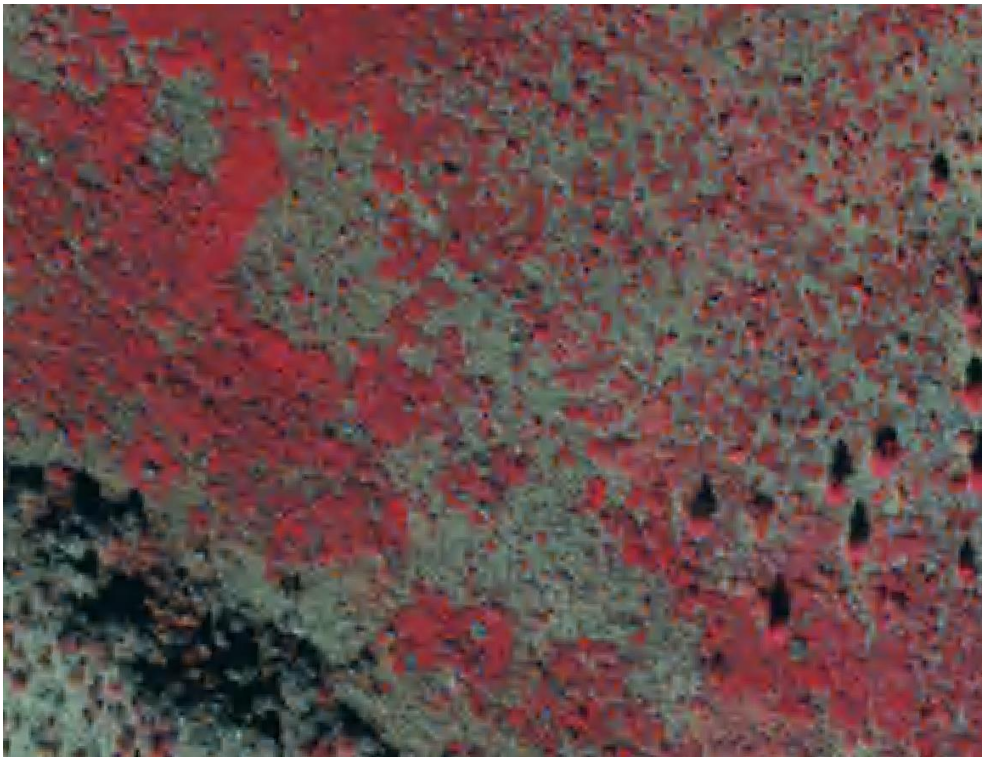
Ceanothus velutinus was commonly found at higher-elevation areas often forming dense, thick mats after fire or disturbance. It has a variable signature, from bright red to a maroon red on the infrared imagery. It has a fairly smooth and flat texture due to its homogenous height, and it grows well on most aspects and slopes. On Google Earth the signature is more of an army-green color.





***Ceanothus velutinus - Prunus emarginata - Artemisia tridenta*ta Association**

These three shrubs commonly mix together, with *C. velutinus* and *P. emarginata* being the most commonly mixing. *Prunus emarginata* is typically taller and is emerging from the *Ceanothus* below with patchy *Artemisia tridentata ssp. vaseyana.*



***Cercocarpus ledifolius* Scrub Alliance**

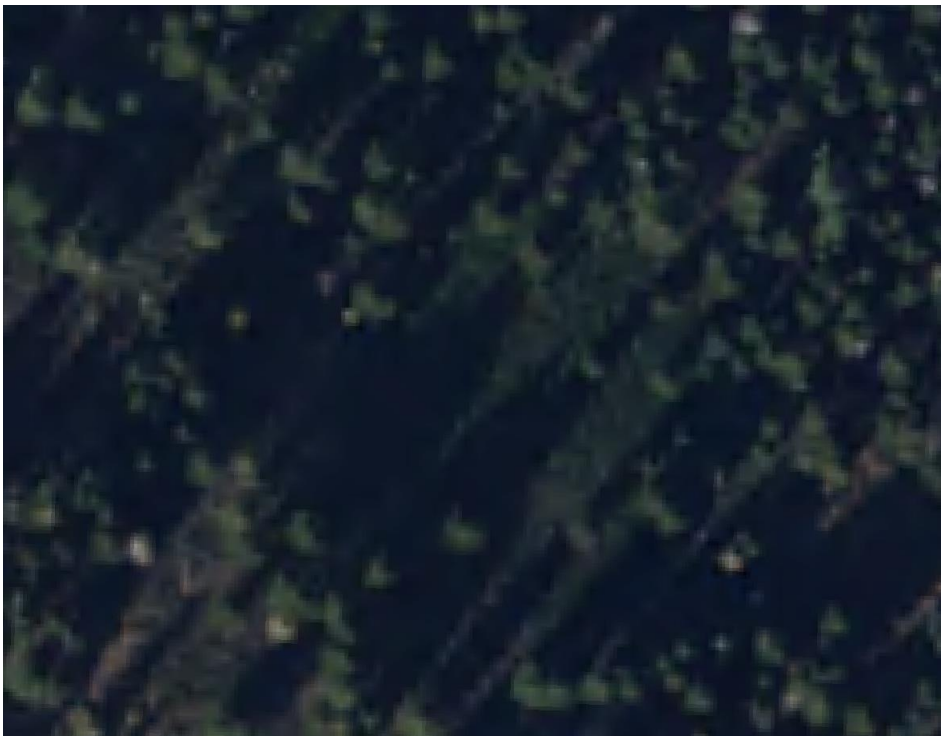
***Cercocarpus ledifolius* Association**

Cercocarpus was most commonly found on mountaintops, mixing with low covers of *Artemisia tridentata*, *Symphoricarpos rotundifolius,* and *Ribes* and *Prunus* species. It is best distinguished on NAIP imagery with its brown to army-green signature and often mixes with *Juniperus occidentalis,* as seen below.

***Chrysolepis sempervirens* Alliance**

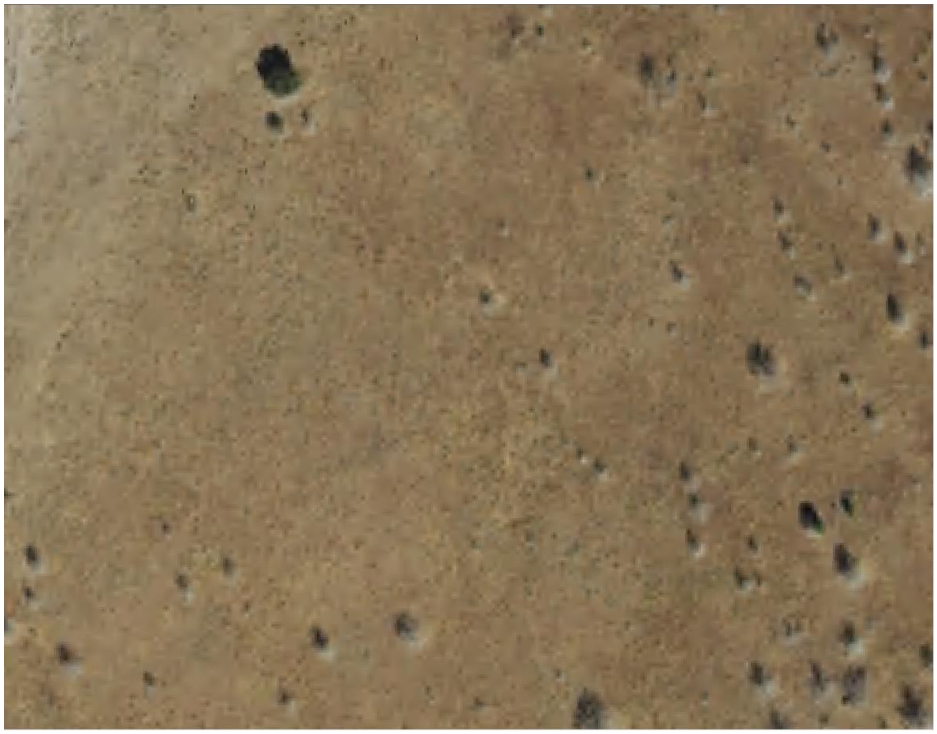
***Chrysolepis sempervirens* Association**

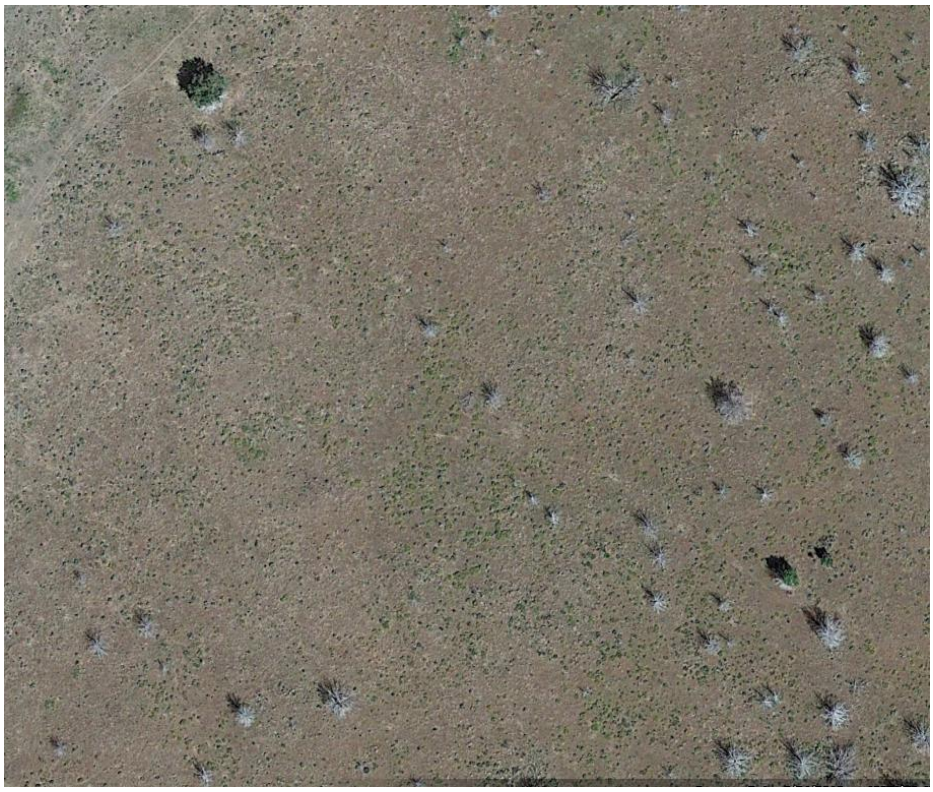
This association was rare in the study area. It has a distinct bright-green signature and typically grows in dense shrub thickets. Stands of this association were often below the 1-acre minimum mapping unit and were included within other vegetation types.



***Chrysothamnus viscidiflorus* Alliance**

Chrysothamnus viscidiflorus is a small-to-medium sized shrub typically homogenous in height, with a bright-to-dark-green hue. It is often found in disturbed areas where fires or agriculture are present. Oftentimes it appears pink to red on infrared imagery.





Cistanthe (umbellata) - Gayophytum (diffusum) Alliance

This alliance is found at higher elevations where there has been disturbance such as logging, and is composed of sparse regenerating herbs that are often a mix of native, naturalized, and invasive species. Note that the signature could also apply to the *Bromus tectorum - Taeniatherum caput-medusae* Ruderal Annual Grassland Alliance or the *Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Alliance depending on the species mix.

Columbia Plateau Cliff, Scree and Rock Mapping Unit

This mapping unit was utilized for rocky areas where there was little to no vegetation present. It has a dark brown to black signature which is representative of the basalt volcanic rocks.

***Cornus sericea* - *Rosa woodsii* - *Ribes* spp. Alliance**

This Alliance rarely occurred in the study area and was most common in the Susanville to Doyle area. It was most often used to map *Rosa woodsii* and the signature has a dark- green hue on NAIP and is a bit more blue green on Google Earth. It occurs only in wet riparian environments and has a homogenous flat signature.

***Danthonia californica - Deschampsia cespitosa - Camassia quamash* Alliance**

This Alliance was typically slightly drier than other wet meadow types and was often found one terrace above them. *Danthonia* and *Camassia* were often co-dominant with wetter species like *Juncus* or *Carex.* It is a difficult signature to map correctly and was often mapped at the Group level.

***Distichlis spicata* Alliance**

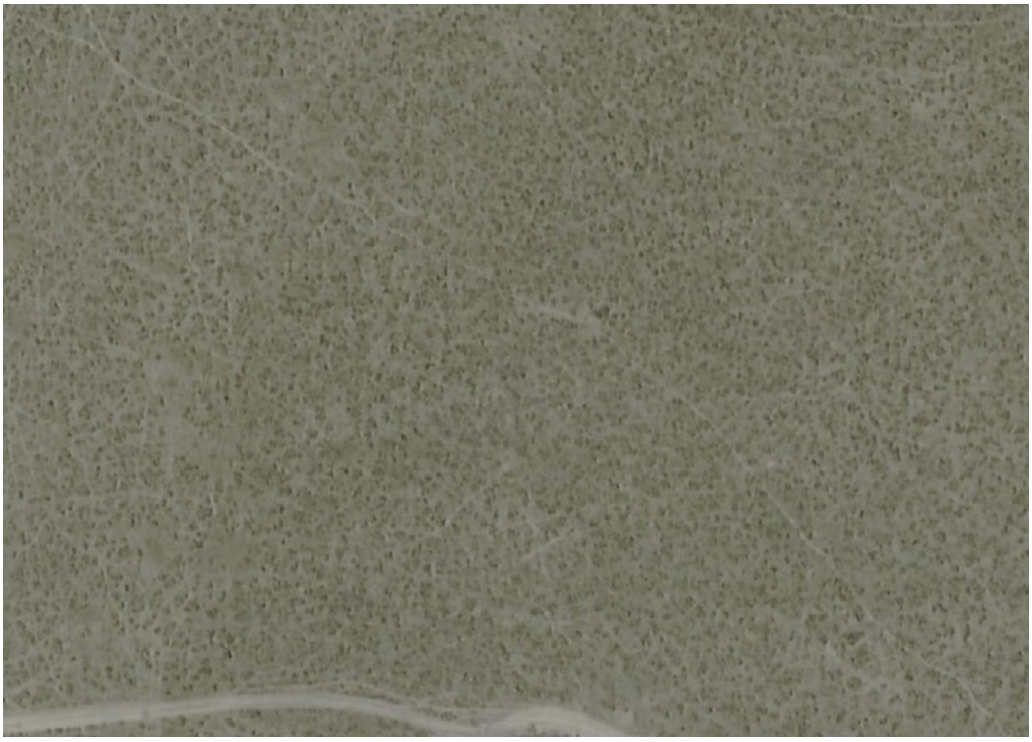
Distichlis spicata is an alkali tolerant grass that is often found around salt scalds and in managed marsh areas. When not completely dried out it has a blue-green signature on both NAIP and Google Earth.

***Elymus cinereus - Elymus triticoides* Alkaline Wet Meadow Alliance**

This sometimes looks like a shrub due to its large size, it most often has a deep-green signature on Google Earth and can often be distinguished from shrubs by its large white flower stalks. When in drier areas, the signature can be variable and more challenging to pick out.

***Ephedra nevadensis - Lycium andersonii - Grayia spinosa* Alliance**

Grayia spinosa is a common shrub in the Great Basin, but was fairly uncommon in the study area. It was found in the drier eastern areas often near alkali *Sarcobatus* stands.

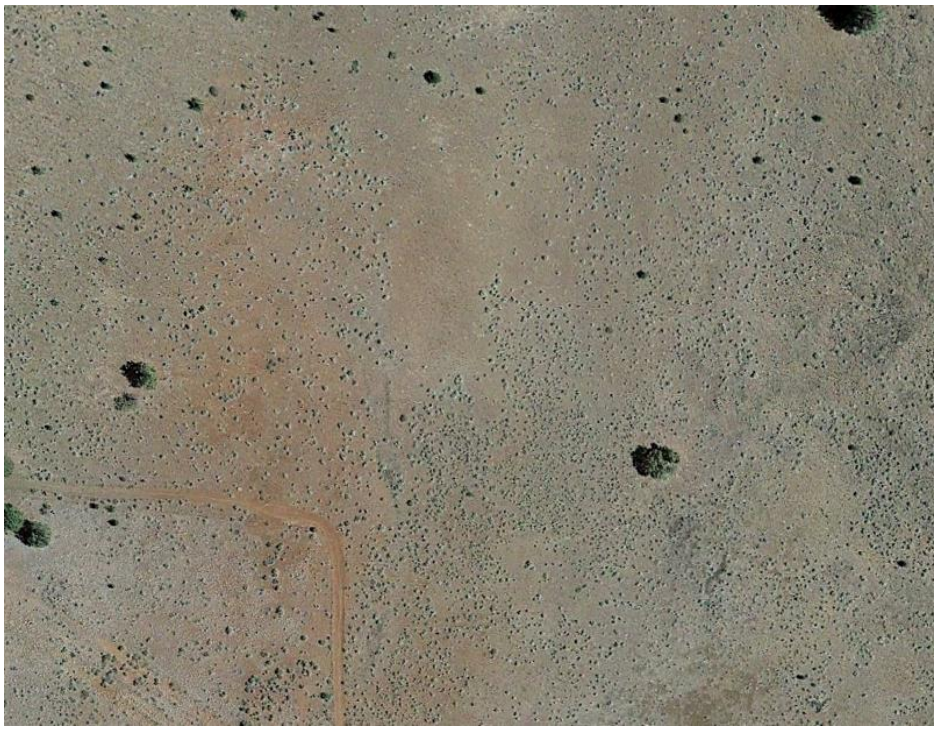


Ephedra viridis Alliance

Ephedra viridis grows in arid climates, often on steep-sparse slopes, and occurred on the eastern side of the study area. It is best detected using infrared imagery where it has a mid-to-dark-red hue and commonly grow to be wide and in non-uniform shapes. On Google Earth it is typically army to very dark green.

***Ericameria nauseosa* Shrubland & Shrub Herbaceous Alliance**

This Alliance has a distinct blue-green signature on Google Earth and when using the CIR layer (not shown here) it will pop out as bubble gum pink. It is often found in disturbed areas and very commonly along roadsides.



***Eriogonum* spp. / *Poa secunda* Dwarf-shrub Herbaceous Alliance**

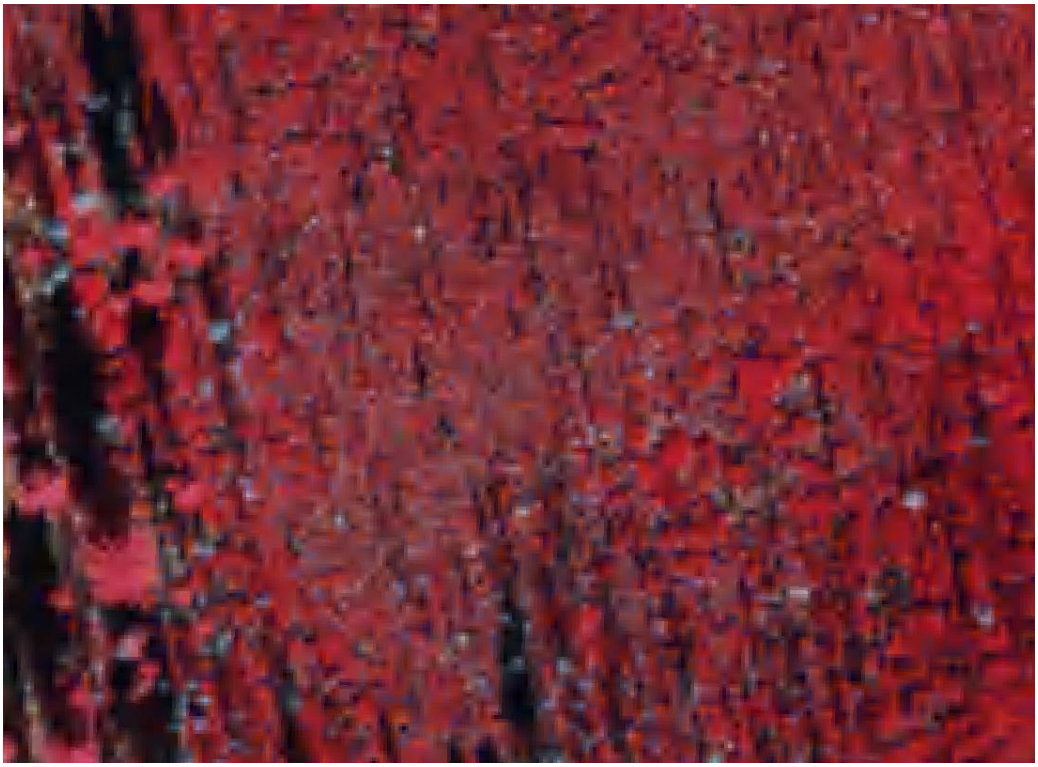
Dwarf shrubs of *Eriogonum* species (*E. vimineum*, *E. sphaerocephalum*, *E. prociduum*) are characteristically present, even as low as <1% cover. Generally, on flats or exposed hilltops with significant volcanic cobble and/or gravel covering the soil surface. Total vegetation cover is usually <10% and often <5%. Photo-interpreters used the thin volcanic soils as an indicator for this Alliance.

***Festuca idahoensis - Pseudoroegneria spicata - Poa secunda* Alliance**

They are best seen on Google Earth where distinct homogenous mounding/clumps of bunch grasses persist, often turning yellow white later in the season.

Hesperocyparis bakeri / Arctostaphylos patula Association

This Association was very rare in the study area and was only detectable in a few spots close to survey points. It has a maroon signature on infrared NAIP imagery and has a minty green hue on Google Earth. All stands were composed of small trees regenerating post fire.



Intermountain Semi-Desert Grassland Group

This group was utilized to map areas where *Ladeania lanceolata* had significant presence. *Ladeania* is a sensitive species that prefers disturbance and is commonly found in sand near roads, dunes, and off-highway vehicle disturbance. Occurrences were only in the Fort Sage OHV park.

Irrigated Pastures Mapping Unit

These areas are typically wet late into the summer months and show signs of irrigation with piping or canals. Grazing trails and/or livestock are typically present.

***Juncus arcticus (var. balticus, mexicanus)* Wet Meadow Alliance**

This Alliance is typically found at the lowest, wettest parts of a meadow. The signature starts off dark green early in the year and fades to a distinctive mid-to-dark brown.

***Juniperus occidentalis* Woodland Alliance**

***Juniperus occidentalis / Artemisia arbuscula / Poa secunda* Association**

Juniper can have various shapes and sizes and can have multiple leaders or one dominant leader. It grows on all aspects, in a variety of soil depths, and covers a wide range of elevation. It typically has an army-green appearance on imagery and rarely exceeds 15 meters in height.

***Juniperus occidentalis / Purshia tridentata - Ceanothus prostratus* Association**

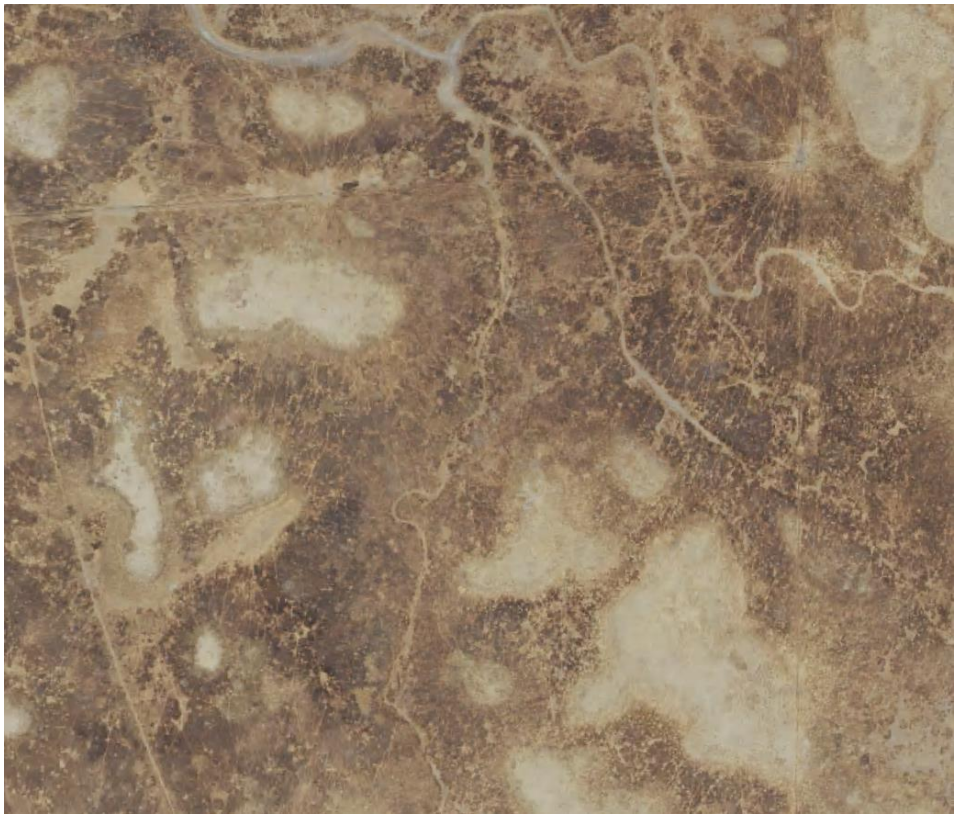
Juniperus occidentalis commonly mixed with *Pinus* species and *Cercocarpus ledifolius, it* was found in transitional areas between pure juniper stands and pine forests. Juniper is pale green to army green in color and *Cercocarpus* can be differentiated by its brownish hue.

***Juniperus occidentalis / Artemisia tridentata - Purshia tridentata* Association**

Pines are typically absent, and stands are at lower elevations compared to the *Juniperus occidentalis / Purshia tridentata - Ceanothus prostratus* Association. *Artemisia tridentata* is present with at least 1% cover but typically dominates or co-dominates the shrub layer. *Purshia tridentata* is usually present with *A. tridentata* and may dominate the shrub layer, but less commonly than *A. tridentata*. *Cercocarpus ledifolius* and *Prunus* spp. are typically absent.

Oregon - Washington - British Columbia Vernal Pool Group

This Group is indicated by the vernal swales and pools which dry out seasonally but are wet for a good portion of the year.



***Penstemon newberryi* Alliance**

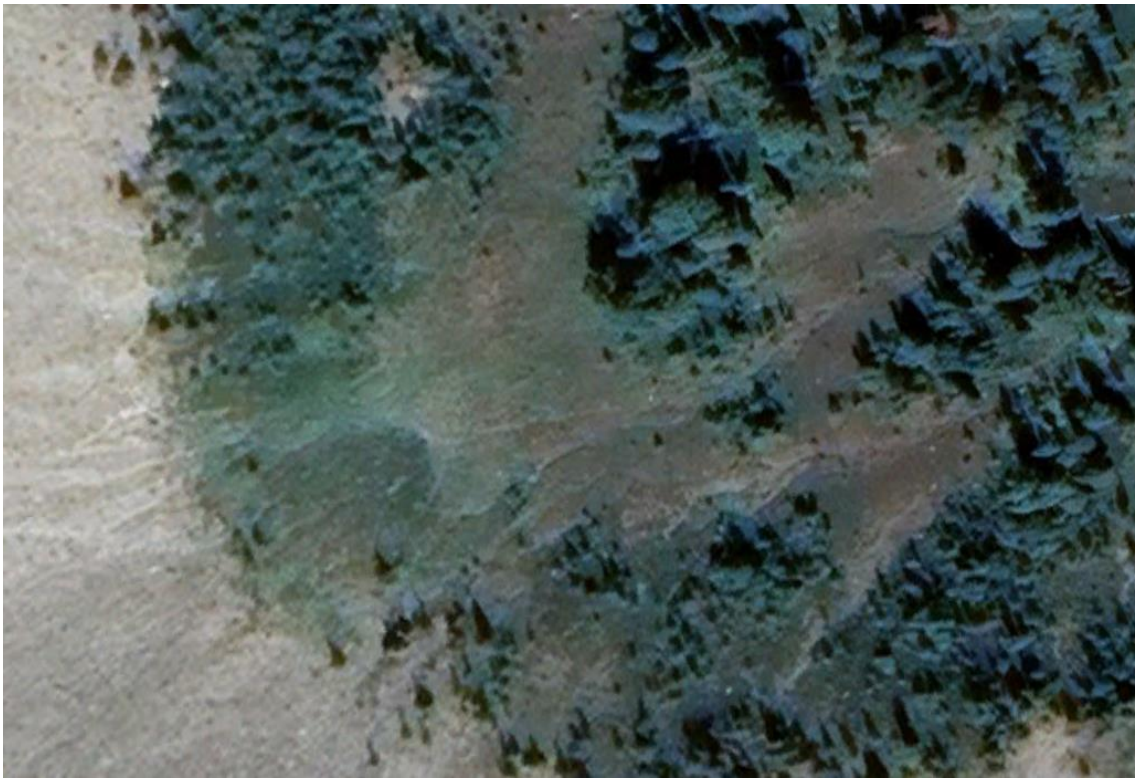
P. newberryi is low growing, sparse, and typically found on steep rock outcroppings. It is only detectable from field survey information.

Perennial Stream Channel (Open Water) Mapping Unit

Rivers and creeks that flow or retain water year-round.

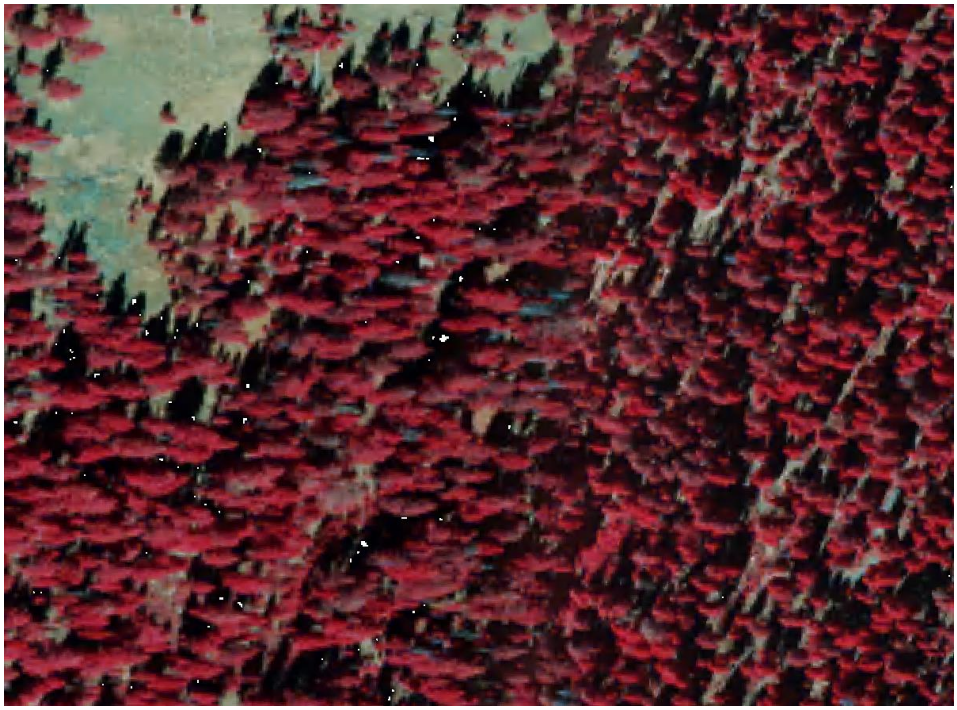
***Phyllodoce breweri - Cassiope mertensiana - Juncus parryi* Alliance**

This Alliance was rare in the study area and was only mapped at the top of Mount Lola. It occurred at high elevations in seeps just below deep receding snowpack.



Pinus contorta Alliance

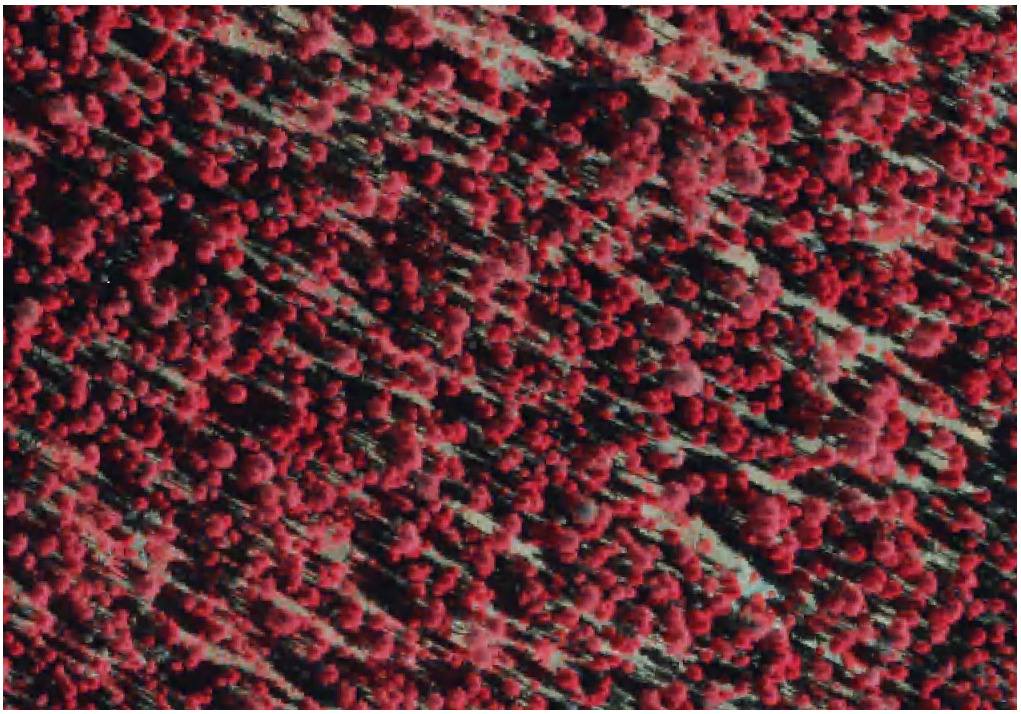
Pinus contorta is best identified by using the infrared NAIP imagery where it gets at purple-pink hue to it compared to the bright red *Abies concolor* in this image. It is found on wet hillsides and commonly surrounds marshes and meadows at mid-to-upper elevations.



***Pinus jeffreyi* Alliance**

***Pinus jeffreyi - Abies concolor* Association**

This Association was common in the study area and the *Pinus jeffreyi* are seen here as bubble gum pink on the infrared imagery and *Abies concolor* is dense dark red. These stands typically start around 5,800 feet elevation up to 7,000 feet.

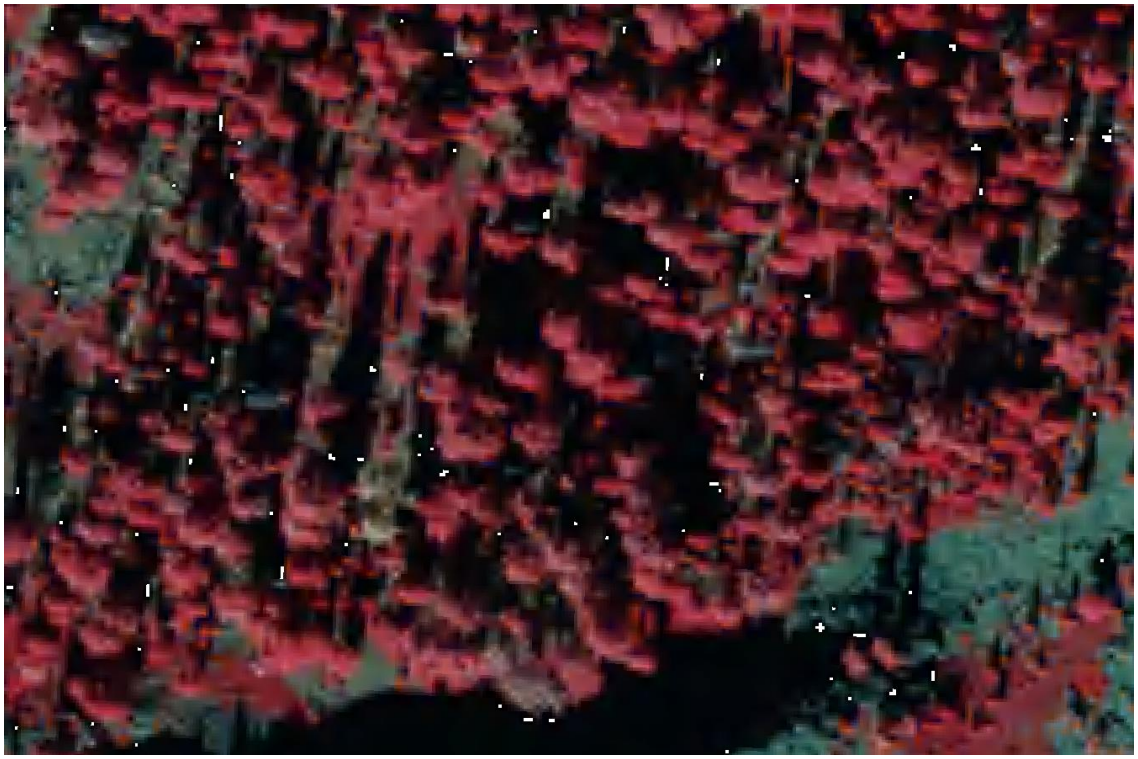


***Pinus jeffreyi* Association**

Pinus jeffreyi is strongly dominant and the shrub and herbaceous layers are sparse. *P.* jeffreyi was typically found in the eastern portion of the study area and commonly mixed with *Pinus ponderosa*. Often times the bole of the tree is visible in shadows due to dropping of lower branches as they mature.

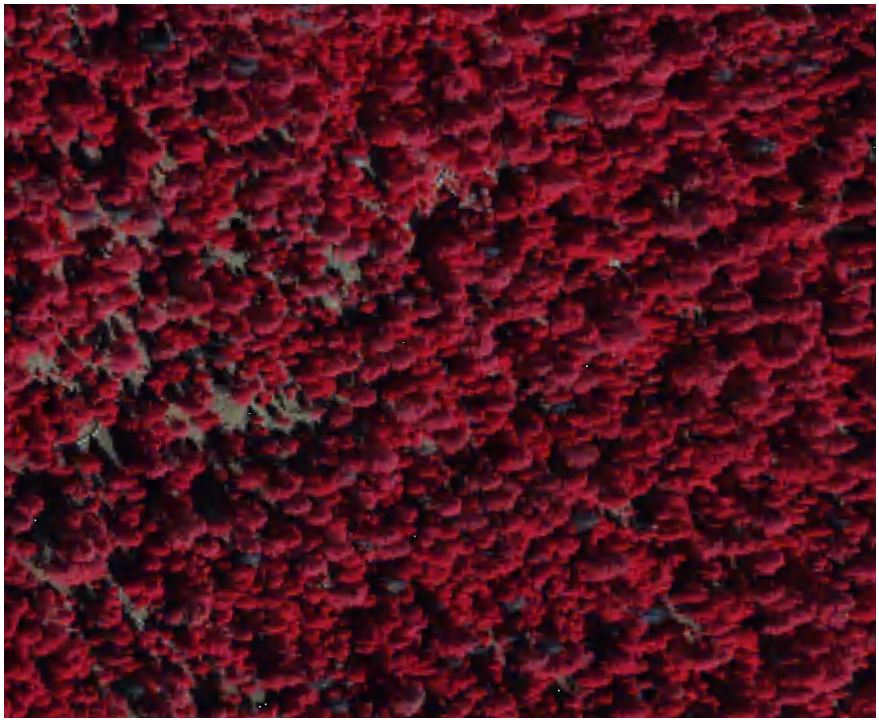
Pinus monticola Alliance

Pinus monticola occurs near 7,000 feet and above in the study area, and its signature on infrared imagery is similar to *Pinus jeffreyi*. It is best identified on Google Earth where its long sweeping branches (similar to *P. lambertiana*) are clearly visible, but not quite as long.



***Pinus ponderosa - Calocedrus decurrens - Pseudotsuga menziesii* Alliance**

Calocedrus decurrens and *Pseudotsuga menziesii* both show up on infrared imagery with a bright red hue. Their signature can be confused with *Abies concolor*, but *Abies* is typically found at higher elevations. *Pinus ponderosa* can be seen here in the pink hue. This Alliance occurred mainly on the western portion of the study area.



***Pinus ponderosa* / Shrub Understory Central Rocky Mountain Alliance**

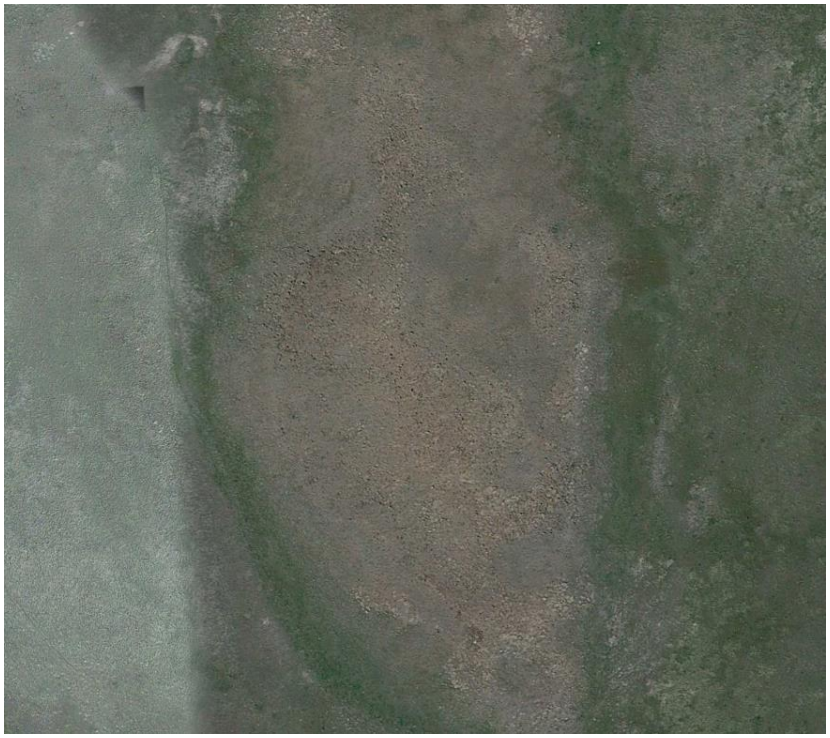
Pinus ponderosa is often confused with *Pinus jeffreyi* but can often be differentiated by the greener color for *P. ponderosa* and a blue-gray green for *P. jeffreyi*. General location is also used to differentiate the two where *P. ponderosa* is considered the wetter-west-side pine and *P. jeffreyi* is the drier-east-side pine, with the crest of the Sierra Nevada mountain range being the general dividing line.

***Pinus (jeffreyi, ponderosa) / (Ceanothus prostratus - Purshia tridentata)* Association**

Pinus sp. can be seen here with the taller shadows and green appearance. *Juniperus* trees are sparse, shorter and are a rusty green. *Cecocarpus* can be seen in brown mostly in the southern portion of the stand.

***Poa secunda - Muhlenbergia richardsonis - Carex douglasii* Alliance**

Stands without strong representatives from either the Californian or Oregon-Washington-British Columbia Vernal Pool Groups. Species present were typically more widespread and typical of slightly alkaline western interior seasonal wetlands such as *Muhlenbergia* spp., *Carex douglasii*, and *Poa secunda* (moist meadow ecotypes). This Alliance was mapped more often from ground surveys than by photointerpretation.



***Populus tremuloides* Forest Alliance**

The *Populus tremuloides* can be seen here on the NAIP imagery in its yellow fall color, and is typically smooth in texture and deep green in color (such as in the Google Earth imagery). In the study area, it is typically shorter in size and more clonal than *P. trichocarpa*. It is frequently found in dense thickets on shaded-cool-northern slopes near rock outcroppings and seeps.

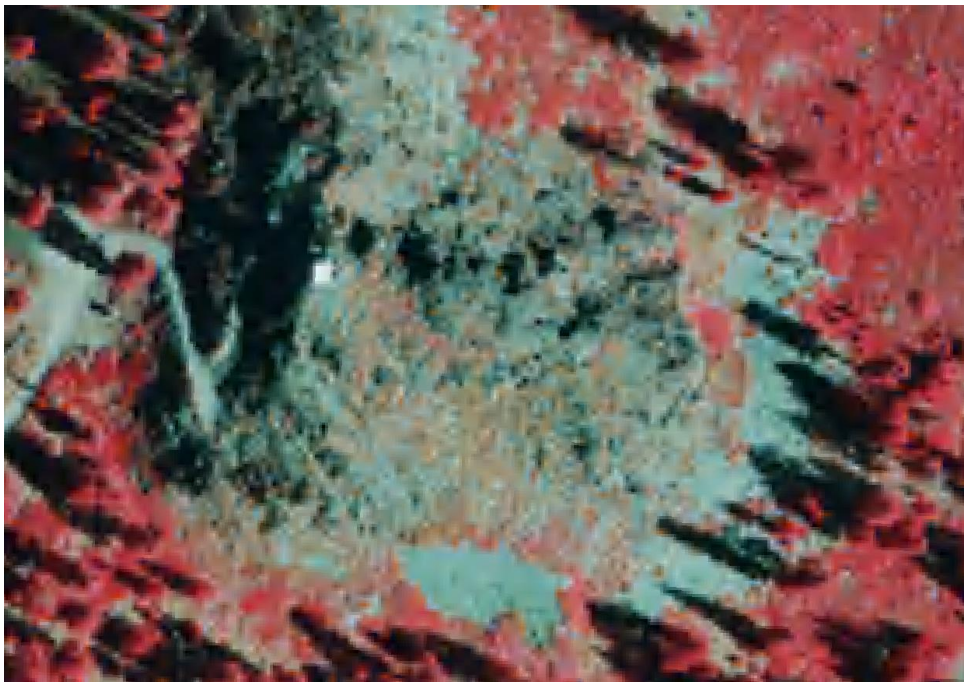
***Populus trichocarpa* Northern Rocky Mountain Riparian Forest Alliance**

Populus trichocarpa was typically found along stream margins and can be seen below in its yellow-green fall colors. It was found in our study area to be taller than *P. tremuloides,* with a greater diameter at breast height, more branching, and with greater spacing between individuals.

Prunus emarginata - Holodiscus discolor Shrubland Alliance

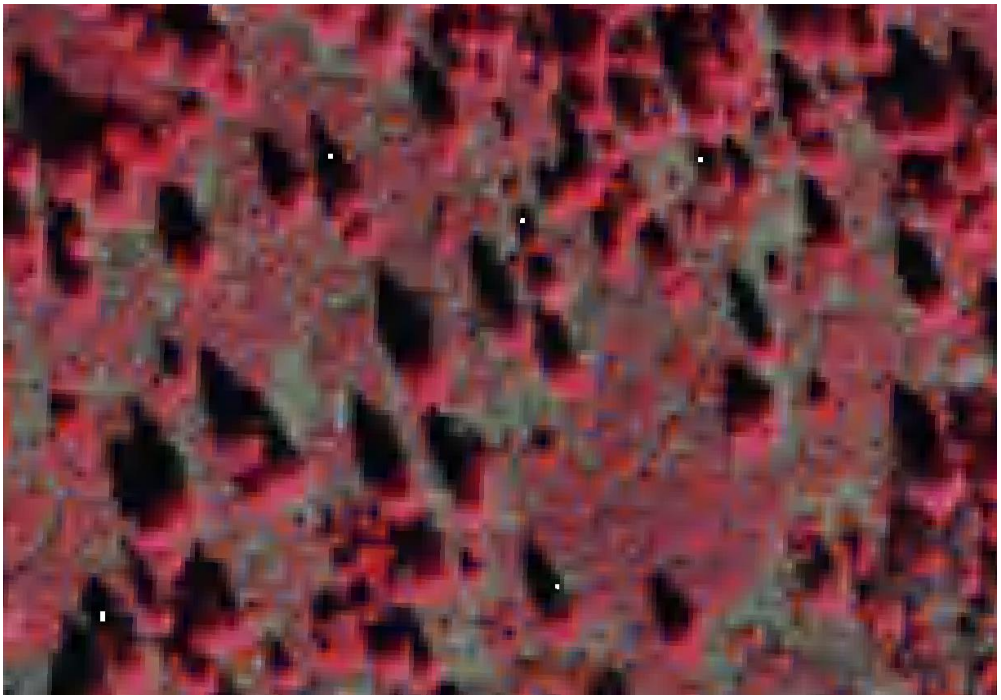
Holodiscus discolor Association

This Association occurs primarily in rocky outcrops and on mountaintops or in the talus piles below ridgelines or summits. It is best detected on infrared NAIP imagery and has a unique orange signature and was often identified by photo-interpreters based on its rocky environments.



***Prunus emarginata* Association**

This Association was commonly found in similar rocky environments as *Holodiscus* (above) and/or on northern aspects. It was best detected on infrared imagery where it appeared maroon pink. On Google Earth imagery, it has a variable mid-to-dark green hue in summer and has a brown signature in early spring/winter. Stands were typically small in size.



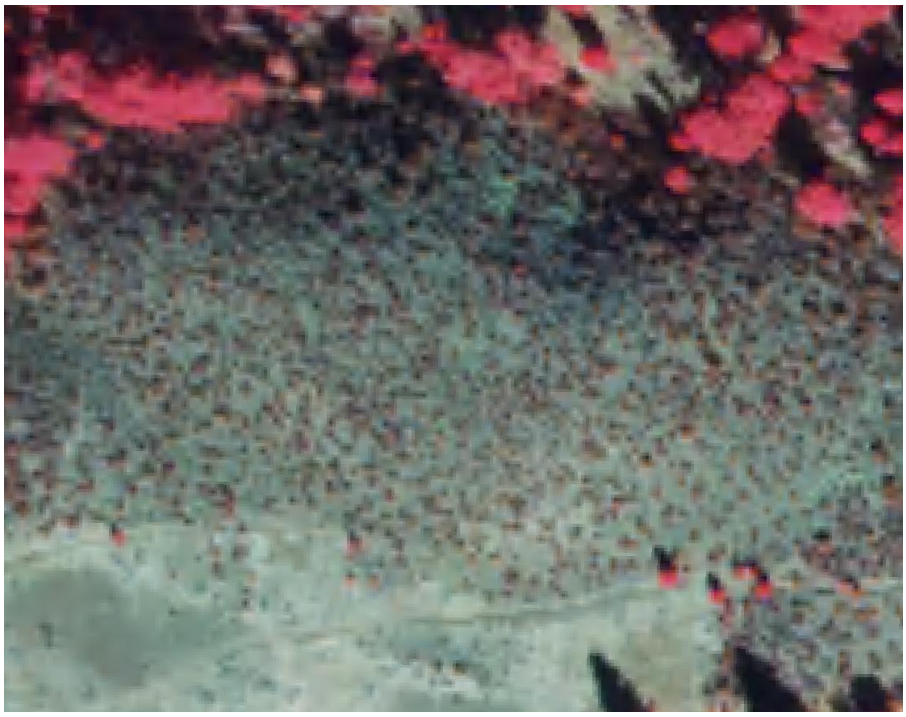
***Prunus virginiana* Alliance**

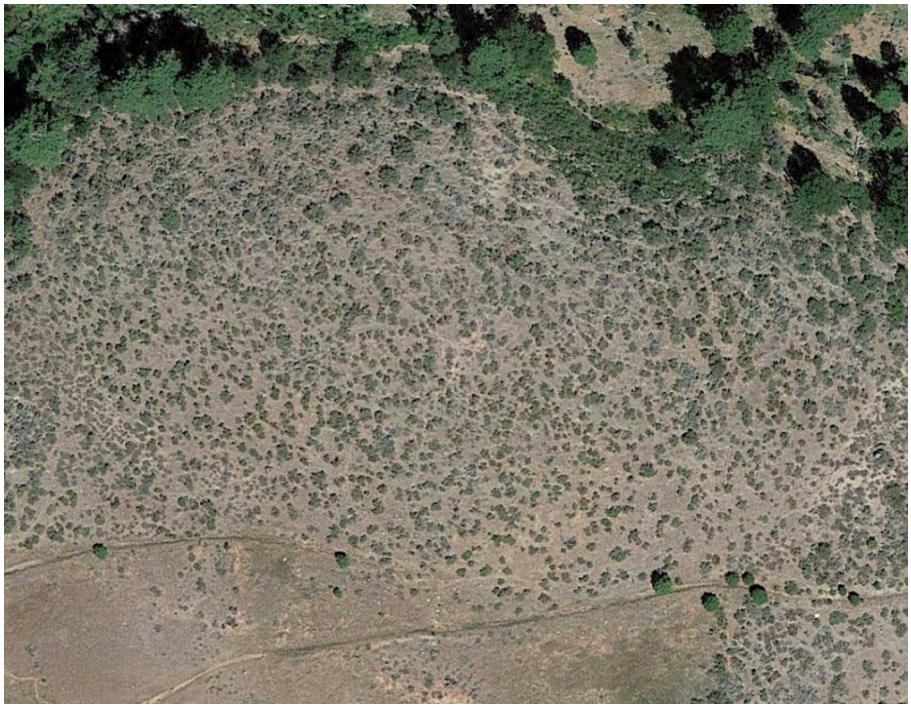
This Alliance was utilized for *Prunus virginiana* and *P. subcordata*, both having a very bright green signature on Google Earth and often found in the lower slopes of talus piles. Both of these *Prunus* species have a similar signature and are best seen on infrared imagery where they have a bright pink to orange pink hue.

***Purshia tridentata - Artemisia tridentata* Mesic Steppe & Shrubland Alliance**

***Purshia tridentata - Artemisia tridentata* Association**

These two shrubs frequently grow together in the study area, and in this example *P. tridentata* is strongly dominant over *A. tridentata*. *P. tridentata* typically has a dark green signature on Google Earth and can be differentiated from *Artemisia tridentata* via the CIR layer, which makes *Purshia* stands out with its dark red color.



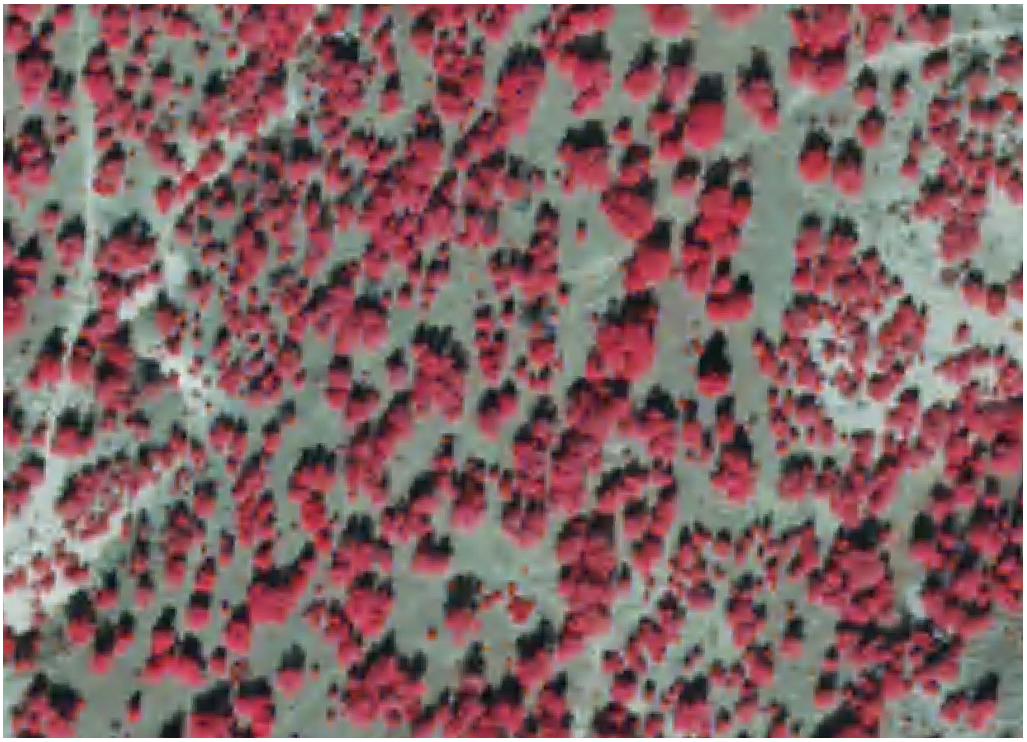


Quercus chrysolepis Alliance

This Alliance was rare in the study area mostly occurring on very western edge of the study area. It was found at mid elevations on very steep slopes and was distinguished by its uniform mounding and its dark-evergreen signature on both NAIP and Google Earth.

Quercus kelloggii Alliance

Quercus kelloggii is best detected on Google Earth imagery during the fall when its leaves are turning yellow as seen below. It has a red with a slight pink hue on infrared imagery and is often difficult to separate from young *Pinus* species.



Tetradymia canescens Association

Tetradymia canescens or *Tetradymia glabrata* are strongly dominant in the shrub layer with other disturbance-related species such as *Chrysothamnus viscidiflorus* and *Ericameria nauseosa*. Severe disturbance is indicated by lack of *Purshia tridentata* and *Artemisia tridentata* cover. The herb layer is dominated by non-natives such as *Bromus tectorum*, *Tragopogon dubius*, and/or *Sisymbrium altissimum*. This is a mixed signature that was difficult to interpret and was most often identified via field surveys.

***Salix boothii - Salix geyeriana - Salix lutea* Montane Wet Shrubland Alliance**

This riparian-mixed shrub Alliance was mainly utilized by photo-interpreters when there was a significant presence of *Salix lasiandra*. It was commonly mixed with other *Salix* species such as here where it is mixing with *S. exigua* but is much taller and greener than *S. exigua*.

***Salix eastwoodiae - Salix lemmonii* Alliance**

This Alliance occurs in the higher elevations with *S. lemmonii* starting around 6,000 feet and *S. eastwoodiae* around 7,600 feet. *S. lemmonii*, the more common of the two species, is shown here in dark green with a ting of yellow. *S. eastwoodiae* has a very similar blue-green signature to *S. exigua* (next Alliance), but *S. exigua* is common in lower elevations.

***Salix exigua* Alliance**

Salix exigua is a riparian shrub that is low and homogenous in height, and has a sage blue to a green or rusty-green signature. It tended to be more of a green to rusty-green hue in the study area especially in the Susanville and Long Valley areas. Easily confused with other *Salix* species when without the presence of survey points.

***Salix lasiolepis* Shrubland Alliance**

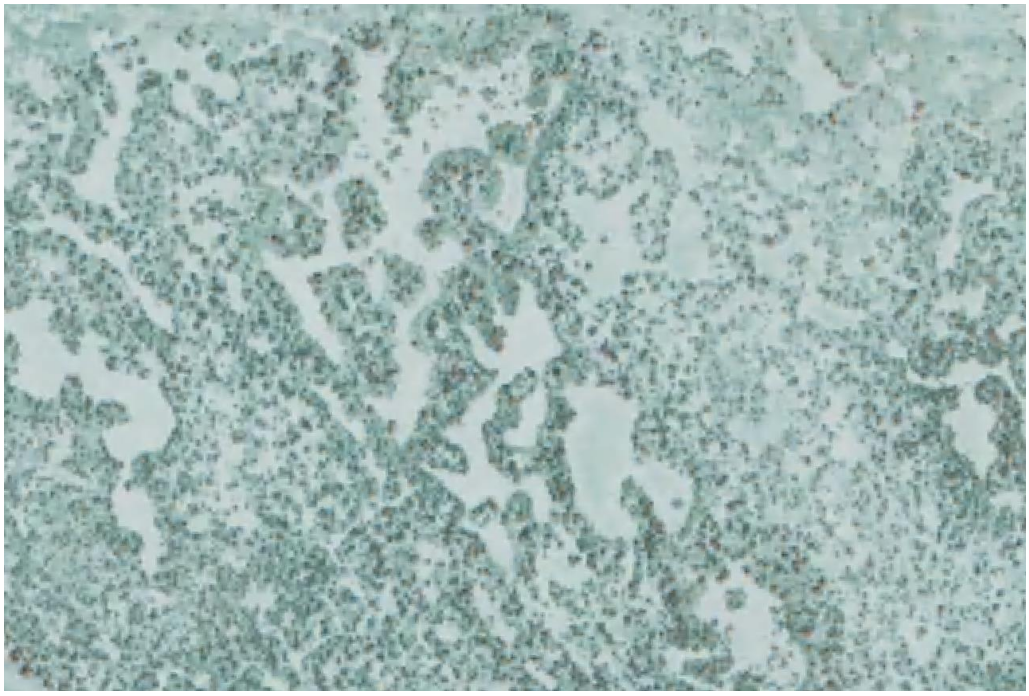
Salix lasiolepis has a rich dark green signature and is most often found streamside in long linear stands. It the study area it is about as wide as it is tall which creates a mounding appearance. Found in lower to mid-level elevations.

***Salix scouleriana* Provisional Alliance**

Salix scouleriana is among the tallest of the *Salix* species in the study areas and is often found emerging from *Ceanothus velutinus* a few years post fire. It is one of the few *Salix* species that regularly occurs outside of riparian environments. It is best detected by its yellow fall color on Google Earth and can potentially be confused with *Quercus kelloggii*.

***Sarcobatus vermiculatus* Alliance**

Sarcobatus vermiculatus is a medium-sized shrub that occurs in alkali areas where the herbaceous layer is often sparse. It has a deep red to maroon hue similar to *Purshia tridentata* in the infrared imagery, but can be differentiated by the alkalinity and flat lowland environment. Sometimes the deep red color does not show up on the infrared and it is more of a darker gray color.

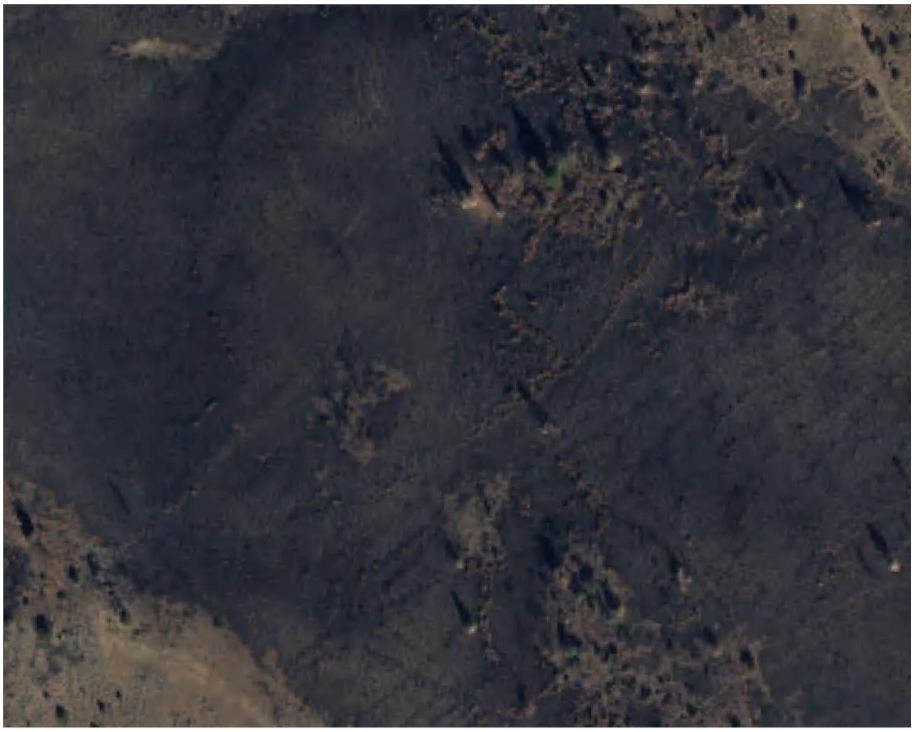


Small Earthen-dammed Ponds & Natural Lakes Mapping Unit

Most of the water bodies mapped during this project fell under this category, which includes both natural and man-made ponds and lakes of varying sizes.

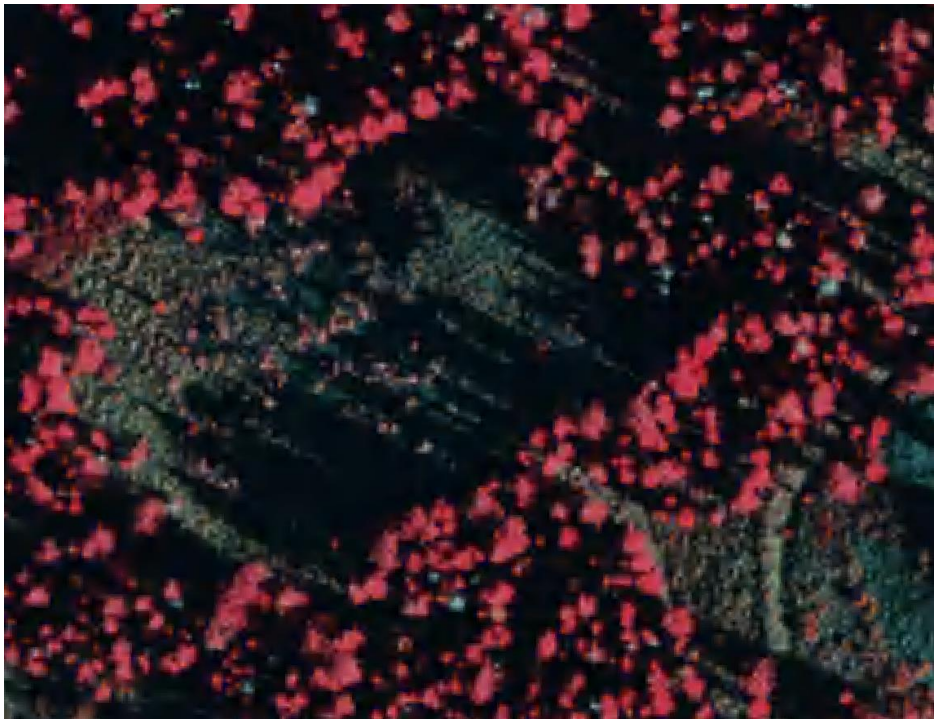
Sparsely Vegetated Recently Burned Areas Mapping Unit

This mapping unit was utilized when there was very recent fire evidence and the photo-interpreters were not able to see enough vegetation to determine a vegetation classification. Dark charred soils were common in these areas.



Symphoricarpos oreophilus Association

This Association is common in disturbed areas where fire or logging has taken place at higher elevations above 5,000 feet. There is typically a red to pink hue to this signature on infrared imagery and signs of clearing or downed debris are common. *Ribes, Chrysothamnus*, and *Wyethia* are commonly found mixing in these areas. Strongly dominate-mature stands of *Symphoricarpos* were uncommon.



***Tamarix* spp. Alliance**

Tamarix is a mid-to-large sized shrub often with a scraggly appearance. It can be seen here on both NAIP and Google imagery as the sparse-dark-green shrubs east of the riparian strip. It is often found around stream beds and disturbance.

Tree Developed Vegetation Mapping Unit

This mapping unit was utilized when the photo-interpreter could identify non-native trees and/or shrubs that were most likely planted by humans and were often found near homes or old homesteads.

***Tsuga mertensiana* Alliance**

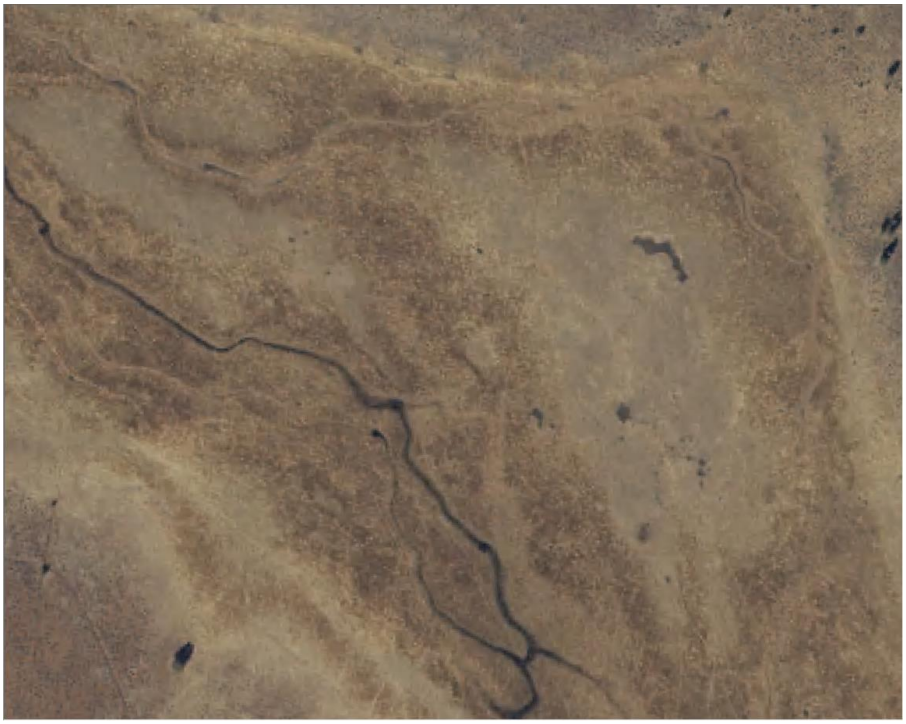
T. mertensiana was found at higher elevations 7,000 feet and above, preferring northern aspects in the study area. It is best characterized by its pointy often bent over tree tops which can often be seen in the shadows of the imagery. It has a scraggly disheveled appearance.

Tsuga mertensiana - Pinus monticola Association

These two species co-dominated with each other at higher elevations mostly in the Lake Tahoe portion of the study area. The furthest north stands in the study area were found on Mt. Ingalls in Plumas County. Both trees have a scraggly sweeping branch structure, with the *T. mertensiana* having a bent pointed top***.***

Vancouverian - Rocky Mountain Montane Wet Meadow & Marsh Group

Stands occur in flooded, wet, moist, or saturated meadows, stream-sides, springs, or swales. Water is usually fresh and not strongly alkaline or salty. This is a large Group that encompasses stands that hold moisture in the soil until mid-to-late summer or stands that dry out before mid-summer. The vegetation is dominated by wet meadow sedges, rushes, and grasses.

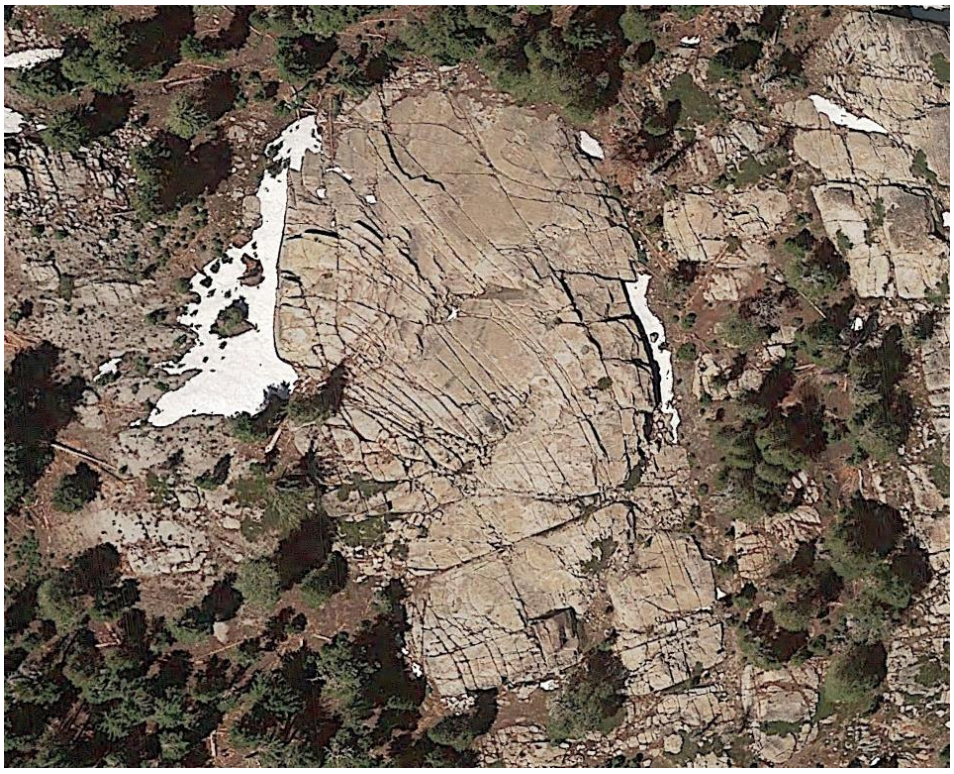


Water Impoundment Feature Mapping Unit

This mapping unit was utilized for man-made features designed to contain water, typically bound on all sides by berms and having a linear form. Duck clubs and a wastewater treatment plant contain examples of this mapping unit within the study area.

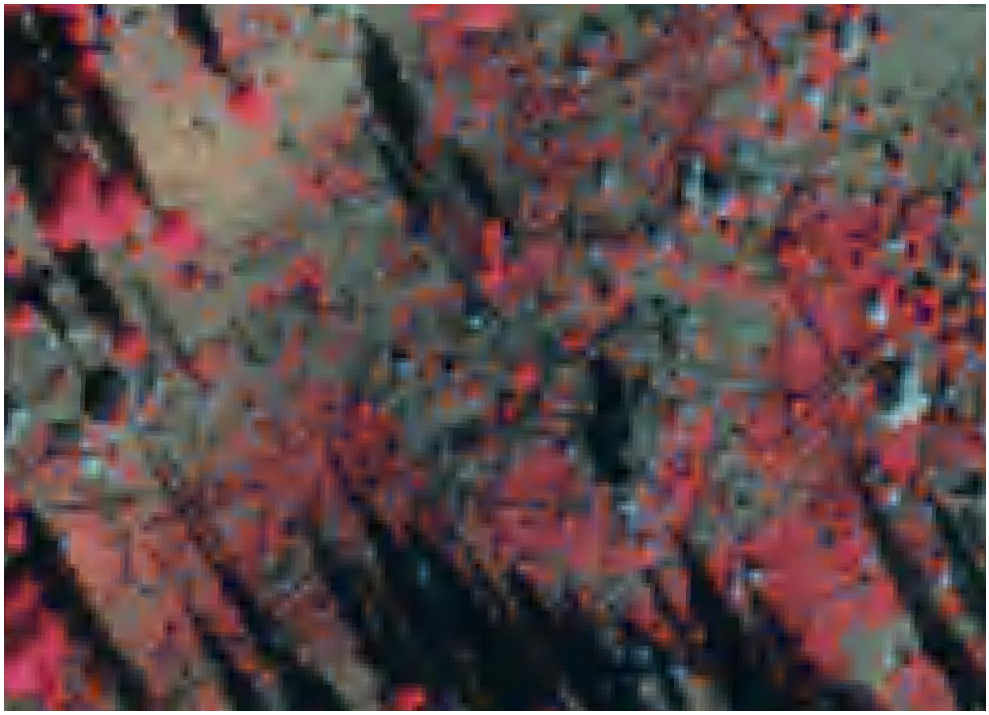
Western North American Cliff, Scree & Rock Vegetation Macrogroup

Barren rock, cliff or scree with little to no vegetation present. This rock Macrogroup was utilized from Lake Tahoe north to the Diamond Mountains.



Western North American Montane Scrub Group

This Group level mapping unit was only used to map areas where *Ceanothus prostratus* was strongly dominant. *C. prostratus* is a low growing shrub that creates thick mats and regenerates quickly post fire. On Google Earth imagery it is slightly more blue green or lighter green than *Arctostapylos nevadensis* which it could be confused with. On infrared NAIP imagery it can vary from pink to mid-red hue.



Western North American Interior Ruderal Grassland & Shrubland Group

This is the drier of the two ruderal grassland groups found to reside in the study area. Stands are often a monoculture due to seeding for livestock. Due to low sampling of the ruderal types photo interpreters often were unsure on which ruderal type to use.

Western North American Ruderal Marsh Wet Meadow and Shrubland Group

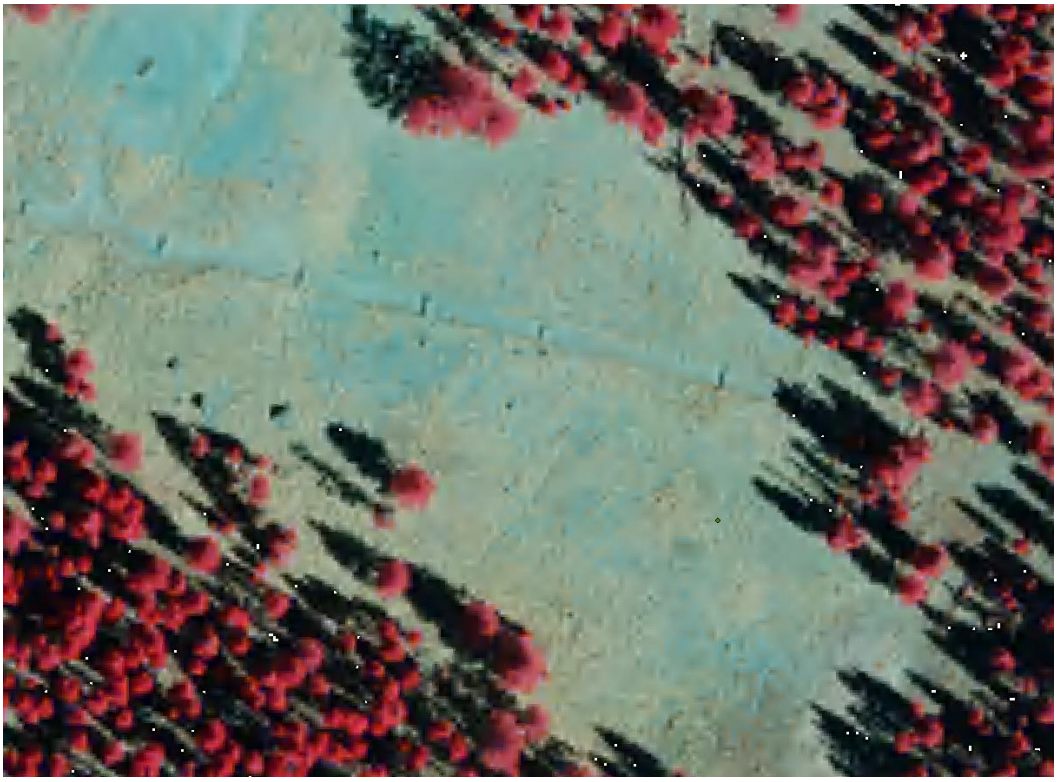
Stands dominated by larger non-native perennial pasture grasses (including *Phalaris arundinacea*, *Phleum pratense*, *Poa pratensis*, *Agrostis gigantea*). These large bunchgrasses were sometimes visible on imagery and typically had a clumpy green to whitish-green highly variable signature. This Group was commonly found around irrigated pastures and agriculture.

Western North American Sparsely Vegetated Rivershore Mapping Unit

This category was utilized for areas where there was no vegetation or very sparse vegetation along the margins of water bodies or in dried-up seasonal waterways.

***Wyethia mollis* Alliance**

W. mollis here has a tan hue which is indicative of how it looks later in the season once its large leaves have died back. When healthy and green on Google Earth the infrared imagery will be bubble gum pink. It follows disturbance and is a sign of recent fire, logging, or over grazing.



Appendix F: Vegetation Key used for Mapping Attribution

Class I. Trees are evenly distributed and conspicuous throughout the stand. Trees generally with >10% absolute cover. Where total vegetation cover is low (<20% total cover), tree cover can be <10% absolute cover but will be evenly distributed across the stand and shrub cover will not be significantly higher (>3 times greater) than tree cover……..**Forests & Woodlands**

A. Forest and woodlands characterized by broad-leaved evergreen or deciduous oaks including *Quercus chrysolepis* or *Quercus kelloggii*. Small-to-large evergreen coniferous trees such as *Abies concolor*, *Calocedrus decurrens, Juniperus occidentalis, Pinus* spp., and *Pseudotsuga menziesii* may be present to co-dominant with the oaks. Stands in the group are found west and south of the Honey Lake Basin….

Californian Broadleaf Forest & Woodland Group

A.1 *Quercus chrysolepis* is the dominant species in the overstory. Other broad-leaf trees such *Q. kelloggii* may be present at low cover…

Quercus chrysolepis tree Association (n=1)
in the ***Quercus chrysolepis*** **(tree) Alliance**

A.2 The tree canopy is dominanted by *Quercus kelloggii* and conifers such as *Pinus ponderosa* may be present to co-dominant. The shrub and herbaceous understory is typically sparse to open...

Quercus kelloggii **Alliance (n=6)**

(a) Quercus kelloggii is co-dominant with at least 30% relative cover in the tree layer with *Pinus ponderosa.* Other conifers may be present and conifer cover may be greater than oak cover.The shrub understory is sparse…

Quercus kelloggii - Pinus ponderosa Association (n=2)

(b) Quercus kelloggii is the sole dominant in the overstory. The shrub and herbaceous layers are sparse. Stands are often found on steep dry slopes with large boulders. Oaks may be shrubby if stand has recently burned…

Quercus kelloggii / Grass - Herb Association (n=4)

(c) Quercus kelloggii is dominant in the tree layer. *Calocedrus decurrens* may be emergent and common. *Arctostaphylos patula* and/or *Ceanothus cordulatus* are dominant in an intermittent shrub layer. Stands are typically found on north to east facing slopes in the Diamond Mountains and Black Mountain west of Honey Lake…

Quercus kelloggii / Arctostaphylos patula Association (n=0)

B. Stands dominated or co-dominated by broad-leaved trees other than oaks including *Populus tremuloides* and *P. trichocarpa*. Stands are found along rivers, streams, in seeps, or other mesic settings throughout the project area…

B.1 *Populus tremuloides* is dominant or co-dominant in the tree layer. Trees may be short and regenerating after a disturbance. Sub-dominant to co-dominant mixes of coniferous trees including *Abies concolor, Pinus ponderosa,* and *Calocedrus decurrens* may be present. If co-dominant with *P. trichocarpa* key to that alliance…

***Populus tremuloides* Alliance (n=17)**
of the **Rocky Mountain Subalpine-Montane Aspen Forest & Woodland Group**

(a) Rosa woodsii is dominant in an open shrub layer. *Purshia tridentata* is characteristic. Stands are found along creeks in the eastern part of the study area in the Northwestern Basin and Range Section…

Populus tremuloides / Rosa woodsii Association (n=3)

(b) Symphoricarpos rotundifolius and/or other mesic shrubs are characteristic in the shrub layer. Regenerating conifers are often present. Often stands have experienced some disturbance such as fire or heavy snowpack that has caused damage to the trees…

Populus tremuloides / Symphoricarpos rotundifolius Association (n=7)

(c) Veratrum californicum and an assortment of other wetland or mesophytic herbs and grasses such as *Senecio triangularis* and *Elymus glaucus* dominate the understory. *Salix* spp. characterize the sparse to open shrub layer. Stands are typically lush and healthy with high diversity in the herbaceous layer and occur mostly in the Sierra Nevada Section of the project area…

Populus tremuloides / Veratrum californicum Association (n=7)

B.2 *Populus trichocarpa* is dominant or co-dominant with *P. tremuloides* along major streams and rivers. *Salix* spp. and *Alnus incana* are present in the understory…

***Populus trichocarpa* Alliance (n=6)**
of the **North-Central Pacific Lowland Riparian Forest Group**

(a) Populus trichocarpa is dominant in the tree layer and emergent conifers other than *Pinus jeffreyi* may be present at low cover. *Salix* spp. and/or *Alnus incana* are dominant in the shrub layer. Stands occur along streams at mid- to upper-elevations and are seasonally flooded…

Populus spp. / *Salix* spp. Association (n=6)

(b) Populus trichocarpa is co-dominant in the tree layer with *Pinus jeffreyi. Rosa woodsii, Artemisia tridentata*, and *Symphoricarpos rotundifolius* characterize the shrub layer. Stands occur mostly along narrow streams in narrow valleys or canyons…

Populus trichocarpa - Pinus jeffreyi Association (n=0)

C. Forest and woodlands characterized by evergreen conifer trees. Broad-leaved evergreen and deciduous trees are less important, not reaching co-dominance…

C.1 Conifers with scale-like leaves such as *Juniperus* spp. and *Hesperocyparis bakeri* are dominant or characteristic in the stand…

C.1a Woodlands characterized by *Juniperus occidentalis* or *J. osteosperma.* If junipers are mixing with mid- to upper-elevation conifers such as *Pinus jeffreyi, Abies* spp., or *Pinus contorta* ssp. *murryana,* assume the juniper is *J. grandis* and key to that alliance….

C.1a.i *Juniperus osteosperma* is dominant in the sparse to open tree canopy. *Artemisia tridentata* is the dominant shrub in a sparse to open understory. *Bromus tectorum* is always present and *Achnatherum thurberianum* is typically present. Stands are limited to the Northwestern Basin and Range Section of the project area…

Juniperus osteosperma / Artemisia tridentata ssp. *tridentata* Association (n=4)
in the ***Juniperus osteosperma*** **Alliance**
of the **Great Basin Pinyon - Juniper Woodland Group**

C.1a.ii *Juniperus occidentalis* is the sole coniferous tree species in the overstory or is strongly dominant with *Pinus jeffreyi* or *P. ponderosa. Juniperus occidentalis* may have as little as 3% cover if the stand includes mature individuals evenly distributed throughout the stand, with an obvious understory of regenerating juniper, and a shrub layer usually less than 10% in absolute cover. Stands are more widespread and typically occur at higher elevations than *J. osteosperma.* They are most extensive in the Frenchman Subsection, in the northeastern portion of the project area…

Juniperus occidentalis **Alliance (n=5)**
of the **Columbia Plateau Western Juniper Open Woodland Group**

(a) Artemisia arbuscula is dominant to co-dominant in the shrub layer with *Purshia tridentata*. Stands are rocky with typically >30% cover of surficial rocks (cobble to bedrock)…

Juniperus occidentalis / Artemisia arbuscula / Poa secunda Association (n=1)

(b) Pines are typically absent or at low cover (<2%). *Artemisia tridentata* is present with at least 1% cover but typically dominates or co-dominates the shrub layer. *Purshia tridentata* is usually present with *A. tridentata* and may be dominant…

Juniperus occidentalis / Artemisia tridentata - Purshia tridentata Association (n=2)

(c) Juniperus occidentalis is dominant with sub-dominant *Pinus jeffreyi* and/or *P. ponderosa* or has a shrub understory that is indicative of higher elevations. Pines may have as little as 1% cover or occasionally may not be present. The shrub understory is variable. When pines are present the understory can be dominated by *Artemisia tridentata* and *Purshia tridentata* with some *Cercocarpus ledifolius* and/or may include other higher elevation shrub species. When pines are not present, higher elevation shrub species such as *Cercocarpus ledifolius, Ribes* spp., *Artemisia tridentata* ssp. *vaseyana,* and *Symphoricarpos* spp. are present in the understory which differentiate this type from *Juniperus occidentalis / Artemisia tridentata - Purshia tridentata* Association…

Juniperus occidentalis - (Pinus jeffreyi - Pinus ponderosa) / Cercocarpus ledifolius Association (n=2)

(d) Juniperus occidentalis stands with minimal shrub component (typically <4% absolute cover). Juniper cover is usually greater than 10% and trees are of mixed age classes. Herb layer is sparse to moderate, sometimes with significant cover of non-native grasses such as *Bromus tectorum*. However, native grasses including *Poa secunda, Pseudoroegneria spicata, Festuca idahoensis,* and/or *Achnatherum thurberianum* are characteristic in the herb layer. If shrubs are present, they are patchy and insignificant…

Juniperus occidentalis / (Poa secunda - Festuca idahoensis - Pseudoroegneria spicata) Association (n=0)

C.1b *Juniperus grandis* has >5% absolute cover and typically has the greatest cover in a sparse to open tree canopy. *Pinus jeffreyi* is typically present and may be co-dominant. *Abies concolor* or *A. magnifica* may be present as sub-dominants. Stands occur above 2200 m on both granitic and volcanic substrates…

***Juniperus grandis* Alliance (n=5)**
of the **Californian Montane Conifer Forest & Woodland Group**

(a) Stands are open woodlands with *Juniperus grandis* dominant or co-dominant with other montane conifers. The shrub layer is characterized by *Ceanothus prostratus, Arctostaphylos nevadensis,* and/or *Quercus vaccinifolia…*

Juniperus grandis / (Arctostaphylos nevadensis - Quercus vaccinifolia) Association (n=3)

(b) Juniperus grandis dominant or co-dominant with *Pinus jeffreyi*. The shrub layer is characterized by *Artemisia tridentata* ssp. *tridentata, Purshia tridentata,* and/or *Symphoricarpos rotundifolius…*

Juniperus grandis / Artemisia tridentata Association (n=2)

C.1c Open to continuous overstory dominated by *Hesperocyparis bakeri*. Recently burned sites will have seedlings or saplings dominant or co-dominant with shrubs such as *Arctostaphylos patula* or *Ceanothus velutinus.* Stands only occur in two locations within the project area, near Wheeler Peak…

Hesperocyparis bakeri / Arctostaphylos patula Association (n=1)
in the ***Hesperocyparis bakeri*** **Woodland & Forest Alliance**
of the **Californian Conifer Forest & Woodland Group**

C.2 Forest and woodlands of lower montane zones in the foothills of the Modoc Plateau, eastern Cascades and east side of the Sierra Nevada. Stand dominated by *Pinus ponderosa* or *P. jeffreyi* found on drier, less snowy settings than alliances found in the Californian Montane Conifer Forest & Woodland Group. Mesic conifers *Pseudotsuga menziesii* and *Calocedrus decurrens* are absent or very low in cover (<2% relative cover)…

Pinus ponderosa **/ Shrub Understory Alliance (n=26)**
of the **Central Rocky Mountain *Pinus ponderosa* Open Woodland Group**

(a) Pinus ponderosa and/or *P. jeffreyi* are dominant in the tree layer. *Juniperus occidentalis* may be present to co-dominant. Shrub layer is sparse to moderately dense characterized by *Cercocarpus ledifolius, Ceanothus prostratus, Purshia tridentata, and Arctostaphylos patula…*

Pinus (jeffreyi, ponderosa) / (Ceanothus prostratus - Purshia tridentata) Association (n=26)

C.3 Stands are low to mid-montane forests and woodlands dominated or co-dominated by *Abies concolor*, *Pinus ponderosa*, *P. jeffreyi*, *P.* lambertiana, *Pseudotsuga menziesii*, *Juniperus grandis*, or *Calocedrus decurrens*...

Californian Montane Conifer Forest & Woodland Group

C.3a Stands contain a mixture of conifers co-dominated by *Pseudotsuga menziesii*, *Pinus ponderosa*, *P. jeffreyi,* and/or *Calocedrus decurrens*. Other trees can co-occur including *Quercus kelloggii*, *Abies concolor*, and/or other *Pinus* spp*.* Understory herbs and shrubs are variable depending upon site moisture…

***Pinus ponderosa - Calocedrus decurrens - Pseudotsuga menziesii* Alliance (n=29)**

(a) Pinus ponderosa is dominant in the overstory with *Pseudotsuga menziesii* subdominant*. Quercus kelloggii* and *Calocedrus decurrens* are also present at low cover. The shrub layer is dominated by *Purshia tridentata.* The herbaceous layer is sparse and characterized by forbs such as *Wyethia mollis, Collinsia parviflora*, and *Collomia grandiflora*…

Pinus ponderosa - Pseudotsuga menziesii / Purshia tridentata var. *tridentata / Wyethia mollis* Association (n=2)

(b) Pinus ponderosa is dominant in the tree canopy with *Pseudotsuga menziesii* and/or *Calocedrus decurrens* is usually present and co-dominant. *Abies concolor* is present but sub-dominant. The shrub and herbaceous layer are sparse to open…

Pinus ponderosa - Pseudotsuga menziesii - Calocedrus decurrens Association (n=13)

(c) Calocedrus decurrens is co-dominant with *Pinus ponderosa. Abies concolor* may be present but is sub-dominant to the other conifers. *Pseudotsuga menziesii* is absent or sub-dominant. The mat forming *Ceanothus prostratus* is dominant in the shrub layer…

Pinus ponderosa - Calocedrus decurrens / Ceanothus prostratus Association (n=11)

(d) Pinus ponderosa and *Pseudotsuga menziesii* co-dominate in the tree canopy. *Quercus chrysolepis* and/or *Q. kelloggii* are present in the midstory. Stands occur on hot dry sites with large rock and bedrock and gravelly to sandy textured soils. The herbaceous layer is characterized by dry-site indicators such as *Galium bolanderi…*

Pinus ponderosa - Pseudotsuga menziesii - Quercus chrysolepis / Galium bolanderi Association (n=1)

(e) Pseudotsuga menziesii is dominant in the tree canopy. Other conifers or hardwoods do not reach co-dominance. Stands are uncommon in the project area but have been observed near the town of Portola…

Pseudotsuga menziesii Association (n=0)

C.3c *Pinus jeffreyi* is dominant to co-dominant in the overstory. *Abies concolor*, *Abies magnifica*, or *Pinus contorta* ssp. *murrayana* may be present to co-dominant in the stand. *Juniperus occidentalis* is absent and *Pinus ponderosa* is absent or sub-dominant in the canopy. Stands are widespread between 1500 - 220 m on open less shaded slopes…

Pinus jeffreyi Alliance (n=83)

(a) Pinus jeffreyi is strongly dominant in the tree canopy. The shrub and herbaceous layers are sparse…

Pinus jeffreyi Association (n=25)

(b) Pinus jeffreyi and *Abies concolor* are co-dominant in the tree canopy. *Juniperus occidentalis* is absent. The understory is either sparse or characterized by dry site indicators such as *Quercus vacciniifolia, Ceanothus cordulatus,* or *Arctostaphylos patula…*

Pinus jeffreyi - Abies concolor Association (n=6)

(c) Pinus jeffreyi is dominant in the tree canopy. *Abies concolor* may be present but does not have to be. *Symphoricarpos rotundifolius, S. mollis* or other mesic shrubs such as *Amelanchier utahensis*. are dominant in the shrub canopy. The herbaceous layer is sparse and variable with *Kelloggia galioides, Monardella odoratissima* sometimes present at low cover…

Pinus jeffreyi - Abies concolor / Symphoricarpos rotundifolius / Elymus elymoides Association (n=7)

(d) This association occurs at the highest elevations of all *Pinus jeffreyi* dominated communities, above 2100 meters. *Abies magnifica* occurs as a co-dominant in the tree canopy. The open shrub layer is typically composed of *Symphoricarpos rotundifolius, Chrysolepis sempervirens,* and/or *Ceanothus velutinus*. The herbaceous layer is sparse…

Pinus jeffreyi - Abies magnifica Association (n=3)

(e) Pinus jeffreyi is dominant in the tree canopy and *Abies concolor* or *Pinus ponderosa* are present but not co-dominant. *A. concolor* is found in the regenerating layer. The shrub layer is dominated by *Quercus vacciniifolia,* or it may be co-dominating with *Ceanothus prostratus…*

Pinus jeffreyi / Quercus vacciniifolia Association (n=3)

(f) Pinus jeffreyi is dominant in an open tree canopy with a dense understory dominated by *Ceanothus cordulatus.* Stands are often associated with recent fire…

Pinus jeffreyi / Ceanothus cordulatus Association (n=1)

(g) Pinus jeffreyi is dominant in the tree canopy. The shrub layer is dominated by *Cercocarpus ledifolius.* The herbaceous layer may be characterized by *Wyethia mollis, Carex rossii, Elymus elymoides,* and/or *Achnatherum occidentale.* Stands occur on rocky sites often with steep slopes where fire tends to be less frequent…

Pinus jeffreyi / Cercocarpus ledifolius Association (n=1)

(h) Pinus jeffreyi is dominant in an open tree canopy with a moderately dense understory with *Arctostaphylos patula* dominant or co-dominant with other shrubs such as *Ceanothus prostratus* or *Purshia tridentata. Ceanothus velutinus* may be the dominant shrub especially after a recent fire and *A. patula* may be absent…

Pinus jeffreyi / Arctostaphylos patula Association (n=5)

(i) Pinus jeffreyi is dominant in the tree canopy. The shrub layer is moderately dense and dominated by *Ceanothus prostratus.* Other shrubs such as *Purshia tridentata* and *Arctostaphylos patula* are present but at lower cover…

Pinus jeffreyi / Ceanothus prostratus Association (n=13)

(j) Pinus jeffreyi is dominant in the tree canopy. The shrub layer is sparse to open and is dominated by *Purshia tridentata* and/or *Artemisia tridentata.* The herbaceous layer is sparse and *Elymus elymoides* and *Wyethia mollis* are often present at low cover…

Pinus jeffreyi / Purshia tridentata var. *tridentata* Association (n=9)

(k) Pinus jeffreyi is dominant in the tree canopy. The shrub layer is sparse with typically less than 10% cover and the herbaceous layer is dense and characterized by tall forbs such as *Wyethia mollis, Balsamorhiza sagittata,* or *Lupinus argenteus.* Stands are dry, open woodlands found in the eastern Sierra Nevada…

Pinus jeffreyi / Wyethia mollis Association (n=8)

C.3d *Abies concolor* is strongly dominant in the tree layer. Other tree species may be present, but if *Pseudotsuga menziesii* or *Pinus lambertiana* are present, their cover is insignificant (<10% relative cover) and *Pinus jeffreyi* and *P. ponderosa* have < 30% relative cover…

***Abies concolor* Alliance (n=49)**

(a) Abies concolor is dominant in the overstory. *Pinus jeffreyi* is usually present but does not reach a level of co-dominance. The shrub layer is typically dominated by *Ceanothus prostratus* but other shrubs including *Ceanothus velutinus, Chrysolepis sempervirens,* and *Quercus vacciniifolia* may be co-dominant. Stands are typically found on dry, rocky slopes and ridges…

Abies concolor / Ceanothus prostratus Association (n=3)

(b) Abies concolor is dominant in the tree layer or co-dominant with *Pinus jeffreyi.* Other conifers are also present but at lower cover. *Symphoricarpos mollis* is dominant to co-dominant in the shrub layer with *Rubus parviflorus* or *Amelanchier utahensis…*

Abies concolor / Symphoricarpos mollis Association (n=7)

(c) Abies concolor is dominant in an open to intermittent tree canopy with a sparse to open shrub layer. The herbaceous layer is sparse to open and characterized by species including *Pyrola picta, Hieracium albiflorum, Monardella odoratissima, Kelloggia galioides,* and *Chimaphila menziesii…*

Abies concolor / Chimaphila spp. - *Pyrola picta* Association (n=32)

(d) Abies concolor is dominant in an open tree canopy. The shrub layer is dominated by *Ceanothus velutinus. Prunus emarginata* and *Salix scouleriana* are often present. Evidence of recent fire or other disturbance is usually present…

Abies concolor / Ceanothus velutinus Association (n=6)

C.3e Stand is characterized by co-dominance of *Abies concolor* and *Pseudotsuga menziesii*. Other tree species including *Calocedrus decurrens* and *Pinus ponderosa* are typically present. If *Pinus lambertiana* is present it does not reach co-dominance….

***Abies concolor - Pseudotsuga menziesii* Alliance (n=21)**

(a) Abies concolor and *Pseudotsuga menziesii* are co-dominant in the tree canopy*. Calocedrus decurrens* is present and often co-dominant. *Pinus* spp. are often also present at low cover. The shrub layer is sparse to open and characterized by *Symphoricarpos mollis* and *Amelanchier utahensis.* Stands are cool and moist, typically found on north slopes…

Abies concolor - Pseudotsuga menziesii - Calocedrus decurrens Association (n=9)

(b) Abies concolor and *Pseudotsuga menziesii* are co-dominant in the tree canopy with *Cornus nuttallii* co-dominant in the lower tree canopy. Mesic shrubs such as *Symphoricarpos mollis, Rosa gymnocarpa, Amelanchier utahensis,* and *Rubus parviflorus* characterize the open shrub layer. Stands are usually found on the western side of the project area below 1500 m…

Abies concolor - Pseudotsuga menziesii / Cornus nuttallii Association (n=2)

(c) Abies concolor and *Pseudotsuga menziesii* are co-dominant in the tree canopy. *Cornus nuttallii* is absent or at low cover. Mesic shrubs such as *Rosa gymnocarpa, Symphoricarpos mollis, Amelanchier utahensis,* and *Rubus parviflorus* characterize the open shrub layer…

Abies concolor - Pseudotsuga menziesii / Rosa gymnocarpa Association (n=4)

(d) Pseudotsuga menziesii is dominant in the tree canopy *Abies concolor* is present to co-dominant. The shrub layer and herbaceous layer are both sparse and together is less than 10% absolute cover. Stands are found on steep north-facing slopes…

Pseudotsuga menziesii - Abies concolor / Sparse understory Provisional Association (n=4)

C.3f Mixed conifer stand with *Abies concolor* co-dominant in the tree layer. *Pinus lambertiana* and/or *Calocedrus decurrens* are always present and typically co-dominating. Other conifer species are usually present, including *Pseudotsuga menziesii* which may reach co-dominance. If *P. menziesii* is present and/or co-dominant, then *P. lambertiana* is also present. If *P. lambertiana* is absent, then key to *Abies concolor - Pseudotsuga menziesii* Alliance…

***Abies concolor - Pinus lambertiana* Alliance (n=17)**

(a) Pinus lambertiana, Pseudotsuga menziesii, and *Abies concolor* together dominate a dense tree canopy. Shrub and herbaceous cover are typically sparse. *Symphoricarpos mollis* is usually present at low cover. *Pyrola picta, Hieracium albiflorum, Festuca rubra,* and *Carex rossii* are common in the understory at low cover…

Abies concolor - Pseudotsuga menziesii - Pinus lambertiana / Carex rossii Association (n=6)

(b) Pinus lambertiana and *Calocedrus decurrens* co-dominate in the tree canopy with *Abies concolor.* Shrub cover is sparse to open and characterized by *Symphoricarpos mollis.* Herbaceous layer is sparse…

Abies concolor - Pinus lambertiana - Calocedrus decurrens / Symphoricarpos mollis / Kelloggia galioides Association (n=11)

C.4 Stands of higher-elevation forests and woodlands in the Sierra Nevada and southern Cascade ranges, typically above 1900 m, are dominated or characterized by *Abies magnifica, Tsuga mertensiana,* or *Pinus monticola.* Stands occur on ridges and slopes where heavy snowpack is a major source of soil moisture in the growing season….

Sierra-Cascade Red Fir - Mountain Hemlock Forest Group

C.4a *Tsuga mertensiana* is dominant to co-dominant in the tree canopy with *Pinus monticola, P. contorta* ssp. *murrayana,* and *Abies magnifica.* Stands occur at high elevations, above 2000 m, usually on north-facing slopes with late-lasting snow….

***Tsuga mertensiana* Alliance (n=25)**

(a) Tsuga mertensiana is the sole dominant tree in the overstory. *Abies magnifica* or *Pinus ponderosa* may be present at low cover. The shrub and herbaceous layer are sparse…

Tsuga mertensiana Association (n=11)

(b) Pinus monticola is typically co-dominant in the tree canopy with *Tsuga mertensiana. Abies magnifica* is usually present and can also be co-dominant. Stands are often found on steep slopes…

Tsuga mertensiana - Pinus monticola Association (n=11)

(c) Tsuga mertensiana is co-dominant in the tree canopy with *Pinus contorta* ssp. *murrayana* and *Pinus monticola.* Stands occur at high elevations above 2200 m on upper north-facing slopes. Stands may be uncommon in the project area but are found near Mt. Ingalls…

Tsuga mertensiana - Pinus contorta ssp. *murrayana - Pinus monticola* Association (n=2)

(d) Pinus albicaulis and *Tsuga mertensiana* are co-dominant in the tree canopy. Stands are localized on steep north-facing slopes at the highest elevation and snowiest sites of the project area such as Mt. Lola…

Pinus albicaulis - Tsuga mertensiana Association (n=1)

C.4b *Abies magnifica* is dominant to co-dominant in a typically dense tree canopy. Other conifers including *Abies concolor*, *Pinus monticola*, and *Pinus contorta* ssp. *murrayana* are often present to co-dominant. The understory is often depauperate. When present the shrub layer is typically composed of *Arctostaphylos nevadensis, Ribes* spp., and/or *Symphoricarpos* spp….

***Abies magnifica* Alliance (n=108)**

(a) Abies magnifica is dominant in a dense tree canopy. Other conifers may be present at low cover. The understory of shrubs and herbs is typically sparse to open…

Abies magnifica Association (n=61)

(b) Abies magnifica and *Abies concolor* are co-dominant in the tree layer. The shrub and herbaceous cover are sparse to open...

Abies magnifica - Abies concolor Association (n=4)

(c) Abies magnifica is dominant in the tree canopy with *Pinus monticola* usually present to co-dominant. *Arctostaphylos nevadensis* is always present and usually the dominant shrub in the understory. Stands are usually found on ridges on mid to upper slopes of moderate steepness…

Abies magnifica - (Pinus monticola) / Arctostaphylos nevadensis Association (n=18)

(d) Abies magnifica and *Pinus monticola* are co-dominant in the tree canopy. The shrub layer is sparse and *Arctostaphylos nevadensis* is absent. *Pedicularis semibarbata* is common in the herbaceous layer. Typically found on upper slopes and ridgetops…

Abies magnifica - Pinus monticola Association (n=9)

(e) Abies magnifica and *Pinus contorta* ssp*. murrayana* are co-dominant in the tree canopy. If *Pinus monticola* is present it is subdominant. Shrubs are variable and sparse to intermittent in cover and may include *Quercus vacciniifolia, Symphoricarpos mollis, Ribes* spp., or *Lonicera conjugialis.* The herbaceous layer is sparse to open and *Pedicularis semibarbata* and *Hieracium albiflorum* are common*…*

Abies magnifica - Pinus contorta ssp*. murrayana* Association (n=9)

(f) Abies magnifica is dominant to co-dominant in the tree layer with *Pinus monticola* and *Pinus contorta* ssp. *murrayana*. *Tsuga mertensiana* is typically present and can also be co-dominant. The shrub layer is sparse with mesic shrubs such as *Lonicera conjugialis, Ribes viscosissimum*, and *Quercus vacciniifolia.* The herbaceous layer is typically sparse and characterized by *Aster breweri* and *Hieracium albiflorum…*

Abies magnifica - Pinus monticola - Pinus contorta ssp. *murrayana* Association (n=4)

C.4c *Pinus monticola* is strongly dominant in the open to intermittent tree canopy with at least 60% relative cover. Typical shrubs in the understory include *Arctostaphylos nevadensis, Artemisia tridentata,* and *Symphoricarpos rotundifolius*…

Pinus monticola / Arctostaphylos nevadensis Association (n=9)

in the ***Pinus monticola*** **Alliance**

C.5 Stands of high montane to sub-alpine forests and woodlands in the Sierra Nevada and southern Cascade ranges, typically near tree line, dominated by *Pinus albicaulis* or *Pinus contorta* ssp. *murryana*….

Sierra-Cascade Cold-Dry Subalpine Woodland Group

C.5a *Pinus albicaulis* dominates the open to intermittent tree canopy. Stands are isolated along highest, exposed ridges and upper north-facing slopes and generally show some evidence of flagging and other effects of extreme exposure to winter weather such as stunted, gnarled growth. If western hemlock is co-dominant key to the *Tsuga mertensiana* Alliance…

Pinus albicaulis / Juniperus communis Association (n=1)
in the ***Pinus albicaulis*** **Alliance**

C.5b *Pinus contorta* ssp. *murrayana* is dominant to co-dominant in the tree canopy. *Abies* spp., *P, jeffreyi* and *P, monticola* can be co-dominant. Stands occur at upper montane to subalpine elevations where high snowpack conditions exist or along forested margins of meadows and lakes …

Pinus contorta **ssp. *murrayana* Alliance (n=30)**

(a) Pinus contorta ssp. *murrayana* is dominant in an open woodland and *Juniperus occidentalis* may be present. Stands have up to 20% exposed boulders and large rock with an herbaceous layer characterized by *Carex filifolia.* Stands occur at upper montane to subalpine elevations…

Pinus contorta ssp. *murrayana / Carex filifolia* Association (n=1)

(b) Stands are open woodlands dominated by *Pinus contorta* ssp. *murrayana. Abies concolor* and *A. magnifica* are present but typically has >30% relative cover. The shrub and herbaceous layer are typically sparse…

Pinus contorta ssp. *murrayana* Association (n=9)

(c) Pinus contorta ssp. *murrayana* is the sole dominant in the tree canopy. The herbaceous layer is characterized by wetland forb species such as *Ligusticum grayi, Thalictrum fendleri,* and *Veratrum californicum.* Stands typically occupy edges of small streams often adjacent to small moist meadows…

Pinus contorta ssp. *murrayana / Ligusticum grayi* Association (n=9)

(d) Pinus contorta ssp. *murrayana* is the sole dominant it the tree canopy. The herbaceous layer is dominated by *Carex* spp. and grasses. The shrub layer is typically sparse. These stands tend to be wetter than the *Pinus contorta* ssp. *murrayana / Ligusticum grayi* Association…

Pinus contorta ssp. *murrayana / Carex* spp. Association (n=4)

(e) Stands are found in very wet settings including fens. The shrub layer is characterized by *Vaccinium uliginosum* ssp. *occidentale…*

Pinus contorta ssp. *murrayana / Vaccinium uliginosum* Association (n=3)

Class II. Shrubs or subshrubs are evenly distributed throughout the stand and typically with at least 10% cover. If the stand is characterized by very low overall vegetation cover (<20%) the shrub cover can be as low as 3% or even <1% for subshrub *Eriogonum* spp. Trees average less than 5% and are not evenly distributed. However, in stands with very high shrub cover (3 times greater than tree cover), tree cover may be >10%.....Shrublands

A. Shrubland stands occurring in meadows, springs, swales, or along streams and rivers. Water is usually fresh and not strongly alkaline or saline…

A.1 Stands with dominant *Artemisia cana* occurring in meadows, valley bottoms, or along flooded edges of creeks. The understory is dominated by wetland species including *Carex* spp., *Hordeum brachyantherum,* and *Juncus* spp.…

*Artemisia cana (*ssp. *bolanderi,* ssp. *viscidula) / Poa secunda* Association (n=3)
in the ***Artemisia cana*** **Alliance**
of the **Rocky Mountain-Great Basin Lowland-Foothill Riparian Shrubland Group**

A.2 Montane to subalpine riparian shrublands in valley bottoms, floodplains, and steep moist avalanche chutes. Stands are dominated by *Acer glabrum, Alnus incana, Cornus sericea, Rosa woodsia,* and shrubby *Salix* spp.…

Western Montane-Subalpine Riparian & Seep Shrubland Group

A.2a *Salix lucida* or *S. geyeriana* are dominant in the shrub layer. Other riparian shrubs are often present including other *Salix* spp. and *Cornus sericea*. Stands occur along creeks…

Salix boothii - Salix geyeriana - Salix lutea **Shrubland Alliance (n=4)**

(a) Salix geyeriana is dominant in the overstory. *S. lemmonii* may be present as a subdominant. The herbaceous layer consists of mesic graminoids such as *Poa pratensis, Carex* spp., and *Juncus* spp.…

Salix geyeriana / Mesic graminoid Association (n=1)

(b) Salix lucida is dominant in the shrub or low tree canopy with a high cover of forbs in the understory including *Equisetum arvense, Trifolium longipes,* and *Veratrum californicum*…

Salix lucida / Mesic forb Association (n=1)

(c) Salix lucida is dominant in the shrub or low tree canopy with a high cover of graminoids in the understory including *Poa pratensis, P. palustris,* and *Elymus glaucus.* Forbs may be present with <20% total cover and lower cover than graminoids…

Salix lucida / Mesic graminoid Association (n=2)

A.2b *Alnus incana* is dominant in the shrub layer. Other riparian shrubs are typically present and occasionally *Salix* spp. are co-dominant. The herbaceous layer can be variable in cover and is characterized by mesic forbs such as *Senecio triangularis, Veratrum californica, and Heracleum maximum.* Stands occur along creeks and in narrow valleys…

Alnus incana Association (n=19)
in the ***Alnus incana*** **Alliance**

A.2c Stands are dominated by *Salix eastwoodiae* or *S. lemmonii* in the open to continuous shrub layer. Other riparian or mesic shrubs may be present, including other *Salix* spp., but are usually not co-dominant. Emergent conifers may be present at low cover. The herbaceous layer is variable but is typically characterized by mesic graminoids and forbs such as *Carex* spp., *Senecio triangularis,* or *Veratrum californica.* Stands typically occur in wet meadows, along slow flowing creeks, or seeps. Stands are common and probably the most widespread willow alliance in the project area…

Salix eastwoodiae - Salix lemmonii **Alliance (n=20)**

(a) Salix eastwoodiae is dominant in the shrub layer. The lush, productive herbaceous layer is dominated by *Senecio triangularis* and *Lupinus polyphyllus. Veratrum californicum* is often present and may also be co-dominant. Stands are at the coolest, highest elevations in the project area ear springs on upper slopes…

Salix eastwoodiae / Senecio triangularis Association (n=7)

(b) Salix lemmonii is dominant in the shrub layer. Other mesic shrubs are present and may be co-dominant such as *Alnus incana, Ribes* spp., and *Salix scouleriana.* The herbaceous layer is characterized by mesic forbs such as *Veratrum californicum, Maianthemum stellatum, Thalictrum fendleri,* and *Solidago canadensis.* Stands occupy stream sides surrounded by coniferous forests and moist wet meadows…

Salix lemmonii / mesic forb Association (n=4)

(c) Salix lemmonii is dominant in the shrub layer. Other mesic shrubs are present but typically sub-dominant. The herbaceous layer is characterized by mesic graminoids such as *Carex* spp., *Juncus* spp., and *Hordeum brachyantherum…*

Salix lemmonii / mesic graminoid Association (n=9)

A.2d *Cornus sericea* or *Rosa woodsii* is dominant or co-dominant in the shrub canopy with other riparian or mesic shrubs. Stands are typically small along meadow margins, stream terraces, and slopes near springs and seeps…

Cornus sericea - Rosa woodsii - Ribes **spp. Alliance (n=3)**

(a) Cornus sericea is dominant or co-dominant in the shrub layer…

Cornus sericea Association (n=2)

(b) Rosa woodsii is dominant in the shrub layer…

Rosa woodsii Association (n=1)

A.2e *Salix jepsonii* is dominant in the shrub canopy. Stands typically occur along steep gradient stream banks in moderate to narrow canyons….

Salix jepsonii / Senecio triangularis Association (n=1)
in the ***Salix jepsonii*** **Alliance**

A.2f *Acer glabrum* is dominant in the shrub canopy. Stands can occur along creeks or upslope in rocky avalanche chutes…

Acer glabrum **Alliance (n=2)**
No Associations defined
of the **Central Rocky Mountain-North Pacific High Montane Mesic Shrubland Group**

A.3 Riparian vegetation with Salix exigua or S. lasiolepis as dominant or co-dominant found along perennial or intermittent streams and rivers typically at lower elevations in the project area…

North American Warm Desert Riparian Low Bosque & Shrubland Group

A.3a Stands occur on sandbars or along seasonal creeks that tend to dry down in the summer. *Salix exigua* is dominant in the shrub layer along creeks or at edges of seeps/springs. Other mesic shrubs may be present at low cover. Understory in characterized by mesic herbaceous layer including *Elymus triticoides, Juncus balticus,* and/or *Lepidium latifolium…*

Salix exigua / Mesic graminoids Association (n=5)
in the ***Salix exigua*** **Alliance**
of the Southwestern North American riparian/wash scrub

A.3a *Salix lasiolepis* is dominant to co-dominant in the shrub layer with other riparian shrubs. Stands can be found at mid- to lower elevations in the project area…

Salix lasiolepis **Alliance (n=0)**

B. Montane shrubland composed of species including *Amelanchier utahensis*, *Arctostaphylos* spp., *Ceanothus* spp., *Cercocarpus ledifolius*, *Chrysolepis sempervirens, Holodiscus discolor, Prunus* spp*.,* and/or *Quercus vacciniifolia.* Stands generally occur on ridges and rocky slopes with southerly aspects…

B.1 Either *Ceanothus cordulatus* or *C. integerrimus* is typically the sole dominant in an intermittent to continuous shrub layer. *C. velutinus* may be present and co-dominant with 50% or less relative cover. Herbaceous layer is generally sparse. Stands are usually found on dry, exposed sites following disturbance by fire….

***Ceanothus cordulatus - Ceanothus integerrimus* Alliance (n=9)**

(a) Ceanothus cordulatus is the dominant species in the shrub layer. Occasionally *C. velutinus* is present and co-dominant. Conifers may be emergent in the overstory but have significantly less cover than the shrub layer…

Ceanothus cordulatus Association (n=8)

(b) Ceanothus integerrimus dominates the shrub canopy. Stands are typically found at low elevation sites and on the westside of the Sierra Nevada and are uncommon in the study area…

Ceanothus integerrimus Association (n=1)

B.2 *Arctostaphylos patula* or *A. nevadensis* is dominant in an intermittent to continuous shrub layer. Although stands are often monotypic with few other shrubs, *Ceanothus* spp. or *Artemisia tridentata* may be co-dominant with *A. patula*. Stands are typically found on steep slopes with rocky well-drained soils. These shrublands typically establish after stand-replacing fires and will succeed to forests after several decades….

***Arctostaphylos patula - Arctostaphylos nevadensis* Alliance (n=18)**

(a) Arctostaphylos patula is strongly dominant in the shrub layer though many other shrub species may be present at low cover including *Purshia tridentata*, *Ceanothus velutinus,* and/or *Ceanothus prostratus*. Herb layer is usually sparse and may include *Poa secunda, Wyethia mollis* or *Phlox diffusa*…

Arctostaphylos patula Association (n=5)

(b) Arctostaphylos patula is co-dominant with other shrubs in the shrub layer. Co-dominant shrubs include *Ceanothus velutinus, Ceanothus prostratus,* and/or *Artemisia tridentata*. If *A. patula* co-dominates with *A. nevadensis* or *Ceanothus fresnensis* see associations *A. nevadensis* and *Arctostaphylos* spp. - *C. fresnensis respectively*…

Arctostaphylos patula - Ceanothus velutinus - Ceanothus prostratus Association (n=6)

(c) Arctostaphylos nevadensis is dominant in the shrub layer though other shrub species may be present and occasionally co-dominant including *Arctostaphylos patula*,

Artemisia tridentata ssp. *vaseyana, Holodiscus* spp., and *Symphoricarpos rotundifolius*. Herb layer is usually sparse and may include *Monardella odoratissima, Wyethia mollis* or *Phlox diffusa*…

Arctostaphylos nevadensis Association (n=5)

(d) Ceanothus fresnensis, a CNPS 4.3 plant, is co-dominant in the shrub layer with *A. patula* and/or *A. nevadensis.* Stands occur on volcanic parent material in the Tahoe National Forest…

Arctostaphylos spp. - *Ceanothus fresnensis* Provisional Association (n=2)

B.3 *Ceanothus velutinus* is dominant in the shrub layer with other shrubs present. *Prunus emarginata* may be co-dominant. *Arctostaphylos patula* may be present with <30% relative cover. Typically found on moderately steep (>10 degrees) slopes. Emergent conifers may be present. Herb layer is sparse…

***Ceanothus velutinus* Alliance (n=7)**

(a) Ceanothus velutinus and *Prunus emarginata* are co-dominant in the shrub layer. Stands tend to occur in concavities…

Ceanothus velutinus - Prunus emarginata - Artemisia tridentata Association (n=1)

(b) Ceanothus velutinus is dominant in the shrub layer. Other shrubs including *Arctostaphylos patula* may be present but does not typically reach co-dominance…

Ceanothus velutinus Association (n=6)

B.4 *Holodiscus discolor* and/or *Prunus emarginata* dominate the shrub layer. Other shrubs such as *Symphoricarpos rotundifolius* and *Ericameria nauseosa* may be present as sub-dominants. Stands are found in forest openings or on rock outcrops…

***Prunus emarginata - Holodiscus discolor* Alliance (n=10)**

(a) Holodiscus discolor is dominant in the shrub layer. *Ericameria nauseosa* and *Chrysothamnus viscidiflorus* are often present and sub-dominant…

Holodiscus discolor Association (n=2)

(b) Prunus emarginata is dominant in the shrub layer with *Symphoricarpos rotundifolius* and/or *Ceanothus velutinus*. *Holodiscus discolor* may be present to co-dominant…

Prunus emarginata Sierran Association (n=8)

B.5 *Quercus vacciniifolia* or *Chrysolepis sempervirens* is dominant to co-dominant in the shrub layer. Other shrubs including *Symphoricarpos* spp., *Prunus emarginata*, and *Arctostaphylos* spp. are typically present and may be co-dominant. Stands are often found on steep upper slopes and ridges…

***Quercus vacciniifolia - Chrysolepis sempervirens* Alliance (n=24)**

(a) Chrysolepis sempervirens is dominant in the shrub layer with *Prunus emarginata* and *Arctostaphylos* spp.…

Chrysolepis sempervirens Association (n=2)

(b) Quercus vacciniifolia is strongly dominant in the shrub layer. Conifers may be emergent in the overstory but have significantly less cover than the shrub layer. The herb layer is sparse to open…

Quercus vacciniifolia Association (n=15)

(c) Quercus vacciniifolia is co-dominant in the shrub layer with *Arctostaphylos patula, A. nevadensis, Ceanothus cordulatus,* and/or *Prunus emarginata*…

Quercus vacciniifolia - Arctostaphylos patula Association (n=6)

B.6 *Prunus virginiana* is dominant to co-dominant in the shrub layer with *Symphoricarpos rotundifolius. Artemisia tridentata* and *Purshia tridentata* may also be present*….*

Prunus virginiana / Symphoricarpos rotundifolius Association (n=1)
in the ***Prunus virginiana* Alliance**

B.7 *Salix scouleriana* is dominant to co-dominant in the shrub layer with *Ceanothus velutinus*, *Ceanothus cordulatus* or other fire related shrubs. Occasionally, *S. scouleriana* may be sub-dominant to other fire related shrubs but will have at least 5% absolute cover. Unlike other willows, *S. scouleriana* is not associated with creeks, seeps, and streams and stands are seral, following disturbance by fire…

Salix scouleriana Provisional Association (n=5)
in the ***Salix scouleriana* Provisional Alliance (n=5)**

B.8 Tall shrubs or small trees of *Cercocarpus ledifolius* are strongly dominant in the overstory. *Juniperus occidentalis*, *Pinus jeffreyi* and *Abies concolor* may be emergent in the overstory but do not have enough cover to key to those associations. Other shrubs may include *Artemisia tridentata, Ribes velutinum, Symphoricarpos rotundifolius*, and/or *Prunus virginiana* at low cover…

Cercocarpus ledifolius Association (n=5)

in the ***Cercocarpus ledifolius*[2] Alliance**
of the **Intermountain Basins Curl-leaf Mountain-mahogany Woodland & Scrub Group**

B.9. *Amelanchier utahensis* is strongly dominant in the shrub layer. Stands may be related to recent fire as *A. utahensis* readily resprouts after fire…

Amelanchier utahensis Association (n=1)
in the ***Amelanchier utahensis - Cercocarpus montanus - Cercocarpus intricatus* Alliance**
of the **Southern Rocky Mountain Mountain-mahogany - Mixed Foothill Shrubland Group**

B.10 *Ceanothus cuneatus* is dominant in the shrub layer. Stands are uncommon in the project area but may be found at lower elevations near the western boundary…

***Ceanothus cuneatus* Alliance (n=0)**
of the **Californian Xeric Chaparral Group**

C. Cool semi-desert shrublands dominated by xeromorphic species including *Artemisia* spp., *Ericameria nauseosa, Purshia tridentata,* shrubby *Eriogonum* spp., *Atriplex* spp., *Ephedra viridis,* and other species more common in the Great Basin and desert ecoregions…

C.1 Semi-arid stand characterized by *Artemisia arbuscula* or *Eriogonum* spp. subshrubs forming an open to intermittent shrub layer. *Poa secunda* and/or *Elymus elymoides* are present in the herbaceous layers. Stands are found on shallow rocky soils….

Intermountain Low & Black Sagebrush Steppe & Shrubland Group

C.1a Dwarf shrub *Eriogonum* spp. (*E. strictum, E. douglasii, E. umbellatum*) are characteristically present even as low as <1% cover and usually no other shrubs are present with greater cover. Generally, on flats or exposed hilltops with significant cobble and/or gravel covering the soil surface. Stands commonly occur on volcanic substrates including ash, basalt, and lahars. Total vegetation cover is usually <10% and often <5%. For stands of *E. wrightii* see key break C.3...

***Eriogonum* spp. / *Poa secunda* Alliance (n=7)**

(a) Eriogonum douglasii and/or *E. umbellatum* are characteristic in these sparse stands. *Artemisia arbuscula* is typically present at low cover. Other shrub species include *Ericameria nauseosa* and *Purshia tridentata.* Characteristic grasses include *Elymus elymoides* and *Poa secunda.* Soils are gravelly and often have large rock present…

[2] *Cercocarpus ledifolius* is considered under separate tree and shrub alliances in the NVCS. However, there is much overlap in California so we put it in one shrub alliance following Sawyer et al. (2009).

Eriogonum douglasii / Poa secunda Association (n=5)

(b) Eriogonum strictum is characteristic in these depauperate, barely vegetated stands. Soils are shallow and rocky…

Eriogonum strictum / Poa secunda Association (n=1)

C.1b *Artemisia arbuscula* (ssp. *arbuscula, longiloba)* is dominant in the shrub layer. *Purshia tridentata, Artemisia tridentata,* and *Ericameria* spp. are typically present at lower cover than *A. arbuscula*. *A. arbuscula* stands tend to grow on flats, depressions, slopes, or ridges with soils that are either very shallow and rocky or poorly drained with heavy clay…

***Artemisia arbuscula* ssp. *arbuscula* Alliance (n=17)**

(a) Artemisia arbuscula is dominant and evenly distributed in the shrub layer and is usually >10% absolute cover although it may be as low as 3% absolute cover. Herb layer is sparse to open and is characterized by native grasses such as *Poa secunda* and *Elymus elymoides*. Other herbs may include *Balsamorhiza hookeri*, *Epilobium brachycarpum*, and *Navarretia intertexta*. Stands can be found at meadow edges or on flats or gentle slopes that have heavy clay soils often with a high amount of surficial rock…

Artemisia arbuscula / Poa secunda Association (n=10)

(b) Stands are in a degraded state from clearing, grazing, fire, or other disturbances (although the mode of disturbance may not be obvious). *A. arbuscula* is dominant in the shrub layer although it may have as low as 5% absolute cover. The herbaceous layer typically has higher cover than more pristine stands of the alliance and is dominated by non-native annual grasses such as *Bromus tectorum* and *Taeniatherum caput-medusae*. Native herbaceous cover is usually insignificant…

Artemisia arbuscula / Bromus spp. - *Taeniatherum caput-medusae* Association (n=0)

(c) Artemisia arbuscula is the dominant shrub and one or more *Eriogonum* spp. subshrubs is characteristically present in a sparse shrub layer. The herbaceous layer is also sparse. Stands have high surficial rock cover…

Artemisia arbuscula - Eriogonum (microthecum, sphaerocephalum) Association (n=3)

(d) Artemisia arbuscula ssp. *longiloba* is dominant in an open shrub layer. *Linanthus pungens* is often present. *Poa secunda* is present in the open herbaceous layer and

Stenotus acaulis an *Eriogonum* spp. are often present. Stands occur on ridgelines and mountain tops above 2000 meters. Sites are very rocky…

*Artemisia arbuscula (*ssp*. longiloba) / Stenotus acaulis* Association (n=4)

C.2 Shrubland and shrub-steppe dominated by *Artemisia tridentata, Purshia tridentata,* or *Symphoricarpos* spp.…

Intermountain Mountain Big Sagebrush Steppe & Shrubland Group

C.2a *Artemisia tridentata* is dominant to co-dominant in the shrub layer. *A. arbuscula* may reach co-dominance but has lower cover than *A. tridentata.* Herbaceous layer is sparse to open. Stands typically occur on deeper soils in valley bottoms…

***Artemisia tridentata* Alliance (n=7)**

(a) Artemisia tridentata is strongly dominant. Other shrubs may be present but are typically low in cover. The herbaceous layer is sparse to intermittent with high relative cover of native herbs. Stands occur below 6000 ft. elevation near meadows and lake edges…

Artemisia tridentata Association (n=7)

(b) Artemisia tridentata is dominant to co-dominant with or without *Ericameria nauseosa* and/or *Chrysothamnus viscidiflorus*. Shrub cover averages around 10% cover but may be as low as 2% and herb cover is typically >10% absolute cover, with very low relative cover of native herbs. Signs of disturbance such as fire, grazing, and roads/trails are present and typically severe. Herb layer is characterized by high non-native grass cover and very low nativity in general…

Artemisia tridentata - (Ericameria nauseosa) / Bromus tectorum Association (n=0)

C.2b *Artemisia tridentata* ssp. *vaseyana, Artemisia tridentata* ssp. *spiciformis,* and/or *Symphoricarpos rotundifolius* dominate in the shrub layer. Found at higher elevations to above tree line on slopes and ridges. *Purshia tridentata* has <50% relative cover in the shrub layer…

***Artemisia tridentata* ssp. *vaseyana* Alliance (n=22)**

(a) Artemisia tridentata ssp. *vaseyana* is dominant or co-dominant in the shrub layer and other mesic shrubs such as *Symphoricarpos rotundifolius* (a synonym for the Jepson manual's *S. oreophilus*) are often present. The herbaceous layer is diverse and characterized by mesic forbs and grasses including *Bromus carinatus*, *Wyethia mollis,* and *Orthocarpus* spp.…

Artemisia tridentata ssp. *vaseyana - Symphoricarpos oreophilus / Bromus carinatus* Association (n=15)

(b) Symphoricarpos rotundifolius (a synonym for the Jepson manual's *S. oreophilus*) or *Symphoricarpos mollis* co-dominates in the shrub layer with *Chrysothamnus viscidiflorus*, *Ribes* spp., and/or *Prunus* spp. but *Artemisia tridentata* ssp. *vaseyana* does not reach co-dominance. This type is indicative of disturbance (fire, grazing, clearing, wind-swept ridges) and may be successionally related to stands formerly dominated or co-dominated by *Artemisia tridentata* ssp. *vaseyana*…

Symphoricarpos oreophilus Association(n=2)

(c) Artemisia tridentata ssp. *spiciformis* is strongly dominant in the shrub layer. If other shrubs are present, they do not co-dominate. The herbaceous layer is characterized by mesic forbs and grasses including *Bromus carinatus.* Stands are found at the upper elevation ranges of the alliance in bottomlands and gentle slopes where higher amounts of snow accumulate…

Artemisia tridentata ssp. *spiciformis* Association (n=3)

C.2c *Purshia tridentata* is typically present with at least 50% relative cover and dominant to co-dominant in the shrub layer with *Artemisia tridentata* (ssp. *tridentata* or ssp. *vaseyana*) and/or *Tetradymia canescens*. In stands that have been disturbed *Tetradymia canescens* and/or *Prunus andersonii* may replace *P. tridentata* as the dominant shrub. If these disturbance related shrubs do not have significant cover and *P. tridentata* does not have at least 50% relative cover with *A. tridentata*, key to *Artemisia tridentata* Alliance. Typically found on moderately steep, north facing slopes.…

***Purshia tridentata - Artemisia tridentata* Alliance (n=22)**

(a) Purshia tridentata is co-dominant in the shrub layer with *Artemisia tridentata* ssp. *tridentata*. Other shrubs such as *Ericameria nauseosa* and *Tetradymia canescens* may be present at low cover. The herb layer is dominated by grasses including *Bromus tectorum…*

Purshia tridentata - Artemisia tridentata Association (n=3)

(b) Purshia tridentata is co-dominant in the shrub layer with *Artemisia tridentata* ssp. *vaseyana*. The herbaceous layer is dominated by perennial forbs such as *Wyethia mollis* or *Balsamorhiza sagittata.* Stands occur at higher elevation sites, above 1600 m…

Purshia tridentata - Artemisia tridentata - Symphoricarpos rotundifolius Association (n=10)

(c) Purshia tridentata, often short in stature, is strongly dominant in the shrub layer. Other shrubs may be present at low cover and do not reach co-dominance. The herbaceous layer is sparse to open and *Elymus elymoides* is often present. Sites are typically rocky. At higher elevation the shrub layer is often quite short (< 1 m)…

Purshia tridentata Association (n=6)

(d) Prunus andersonii is dominant to co-dominant in the shrub layer with *Artemisia tridentata (*ssp. *tridentata)* with disturbance related shrubs such as *Tetradymia canescens, Chrysothamnus viscidiflorus,* and *Ericameria nauseosa.* The herbaceous layer is sparse to open and often characterized by *Bromus tectorum* or other non-native species. Disturbance such as fire is usually evident…

Purshia tridentata - Artemisia tridentata - (Tetradymia canescens / Eriogonum umbellatum) Association (n=5)

C.3 Semi-arid shrublands not characterized by *Artemisia* spp. Characteristic shrubs include *Ericameria nauseosa, Krascheninnikovia lanata, Ephedra viridis,* and *Eriogonum* wrighti If stand is characterized by *Eriogonum* spp. subshrubs see Intermountain Mountain Big Sagebrush Steppe & Shrubland Group (C.1)…

C.3a Stands are dominated or characterized by *Eriogonum wrightii* or *Ephedra viridis…*

Mojave Mid-Elevation Mixed Desert Scrub Group

C.3a.i *Eriogonum wrightii* dominant in stands, though other shrubs may be present including *Tetradymia canescens* or *Prunus andersonii* at lower cover…

Eriogonum wrightii (ssp. *subscaposum*, ssp. *wrightii)* Association (n=1)
in the ***Eriogonum wrightii - Eriogonum heermannii - Buddleja utahensis*** **Alliance**

C.3a.ii Open stand dominated or co-dominated by *Ephedra viridis.* Herbaceous layer is sparse to open. Stands occur on rocky, well-drained soils…

Ephedra viridis Association (n=1)
in the ***Ephedra viridis*** **Alliance (n=1)**

C.3b Stands are dominated by woody disturbance related shrubs *Ericameria nauseosa, Chrysothamnus viscidiflorus* or *Krascheninnikovia lanata*….

Intermountain Semi-Desert Steppe & Shrubland Group

C.3b.i *Ericameria nauseosa* is dominant in the sparse to open shrub layer. Herbaceous layer is sparse to open and often dominated by *Elymus elymoides* and/or *Bromus tectorum….*

***Ericameria nauseosa* Alliance (n=2)**

(a) Evidence of disturbance from fire, grazing, or other clearing is present. Typically, the low diversity herbaceous layer is dominated by non-native annual herbs such as *Bromus tectorum*, *Erodium cicutarium*, and *Elymus elymoides…*

Ericameria nauseosa / Bromus tectorum Association (n=2)

C.3b.ii *Chrysothamnus viscidiflorus* dominates in the shrub layer without significant cover of *Artemisia tridentata* or *Purshia tridentata. Poa secunda* is generally present in the herb layer. In disturbed sites, *Bromus tectorum* may dominate the herb layer. Stands were not surveyed in the study but have been observed…

***Chrysothamnus viscidiflorus* Alliance (n=0)**

C.3b.iii *Krascheninnikovia lanata* is dominant in the open shrub layer. Herbaceous layer is typically sparse and dominated by *Elymus elymoides* and/or *Bromus tectorum….*

Krascheninnikovia lanata Association (n=2)
in the ***Krascheninnikovia lanata* Alliance**

C.4 Dominant or characteristic shrubs are associated with old playas or lakeshores occurring on semi-alkaline, sandy, or clayey soils. Shrub layer is typically open to intermittent and dominated or co-dominated by *Atriplex canescens* or *A. confertifolia*…

Intermountain Shadscale - Saltbush Scrub Group

C.4a *Atriplex canescens* is dominant to co-dominant in the shrub layer with *Krascheninnikovia lanata…*

Atriplex canescens - Krascheninnikovia lanata Association (n=1)
in the ***Atriplex canescens* Alliance**

C.4b *Atriplex confertifolia* is dominant to co-dominant in the shrub layer with *Picrothamnus desertorum* or *Grayia spinosa*…

***Atriplex confertifolia* Alliance(n=2)**

(a) Atriplex confertifolia is dominant in the open shrub layer. The herbaceous layer is sparse to open and typically dominated by non-native species such as *Bromus tectorum, Ranunculus testiculatus,* and *Lepidium perfoliatum…*

Atriplex confertifolia Great Basin Association (n=1)

(b) Atriplex confertifolia and *Picrothamnus desertorum* are co-dominant in the shrub layer…

Atriplex confertifolia - Picrothamnus desertorum Association (n=1)

(c) Atriplex confertifolia is co-dominant with *Grayia spinosa* which may be greater in cover…

Atriplex confertifolia - Grayia spinosa Provisional Association (n=0)

C.5 Saline wetland with *Sarcobatus vermiculatus* sub-dominant to dominant. If *S. vermiculatus* is sub-dominant, other salt-tolerant shrubs are also present. Stands occur in playas, washes, mudflats and depressional wetlands where evaporation exceeds precipitation…

***Sarcobatus vermiculatus* Alliance (n=4)**
of the **North American Desert Alkaline-Saline Wet Scrub Group**

(a) Sarcobatus vermiculatus is dominant to sub-dominant with *Chrysothamnus viscidiflorus* and/or *Artemisia tridentata* in the shrub layer…

Sarcobatus vermiculatus - Artemisia tridentata Association (n=2)

(b) Sarcobatus vermiculatus is dominant to sub-dominant with *Picrothamnus desertorum* and/or *Atriplex confertifolia*…

Sarcobatus vermiculatus - Atriplex confertifolia - (Picrothamnus desertorum, Suaeda moquinii) Association (n=2)

D. Non-native *Tamarix* spp. dominates in the shrub canopy along riparian or bottomland settings. Other trees or shrubs may be present at low cover…

***Tamarix* spp. Semi-Natural Alliance (n=0)**
of the **Interior West Ruderal Riparian Forest & Scrub Group**

E. Alpine to subalpine habitat, above 2300 m in the study area, composed of open to intermittent subshrub and/or herbaceous canopy dominated by *Ericameria discoidea*, *Phyllodoce breweri,* or graminoids such as *Juncus parryi* or *Carex spectabilis.* Vegetation height is typically low as a result of exposure to extreme winter conditions….

E.1 *Ericameria discoidea* is dominant in the subshrub or herbaceous layer. Other species typically present at low cover include *Artemisia* spp., *Polygonum davisiae, Lupinus arbutus,* and *Elymus multisetus…*

Ericameria discoidea - Phacelia hastata Association
in the ***Phlox covillei - Ericameria discoidea*** **Alliance (n=4)**

E.2 *Phyllodoce breweri* and/or *Cassiope mertensiana* are dominant in the subshrub or herbaceous layer. High elevation conifers such as *Tsuga mertensiana* and *Pinus monticola* may be emergent with low cover. Stands are typically small and limited to snow accumulation areas or moist rocky edges of subalpine streams and meadows where sites remain moist throughout their short growing season…

Phyllodoce breweri - Cassiope mertensiana - Juncus parryi Association (n=3)
in the ***Juncus drummondii - Juncus parryi - Sibbaldia procumbens*** **Alliance**

Class III. Annual or perennial herbs, including grasses, graminoids (sedges and rushes), and forbs, average >2% cover and are evenly distributed across the stand. Trees and shrubs, if present, each average less than 4% cover and/or are not evenly distributed…….. Herbaceous Stands

A. Stands occur in dry upland settings and are dominated by cool-season bunchgrasses or non-native annuals…

A.1 Grassland dominated by cool-season perennial bunchgrasses such as *Pseudoroegneria spicata, Poa secunda* and/or *Festuca idahoensis. Poa secunda* is typically present but not the only characteristic bunchgrass…

Festuca idahoensis - ***Pseudoroegneria spicata*** - ***Poa secunda*** **Alliance (n=1)**
of the **Central Rocky Mountain Lower Montane, Foothill & Valley Grassland Group**

(a) Stands are characterized by *Pseudoroegneria spicata* and/or *Poa secunda*, usually on warmer aspects with rocky substrate. Non-native species such as *Bromus tectorum* or *Taeniatherum caput-medusae* often co-dominate or dominate the herb layer but native cover is usually >20% relative cover. Other native herb species present include *Elymus elymoides, Epilobium brachycarpum, Blepharipappus scaber, Achnatherum thurberianum,* and/or *Lomatium* spp. *Festuca idahoensis* may be present but sub-dominant. Stands have typically burned within the past 10 years…

Pseudoroegneria spicata - Poa secunda Association (n=1)

A.2 Stands strongly dominated by *Elymus elymoides* with all other herbaceous species having very little cover. Species diversity is very low and may have obvious signs of disturbance such as fire and/or juniper removal…

Elymus elymoides (n=1)
in the **Aristida purpurea - Elymus elymoides - Poa secunda Alliance** of the **Central**
of the **Intermountain Semi-Desert Grassland Group**

A.3 Grassland dominated by perennial non-native species including *Bromus inermis* or *Agropyron cristatum.* Stands can be in dry to mesic settings and are often a monoculture as these species are seeded for soil erosion or livestock feed….

Agropyron cristatum - ***Bromus inermis*** - ***Poa pratensis*** **Ruderal Grassland Alliance (n=3)**
of the **Western North American Interior Ruderal Grassland & Shrubland Group**

(a) Agropyron cristatum is typically strongly dominant but *Bromus tectorum* is often present with high cover and can reach co-dominance…

Agropyron cristatum Association (n=1)

(b) Bromus inermis or *Festuca pratensis* is dominant in disturbed meadows…

Bromus inermis - (Pascopyrum smithii) Association (n=2)

A.4 Upland stands dominated by *Bromus tectorum* with other non-native annuals such as *Erodium cicutarium* and *Sisymbrium altissimum*. Stands often associated with recent fire, clearing, or other heavy disturbance. Often stands were previously dominated by shrubs such as *Artemisia tridentata, A. arbuscula,* and/or *Purshia tridentata…*

Bromus tectorum - Taeniatherum caput-medusae **Alliance (n=3)**
of the **Great Basin-Intermountain Ruderal Dry Shrubland & Grassland Group**

(a) Bromus tectorum is usually strongly dominant in the herb layer. Other non-native or disturbance related herbs are present…

Bromus tectorum Association (n=3)

(b) Taeniatherum caput-medusae is strongly dominant to co-dominant with *Bromus tectorum, Bromus arvensis, Erodium cicutarium*, and/or *Lactuca serriola*…

Taeniatherum caput-medusae Provisional Association (n=0)

B. Stands occur in fens or wet meadows with seasonally to annually saturated or flooded soils. Stands typically stay moist throughout the growing season and may have standing water...

B.1 Stands occur in marshes, wet meadows, riparian corridors, seeps, or springs on mineral or shallow organic layers….

B.1a Freshwater marsh with lush, dense vegetation dominated by *Schoenoplectus* spp. or *Typha* spp.…

Arid West Interior Freshwater Marsh Group

(a) Schoenoplectus acutus is strongly dominant in the herbaceous layer…

Schoenoplectus acutus Association (n=1)
in the ***Schoenoplectus (acutus, californicus)*** **Alliance**

(b) Typha latifolia is strongly dominant in the herbaceous layer…

Typha (latifolia, angustifolia) Association (n=1)
in the ***Typha (angustifolia, domingensis, latifolia)*** **Alliance**

B.1b Wet montane meadow dominated by graminoids and/or forbs including *Carex* spp., *Eleocharis* spp., *Juncus* spp., *Camassia quamash, Deschampsia cespitosa*,

Calamagrostis canadensis, Danthonia unispicata¸ D. californica, Elymus glaucus, *Hordeum brachyantherum, Scirpus microcarpus, Veratrum californica, Mimulus* spp. and/or *Trifolium longipes.* These meadows typically retain moisture throughout the growing season…

Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group

B.1b.i Wet montane meadow dominated by graminoids including *Carex* spp., *Eleocharis* spp., *Calamagrostis canadensis,* and *Torreyochloa pallida* var. *pauciflora.* Stands of this alliance typically stay wet and may have standing water throughout the growing season…

***Carex utriculata - Calamagrostis canadensis* Alliance (n=64)**

(a) Eleocharis macrostachya is dominant in meadows that are typically permanently saturated but can occasionally be found in temporarily sites that dry out later in the season…

Eleocharis macrostachya Montane Association (n=3)

(b) Eleocharis acicularis is dominant in very wet or saturated wet meadow...

Eleocharis acicularis Montane Association (n=2)

(c) Carex utriculata is dominant in a dense herbaceous layer of typically very wet meadows, in seeps, or along streams or lakesides where the water table is near the surface all growing season…

Carex utriculata Association (n=7)

(d) Carex vesicaria is dominant in a dense herbaceous layer of wet meadows or shallow lakes or ponds…

Carex vesicaria Association (n=4)

(e) Calamagrostis canadensis is dominant in the dense herbaceous layer. Stands occur in wet meadows with deep organic matter…

Calamagrostis canadensis - (Carex utriculata) Association (n=1)

(f) Carex nebrascensis is dominant to co-dominant with at least 30% relative cover in the herbaceous layer with *Poa pratensis, Deschampsia cespitosa, Trifolium longipes,* and *Symphyotrichum spathulatum…*

Carex nebrascensis Association (n=42)

(g) Carex microptera is dominant to co-dominant in the herbaceous layer. Often found near the drying edges of wet meadows…

Carex microptera Association (n=1)

(h) Stands dominated or co-dominated by *Scirpus microcarpus.* Stands are small and concentrated in areas with organic-rich substrates, typically saturated by seeping cold water…

Scirpus microcarpus Association (n=2)

(i) Torreyochloa pallida is dominant or co-dominant. Stands are often in standing water of seasonal ponds resulting from snow melt or shallow mountain lakes. Overall cover may be low…

Torreyochloa pallida Association (n=1)

(j) Carex aquatilis dominant to co-dominant in the stand. No other *Carex* spp. has higher cover. *Poa pratensis* may be co-dominant…

Carex aquatilis Association (n=1)

B.1b.ii *Juncus balticus* and/or *J. mexicanus* is dominant in the herbaceous layer or may be co-dominant with *Poa pratensis* or other wetland species that are not strong indicators of the other alliances in the Vancouverian-Rocky Mountain Montane Wet Meadow & Marsh Group…

Juncus arcticus var. *balticus* - (var. *mexicanus*) Association (n=13)
in the ***Juncus arcticus* (var. *balticus, mexicanus*) Alliance**

B.1b.iii *Elymus glaucus* is dominant in moist, loamy montane meadows or may be characteristic with other moist meadow species such as *Carex* spp. or *Agrostis gigantea…*

***Elymus glaucus* Montane Alliance (n=1)**

B.1b.iv Seasonally wet meadow characterized by *Deschampsia cespitosa, Danthonia unispicata, Camassia quamash,* or *Hordeum brachyantherum.* Stands are typically drier later in the season than stands of the *Carex utriculata - Calamagrostis canadensis* Alliance*…*

***Danthonia californica - Deschampsia cespitosa - Camassia quamash* Alliance (n=33)**

(a) Danthonia californica is co-dominant in the herbaceous layer and *Muhlenbergia filiformis* is often present to co-dominant. Other species often present include *Symphyotrichum* spp. and *Juncus* spp….

Danthonia californica - (Muhlenbergia filiformis) Association (n=6)

(b) Stands with dominant to co-dominant *Deschampsia cespitosa* with other seasonally saturated meadow herbs including *Trifolium longipes*, *Hordeum brachyantherum*, *Carex* spp. (not characteristic of the *Carex utriculata - Calamagrostis canadensis* Alliance) and *Juncus* spp. *D. cespitosa* is very palatable therefore stands typically indicate an absence of regular livestock grazing…

Deschampsia cespitosa Association (n=8)

(c) Juncus nevadensis is dominant to co-dominant with *Juncus arcticus…*

Juncus nevadensis Association (n=4)

(d) Moist meadow stands with *Danthonia unispicata*, and/or broad-leaved bulbiferous monocots such as *Allium* spp. or *Camassia* spp. conspicuous. *Poa secunda* is usually present to co-dominant. Other herbs may include *Lomatium* spp., *Perideridia* spp., and *Epilobium* spp. …

Danthonia unispicata - Poa secunda Association (n=7)

(e) Hordeum brachyantherum is dominant to co-dominant in herb layer with other moist meadow species including *Juncus* spp., *Elymus glaucus*, and/or *Lotus purshiana*…

Hordeum brachyantherum Montane Association (n=2)

(f) Carex praegracilis is dominant to co-dominant in the herb layer…

Carex praegracilis Montane Association (n=2)

(g) Vegetation is dominated by *Carex athrostachya* found at drying edges of meadows, lakes, or ponds…

Carex athrostachya Association (n=2)

(h) Vegetation is dominated by *Carex integra* typically found on the drying meadow edge…

Carex integra Association (n=2)

B.1b.v Vegetation is dominated by *Veratrum californica, Senecio triangularis, or Mimulus* spp. together or individually. Stands are found in seasonally saturated meadows that do not remain saturated through the growing season, raised areas of wet meadows, or stringer meadows along streams in the montane zone…

***Senecio triangularis - Veratrum californicum - Mimulus* spp. Alliance (n=8)**

(a) Senecio triangularis and *Veratrum californicum* are co-dominant in the stand with other mesic forbs such as *Mimulus primuloides* and *Mimulus guttatus…*

Veratrum californicum - Senecio triangularis Association (n=5)

(b) Veratrum californicum is dominant in the stand. If *Senecio triangularis* is present it does not reach co-dominance…

Veratrum californicum Association (n=2)

(c) Mimulus guttatus is dominant in the stand. *Senecio triangularis Veratrum californicum, and Mimulus primuloides are present to co-dominant…*

Mimulus guttatus Montane Association (n=1)

B.1b.vi Stands in disturbed drier meadows dominated by forbs that tolerate grazing such as *Trifolium longipes, Muhlenbergia filiformis, Symphyotrichum* spp., *Penstemon rydbergii,* and *Potentilla gracilis…*

***Trifolium longipes - Muhlenbergia filiformis* Alliance (n=13)**

(a) Trifolium longipes and/or *Symphyotrichum* spp. are dominant in the meadow stand and no other meadow indicators such as *Deschampsia cespitosa* or *Carex (nebrascensis, aquatilis, utriculata*) have higher cover…

Trifolium longipes - (Muhlenbergia filiformis - Symphyotrichum spp.) Association (n=10)

(b) Penstemon rydbergii is dominant to co-dominant in the stand. *Trifolium longipes* is often present and co-dominant but has lower cover than *P. rydbergii…*

Penstemon rydbergii - (Muhlenbergia filiformis) Provisional Association (n=2)

B.1c Stands occur in larger streams with large boulders. *Carex nudata* is dominant in the herbaceous layer. Emergent riparian trees may be present. Stands are not common in the study area but may be found near the northwestern boundary…

Carex nudata Association (n=1)
in the ***Carex nudata* Alliance**
of the **Vancouverian Freshwater Wet Meadow & Marsh Group**

B.1d Lotus unifoliolatus is dominant in the herbaceous layer. Stands are found on intermittently flooded alluvial flats or lake shores…

***Lotus unifoliolatus* Provisional Alliance (n=0)**
of the **Temperate Pacific Freshwater Wet Mudflat and Floodplain Group**

B.2 Stand is a fen with graminoid vegetation and moss cover is high on the surface. Organic layer is deep and/or soil is muck…

***Carex limosa - Carex buxbaumii - Eleocharis quinqueflora* Alliance (n=22)**
of the **Rocky Mountain Alkaline Fen Group**

(a) Carex simulata is dominant to co-dominant in the herbaceous layer. If *C. vesicaria* is present it is sub-dominant…

Carex simulata Association (n=6)

(b) Carex simulata and *C. vesicaria* are co-dominant in the herbaceous layer…

Carex simulata - Carex vesicaria Association (n=2)

(c) Carex capitata is characteristic in the herbaceous layer…

Carex capitata Fen Provisional Association (n=3)

(d) Carex luzulina is dominant in the herbaceous layer…

Carex luzulina Provisional Association (n=1)

(e) Eleocharis quinqueflora is dominant to co-dominant in the herbaceous layer with *Mimulus primuloides,* and *Muhlenbergia filiformis…*

Eleocharis quinqueflora Association (n=2)

(f) Mimulus primuloides is dominant in the herbaceous layer and no other species has greater cover…

Mimulus primuloides Association (n=2)

(g) Carex echinata is dominant to co-dominant in the herbaceous layer with no other vascular species having greater cover. Mosses are characteristic in the stand with high cover. Stands are mostly found on sloping fens but can be found in basin fens and wet meadows…

Carex echinata / (Philonotis fontana - Sphagnum subsecundum) Association (n=2)

(h) Carex scopulorum > 5% absolute cover in herbaceous layer; if *Carex utriculata* or *C. vesicaria* are present, *C. scopulorum* has > 50% relative cover. Stands of *C. scopulorum* not in a fen likely belong to the *Carex utriculata - Calamagrostis canadensis* Alliance …

Carex scopulorum Association (n=1)

B.3 Stand is typically a monoculture of freshwater floating aquatic vegetation

Western North American Temperate Freshwater Aquatic Vegetation Group

B.3a Stand is dominated by *Nuphar polysepala,* which is often the only species present. Other aquatic and emergent species may be present and subdominant…

Nuphar lutea spp. *polysepala* Association (n=1)
in the ***Nuphar lutea*** **Alliance**

B.3b Stand is dominated by *Potemogeton natans* or *P. pusillus.* Other aquatic and emergent species may be present and subdominant…

Potamogeton spp. Association (n=3)
in the ***Stuckenia (pectinata) - Potamogeton*** **spp. Alliance**

B.4 Grassland dominated by perennial non-native species including *Bromus.* Native herbaceous cover is less than 10% relative cover. Stands can be in dry to mesic settings and are often a monoculture as these species are seeded for soil erosion or livestock feed….

Agropyron cristatum - ***Bromus inermis*** - ***Poa pratensis*** **Ruderal Grassland Alliance (n=3)**
of the **Western North American Interior Ruderal Grassland & Shrubland Group**

(a) Bromus inermis or *Festuca pratensis* is dominant in disturbed meadows. …

Bromus inermis - (Pascopyrum smithii) Association (n=2)

C. Mesic to dry montane meadow characterized by grasses and/or forbs. Soils may be wet to moist but typically dry out by the end of the growing season…

Rocky Mountain-North Pacific Subalpine-Montane Mesic Grassland & Meadow Group

C.1 Moist deep-soil meadows dominated by *Poa secunda* ssp. *junicfolia, Muhlenbergia richardsonis,* and/or *Carex douglasii….*

Poa secunda - Muhlenbergia richardsonis - Carex douglasii **Alliance (n=0)**

(a) Muhlenbergia richardsonis is dominant in the stand. *Juncus balticus* or *J. mexicanus* is typically present and may co-dominate…

Muhlenbergia richardsonis Association

(b) Carex douglasii is dominant in the stand. Sites may be disturbed and soil alkaline…

Carex douglasii Association

C.2 Dry upper-montane meadow where soils may be seasonally saturated from snowmelt or subsurface flow originating upslope, though they are dry by mid-summer. Soils are gravelly. Stands are often diverse but include a high constancy of *Polygonum* spp.*, Gayophytum diffusum,* and *Cistanthe (Calyptridium)* spp. Indicators of other wet meadow alliances are typically absent but stands can occur in soil deposition zones surrounding meadows where soils do not remain saturated in the growing season...

***Cistanthe (umbellata) - Gayophytum (diffusum)* Alliance (n=10)**

(a) Polygonum douglasii and *Gayophytum diffusum* characterize the stand. Total vegetation cover is often low with a high amount of bare ground…

Polygonum douglasii - Gayophytum diffusum Association (n=7)

C.3 Montane mesic meadow dominated by *Wyethia mollis* with ≥50% relative cover. Stands often occur in forest openings and may be the result of disturbance by fire. Other mesic meadow species such as *Allium campanulatum, Bromus carinatus, Lupinus* spp., and *Sidalcea glaucescens* are often present with lower cover…

Wyethia mollis - Balsamorhiza sagittata Association (n=9)
in the ***Agastache urticifolia - Geranium viscosissimum - Pteridium aquilinum* Alliance**

C.4 *Carex filifolia* is dominant in the stand and has at least 15% absolute cover if other herbaceous species are present. Stands occur on gentle upper elevation slopes with coarse or gravely substrates. Montane shrubs are emergent in the stands…

***Carex filifolia* Alliance (n=0)**

E. Disturbed meadows found in lowlands and montane zones dominated by non-native grasses and forbs such as *Phalaris* spp., *Thinopyrum*, *Lepidium* spp., and *Lactuca serriola*. Stands are usually seasonally wet, drying by late summer…

Western North American Ruderal Marsh, Wet Meadow & Shrubland Group

E.1 Stands dominated by larger non-native perennial pasture grasses such as *Phalaris aquatica, Phalaris arundinacea, Thinopyrum ponticum (Elymus pontius)* or *T. intermedium* (*Elymus hispidus*) and/or by weedy annual or perennial non-native herbs such as *Lactuca* spp., *Sisymbrium* spp., and *Lepidium* spp.

Thinopyrum (ponticum, intermedium) Association (n=2)
in the ***Phalaris aquatica - Phalaris arundinacea* Ruderal Alliance**

E.2 *Lepidium latifolium* is dominant or co-dominant in the stand with other weedy species in intermittently and seasonally flooded wetlands that are in alkaline or saline settings. *Distichlis spicata* is commonly present at low cover (< 1% absolute cover)…

***Lepidium latifolium* - *(Lactuca serriola)* Alliance (n=0)**

D. Alkaline or saline marsh or playa characterized by *Leymus cinereus, L. triticoides, and/or Distichlis spicata*…

North American Desert Alkaline-Saline Marsh & Playa Group

D.1 Grassland stands of relatively heavy soils (including clay mounds), not always in obvious alkaline basins, but often moist in early summer. *Leymus triticoides* or *L. cinereus* are obvious and consistent throughout stand and are dominant…

***Leymus cinereus* - *Leymus triticoides* Alliance (n=0)**

D.2 Stands characterized by *Distichlis spicata*, though other herbaceous species may have higher cover. May have other halophytes (*Bassia, Nitrophila*, etc.). Expected at Pleistocene alkaline lakebeds/playas. If *Juncus balticus* co-dominates then key here…

***Distichlis spicata* Alliance (n=0)**

F. Herbaceous communities with high diversity and endemism within vernal pools or shallow ephemeral pools on hardpan soils or shallow soils over bedrock. Characteristic species include *Psilocarphus brevissimus, Marsilea oligospora, Polygonum polygaloides, Taraxia tanacetifolia, Muhlenbergia richardsonis, Navarretia leucocephala,* and *Porterella carnosula*…

***Navarretia leucocephala* ssp. *minima* - *Plagiobothrys cusickii* Alliance (n=9)**
of the **Oregon-Washington-British Columbia Vernal Pool Group**

(a) Taraxia tanacetifolia is dominant to co-dominant with other Great Basin vernal pool species such as *Polygonum aviculare, Psilocarphus brevissimus* and/or *Muhlenbergia richardsonis.* Vernal pools are likely disturbed and/or grazed. *T. tanacetifolia* can tolerate somewhat alkaline water and stands may also be associated with artificial ponds or reservoirs…

Taraxia tanacetifolia - Iva axillaris Association (n=1)

(b) Polygonum polygaloides and/or *Downingia bacigalupii* are characteristic in the vernal pool. *Navarretia leucocephala* is also typically present. These pools dry sooner or are shallower than the *Marsilea oligospora - Eleocharis (acicularis, bella)* Association…

Polygonum polygaloides - Downingia bacigalupii Association (n=3)

(c) Marsilea oligospora, Porterella carnosula, and *Eleocharis bella* are characteristic in the vernal pool. These pools have longer inundation periods than others in the region…

Marsilea oligospora - Eleocharis (acicularis, bella) Association (n=3)

G. Alpine to subalpine habitat, above 2300 m in the study area, composed of open to intermittent subshrub and/or herbaceous canopy dominated by *Ericameria discoidea*, *Phyllodoce breweri,* or graminoids such as *Juncus parryi* or *Carex spectabilis.* If total vegetation cover is <10% key to the Western North American Cliff, Scree & Rock Vegetation Macrogroup. Vegetation height is typically low as a result of exposure to extreme winter conditions…

Rocky Mountain-Sierran Alpine-Subalpine Turf & Fell-field Group

G.1 *Ericameria discoidea* is dominant in the subshrub or herbaceous layer. Other species typically present at low cover include *Artemisia* spp., *Polygonum davisiae, Lupinus arbutus,* and *Elymus multisetus…*

Ericameria discoidea - Phacelia hastata Association
in the ***Phlox covillei - Ericameria discoidea*** **Sparsely Vegetated Alliance (n=4)**

G.2 *Phyllodoce breweri* is dominant in the subshrub or herbaceous layer. *Cassiope mertensiana* is typically present. High elevation conifers such as *Tsuga mertensiana* and *Pinus monticola* may be emergent with low cover. Stands are typically small and limited to snow accumulation areas or moist rocky edges of subalpine streams and meadows where sites remain moist throughout their short growing season…

Phyllodoce breweri - Cassiope mertensiana - Juncus parryi Association (n=3)
in the ***Juncus drummondii - Juncus parryi - Sibbaldia procumbens*** **Alliance**

G.3 *Carex spectabilis* is dominant in the herbaceous layer. Stands typically occur above 2000 m on slopes with long-lasting snow patches…

Carex spectabilis - Sibbaldia procumbens Association(n=3)
in the ***Carex spectabilis*** **Alliance**
of the **North Pacific Alpine-Subalpine Tundra Group**

H. Sparsely vegetated rock outcrop and cliff face including patchy vegetated fractures in the rock surface and less steep or more stable slopes that are composed of scattered trees and/or shrubs. Total vascular vegetation is < 10% absolute cover while mosses or lichens may be very dense, well-developed and display cover well over 10%.

Western North American Cliff, Scree & Rock Vegetation Macrogroup

H.1 Sparsely vegetated stands on steep slopes, rock outcrops or cliff faces where plants grow in cracks of glaciated granitic bedrock in the Sierra Nevada. Characteristic vascular species may include high elevation conifers such *Pinus jeffreyi*, *P. contorta* ssp. *murrayana, Abies magnifica, Juniperus grandis, Arctostaphylos* spp., *Penstemon newberryi* or *Spiraea splendens,* all at low covers...

Southern Vancouverian Cliff, Scree & Rock Vegetation Group

H.1a *Penstemon newberryi* is dominant in the shrub. Stands are often sparsely vegetated and occur on high elevation cliffsides or boulder/bedrock outcrops…

Penstemon newberryi Provisional Association
in the ***Penstemon newberryi*** **Sparsely Vegetated Alliance (n=4)**

H.2 Sparsely vegetated stands within the Great Basin Ecoregion on steep slopes, rock outcrops or cliff faces. Characteristic vascular species may include *Ericameria nauseosa, Ephedra viridis, Holodiscus discolor, Poa secunda, Elymus elymoides,* and *Stipa speciosa...*

Columbia Plateau cliff, scree and rock mapping unit