



Vegetation Mapping and Classification Project

Redwood National and State Parks, California

Natural Resource Report NPS/REDW/NRR—2017/1431



ON THE COVER

Coast redwood (*Sequoia sempervirens*) and sword fern (*Polystichum munitum*) at Redwood National and State Parks.
National Park Service photograph.

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Executive Summary

A vegetation classification and vegetation and land cover map of Redwood National and State Parks (RNSP) was created from remotely sensed and ground-verified data, as a part of the National Park Service Vegetation Mapping Inventory (NVMI), which creates vegetation classifications and maps for more than 270 United States National Park areas. The project was undertaken to provide data with which to inform local NPS management and the public. Products of the project include a digital vegetation and land cover map, a taxonomic classification, quantitative floristic vegetation plot data, and this report, which describes of methods and findings.

Floristic, physiognomic, and environmental data were collected from three hundred fifty-five (355) vegetation relevés, in order to classify and describe vegetation. Fifty-one (51) vegetation types at the approximate level of generalized alliance, and usually at the level of association were described.

The map employed the U.S. National Vegetation Classification (USNVC) to map 142,062 acres (57,491 hectares) of RNSP. Forty-five (45) vegetated map classes at the level of USNVC alliance and four non-vegetated land cover classes were mapped. Eighty-nine (89)% (126,796 acres) of RNSP mapped as forest or woodland, 0.9% (1,322 acres) was mapped as shrubland, 3.7% (5,294 acres) was mapped as herbaceous vegetation, 1.4% (2,053 acres) was mapped as barren, 4.2% (6,035 acres) was mapped as water, and 0.4% (562 acres) was not classified and was mapped as unknown land cover.

Old-growth coastal redwood forest characterized by coast redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*) grows on approximately 30% of the parks, the majority of which occurs within the three state parks. Second-growth stands of forests are characterized by Douglas-fir which becomes re-established following fire or logging more quickly than do coast redwoods. Dry forest communities have become established in the Redwood Creek basin along the ridges from Slide Creek to Coyote Creek. Little Bald Hills include an area of about 1,500 acres (607 hectares) of serpentinite soils in the northeastern portion of the parks. Dry ridgetops support scattered Jeffrey pine (*Pinus jeffreyi*) with an herbaceous understory of Idaho fescue (*Festuca idahoensis*) in the Little Bald Hills area. A complex mosaic of plant communities including coniferous forest, Oregon white oak (*Quercus garryana*) woodland, and grassland types occur in the Bald Hills. Coastal scrub, coastal grasslands, and Sitka spruce and red alder forests occur in a narrow band along the coastal bluffs, while coastal dunes and beaches support communities adapted to their harsh and changing conditions.

A thematic accuracy assessment was conducted on the 30 most abundant vegetation classes, employing 512 observations throughout RNSP. The overall accuracy at the alliance level vegetation classes was found to be 65.5%. When the classes are aggregated to thematically coarser levels, the accuracy is 86.2% at the USNVC group level and 95.4% at the level of USNVC macrogroup.

The true areas of each class, adjusted for mapping error, were estimated for 35 map classes. This information is informative for management, since it enables more representative estimates of the true areas of vegetation classes, accounting for tendencies to over-map or under-map individual types.

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Staff of the National Park Service (NPS) provided necessary and helpful guidance, assistance, review, and logistical and administrative support. Key NPS personnel for the project were Dave Best, Judy Wartella, and Leonel Arguello of Redwood National and State Parks and Karl Brown and Tammy Cook of the Vegetation Mapping Inventory. The National I&M Program congratulates the Park staffs on the 2016 completion and dedicated support to review and optimize this product for Park use.

Ayzik Solomeshch (University of California-Davis) collected relevé (field plot) data and performed the floristic vegetation classification as based on relevés.

Kyle Wear, Jennifer Kalt, Paul Trichilo, Andy Jahn, and Bill Kier (all of Kier Associates) conducted the thematic accuracy assessment, reported the results, and wrote part of the thematic accuracy assessment chapter.

Chris Lea, Jim Von Loh, and Dan Cogan (all of Cogan Technology, Inc.) wrote chapters, appendices, or parts thereof for the introduction, thematic accuracy assessment (in part), and vegetation descriptions and edited the report and the project data.

Funding was provided by the NPS Vegetation Mapping Inventory (Inventory and Monitoring Program).

Chapter 1 - Introduction

1.1 National Park Service National Vegetation Mapping Inventory

The purpose of this project was to produce a vegetation classification and digital map of the vegetation and land cover of Redwood National and State Parks (RNSP) in northern California. Data sets will provide comprehensive coverage of the RNSP lands, including the recent Mill Creek Acquisition lands. This information is expected to provide input to habitat evaluation and fire fuels modeling efforts, as well as provide valuable baseline information about vegetation/land cover status and the distribution and relative abundance of many of the RNSP's plant species. It is intended to provide data that will conform to NPS standards, be compatible with other I&M mapping programs, and provide the information required for the design of monitoring programs within the Park.

This project is part of the Inventory and Monitoring (I&M) Program of the National Park Service (NPS), pursuant to the United States Congress passed the Omnibus National Parks Management Act of 1998, which became Public Law 105-391. The I&M Program provides reliable and consistent scientific information that may be used to assess the status and trends in conditions of National Park ecosystems in 270 National Park units with significant natural resources. The NPS National Vegetation Mapping Inventory (NVMI), a part of the Inventory and Monitoring (I&M) Program (USDI-NPS 2015), oversees vegetation (including land cover) mapping. The NVMI is located at Fort Collins, Colorado and funded at the national level of the NPS. Operations for individual NPS unit projects typically are coordinated by local NPS staff located at individual park units or in 32 I&M network offices that are local to clusters of individual park units.

The NVMI uses quality control and methodology procedures for data collection and production of vegetation and land cover maps mapping ensure the reliability of the vegetation data and encourage the use of resulting maps, reports, and databases at multiple scales. A complete vegetation classification and mapping project for a park includes, at a minimum, the following products:

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

Classified vegetation types are described both as they appear locally at individual park units and also in the national context of the U.S. National Vegetation Classification (usnvc.org), using recognized USNVC units, whenever feasible. Classified units also are supported by vegetation plots that comprehensive floristic data (TNC and ESRI 1994). Vegetation map classes are based on the locally classified vegetation types, Maps are produced in Universal Transverse Mercator (UTM) coordinates (NAD 83) with a 1:24,000 scale and a minimum mapping unit of 0.5 hectares (ha) (1.24 acres (ac)). In addition to assessing overall thematic accuracy, the accuracy of individual map classes that comprise the map is assessed and reported; these estimates allow users to be informed of map

limitations (Lea and Curtis 2010). Digital vegetation products are accompanied by FGDC-compliant metadata, which describe the content, quality, condition, and other characteristics of the spatial dataset and are critical elements that expedite the interpretation and exchange of information among users. NVMI products are available through the NPS Data Store (<http://science.nature.nps.gov/im/datamgmt/IRMA.cfm>).

1.2 U.S. National Vegetation Classification

Through presidential Executive Orders and federal Office and Management and Budget (OMB) directives, the FGDC (2008) standard requires that federally funded vegetation classification studies collect data in a manner that enables translation of the data to the USNVC and sharing results between agencies, but does not require use of that standard by agencies for internal mission needs. This mandate does not apply to the function of mapping vegetation. As a matter of protocol (Lea 2011), the NVMI employs the USNVC content for both vegetation and map classes whenever feasible, since its use helps to ensure compatibility of vegetation information within the NPS, as well as on sharing of the information with partner agencies and organizations federal and state agencies and with the public.

The USNVC is a hierarchical system for vegetation classification within the United States that was originally developed by The Nature Conservancy (TNC) (Grossman et al. 1998). The Federal Geographic Data Committee adopted the upper hierarchy levels of the original TNC version with some modifications as a federal standard (FGDC-STD-005) (FGDC 1997) which was intended to facilitate the sharing and merging of vegetation data throughout the United States. In 2008, the FGDC adopted a new version of the USNVC (FGDC 2008); this version extensively revised the upper levels of the hierarchy into units that were more coherent biogeographically, floristically, and ecologically than were the units of the 1997 version, which were more strongly based on vegetation physiognomy and structure. Since 2008, the FGDC and partners, including the Ecological Society of America Panel on Vegetation Classification, NatureServe, and individual federal agencies including the NPS have supported the development of taxonomic units for the revised hierarchy and the dissemination of the content of the USNVC and its public availability (USNVC 2015).

The upper three hierarchy levels of the USNVC (class, subclass, and formation) are based on vegetation physiognomic characteristics that reflect patterns of climate, hydrology, and substrate that recur globally (USNVC 2015). The fourth level (division) represents geographic partitions of Formations that vary by major intracontinental climate and biogeographical patterns at the scale of biotic regions, provinces, or subprovinces (Dice 1943, McLaughlin 2007). Most divisions recognized by the USNVC are unique to North America. The next levels (macrogroup and group) subdivide divisions based on broad sets of diagnostic plant species and habitat factors along intraregional topographic, edaphic, and disturbance gradients. Units of the lower two levels (alliance and association) are distinguished from one another by differences in local floristic composition. Alliances are physiognomically uniform groupings of plant associations that share dominant or diagnostic species, usually in the uppermost stratum of the vegetation. Alliances are generally more wide-ranging geographically than are associations, although many monotypic alliances have been classified.

The basic unit of vegetation classification in the USNVC is the association (a plant community type that is relatively homogeneous in composition and structure, and occurs in a uniform habitat). Associations are roughly equivalent in taxonomic scale to the plant association of European phytosociologists (Mueller-Dombois and Ellenberg 1974). They are defined from a range wide perspective and are assigned global rarity ranks as well as ranking specifications to be applied to individual occurrences of associations across their range. A map of associations occurring at a site can provide information about the abundance and distribution of each type, the significance of the individual occurrences, as well as providing surrogate information about the location and abundance of individual species characteristic of the association.

1.3 Redwood National and State Parks

1.3.1 Administration

RNSP was initially created in 1968, expanded in 1978, and further expanded in 2000 and 2005. Initially, the 58,000 acre (23,472 hectare) Redwood National Park (RNP) was created in 1968 during the administration of President Lyndon B. Johnson (Public Law 90-545; 16 U.S.C. 79b) to preserve “*significant examples of the primeval coastal redwood (*Sequoia sempervirens*) forests and the streams and seashores with which they are associated.*” An additional 19,425 ha (48,000 acres) was added to the RNP boundary in 1978 under the signature of President James E. Carter, to: “*protect existing irreplaceable resources from damaging up slope and upstream land uses, to provide a land base sufficient to insure preservation of significant examples of the coastal redwood in accordance with the original intent of Congress, and to establish a more meaningful Redwood National Park for the use and enjoyment of visitors*” (Public Law 95-250, 1978).

In 2000, a minor boundary revision was noticed in the Federal Register (F.R. Notice March 9, 2000; Vol. 65, No. 47, Page 12573) which added NPS lands in several park areas. The bulk of this adjustment was the acquisition of land in the Coyote Creek drainage in 1991 from within the Park Protection Zone (PPZ) as authorized by Congress in 1978 (Public Law 95-250, 1978). These adjustments brought the park acreage in 2000 to 104,312 acres, exclusive of submerged lands and public rights of way. In 2005 Congress authorized the revision of the park boundary to include approximately 26,400 acres of additional lands that had been acquired by the California Department of Parks and Recreation in the upper Mill Creek drainage, and parts of the Wilson and Rock Creek drainages (P.L. 109-131). This act increased the acreage ceiling for the NPS boundary to 133,000 acres.

In 1994, the NPS and the California Department of Parks and Recreation (CDPR) entered into a cooperative agreement to jointly manage and protect the state and federal lands within the congressionally authorized boundary of RNP. The three California state parks, encompassing approximately 14,731 ha (36,400 acres) and RNP were to be collectively referred to as Redwood National and State Parks (RNSP). While the State of California and the NPS retain separate ownership of their land and facilities in the parks; the intent of this administrative agreement was to manage more cooperatively and efficiently the federal and state lands existing within the congressionally authorized boundary of RNP. This collective of four parks preserve and protect approximately 45% of all the old-growth redwood forest remaining in the range of coast redwoods.

The parks are designated a World Heritage Site and are part of the California Coast Range Biosphere Reserve (Senate Report 108-372, 2004).

The north-to-south distance of these four parks is 50 miles (80 km), and there is 35 miles (56 miles) of coastline; the RNSP lands vary in width from 0.5 to 8 miles (0.8 to 13 km). The total land area surveyed in this vegetation inventory and mapping project was 182,433 acres (73,828 hectares), inclusive of all lands within RNSP and 1 mile buffer outside of the park boundary in order to more meaningfully extend and characterize the mapped vegetation classes.

1.3.2 Setting and Natural Environment

RNSP is located in Del Norte and Humboldt Counties in northern California. It is adjacent to the Pacific Ocean and is bisected in the northern portion by the Klamath River; the park units lie within the northwestern California counties of Del Norte and Humboldt (Figure 1). The Jedediah Smith Redwoods State Park unit is located east of Crescent City and is accessed by SH 199 and Howland Hill Road; the Del Norte Coast Redwoods State Park unit is located southeast of Crescent City and is accessed off SH 101; the Prairie Creek Redwoods State Park Unit is located east of Gold Bluffs Beach and is accessed from SH 101 and the Newton B. Drury Scenic Parkway; and the Redwood National Park unit is located southeast of Orick and is accessed from SH 101 and the Bald Hills Road. An information center and park headquarters are located in Crescent City and visitor/information centers have been constructed at Kuchel, Prairie Creek, and Hiouchi.

RNSP are located on the western side of the Outer Northern Coast Ranges and adjacent to the Pacific Ocean shoreline at elevations ranging from sea level to nearly 3,100 feet (944 m).

The climate of the region is strongly moderated by the Pacific Ocean, which contributes to relatively wet and mild winters, dry summers, and frequent coastal fog (USDI-NPS 2010). Fog is a dominant climate feature within a few miles of the coast during the summer (occurs daily) and relatively frequently the remainder of the year. The highest elevations are typically free of fog year-around. Annual precipitation ranges from 70-100 inches (178-254 cm) depending on location and results in flooding along creeks and rivers.

Temperatures vary slightly from summer-to-winter along the coast (temperatures in Crescent City, CA average 47°F (8.3°C) in January and 59°F (12.5°C) in August), but have greater fluctuation in inland areas (temperatures near Orick, CA average 45°F (6.9°C) in January and 59°F (15.1°C) in August) (WRCC 2015). Temperatures may exceed 90°F (32.2°C) at inland sites including Bald and Little Bald hills. Light winds are common, especially prevailing winds from the northwest or south-southwest; warm dry winds from the east occur in the fall season and produce a rapid drying effect (USDI-NPS 2010).

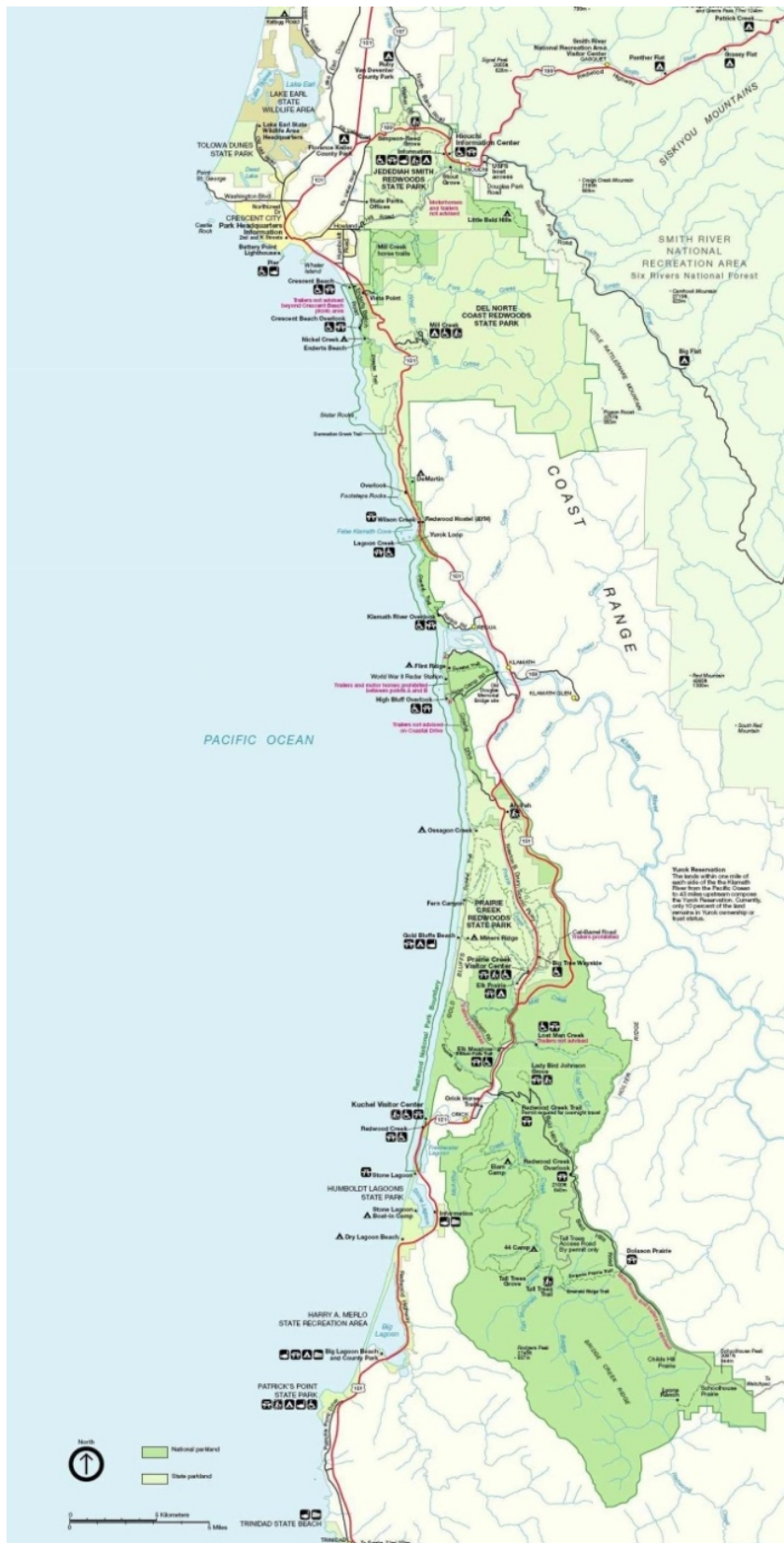


Figure 1. Redwood National and State Parks location in northern California.

The northern California coast is tectonically active and its complex geology and topography are controlled by movement along faults and crust-plates. Steep slopes along major streams result from recent tectonic uplift; several north-northwest trending faults further influence the topography. Rapid tectonic uplift, abundant and intense rainfall, and sheared bedrock make much of the parks surface highly erodible, deeply incised, and generally rugged. Steep bluffs characterize much of the 35-mile-long (56 km) Pacific Ocean coastline with few significant beach deposits (Crescent, Enderts, Gold Bluffs beach, and Freshwater Spit). Many areas within the parks are susceptible to mass wasting processes including debris slides and avalanches, block falls, shallow and deep-seated landslides, streamside landslides, and earthflows.

Generally, the park region is underlain by rocks of Jurassic-Cretaceous age of the Franciscan assemblage (sandstone, siltstone, schist, minor conglomerates, isolated chert and volcanic greenstone). The Prairie Creek area is underlain by Pliocene to Pleistocene age coastal plain sediments of the Prairie Creek Formation. Tertiary marine deposits and serpentinites are deposited in the Little Bald Hills area east of Crescent City. The stream valleys and coastal areas of the parks are covered by Quaternary alluvial and marine deposits.

Soils in the park units are typically well developed because the mild wet climate caused a high degree of weathering of underlying rocks and materials. They formed primarily from rocks of the Franciscan complex. Residual soils formed in isolated areas on sloping ridge crests and alluvial soils formed in valleys, on floodplains, and on stream terraces.

Most soils of the park units have strongly developed surface horizons rich in organic matter and nutrients, particularly under coniferous forest, oak woodland, and prairie canopies. These soils are moderately coarse-textured which along with steep terrain and rainy climate make the area susceptible to erosion. The high organic matter content contributes to high natural growth rates of vegetation in plant communities established on them.

Surface water within the parks is diverse including deep- and shallow-ocean (saltwater), estuaries and lagoons (brackish water), and rivers, creeks, and streams (freshwater). Abundant rainfall, the temperate climate, and topographic relief result in different types of aquatic habitats and wetlands including headwater streams, large rivers, ocean shoreline, deep ocean habitat, and artificial impoundments. Annual runoff and stream flows are highly variable in this region due to the seasonal precipitation pattern (the rainy season extends from October through April). Most of the precipitation and related high flows in drainages occurs from November through March. There is less precipitation and low flow occurs during the summer and fall seasons.

Three large drainages traverse the parks and carry runoff to the Pacific Ocean, they are: (1) Smith River in the north; (2) Klamath River near the center; and (3) Redwood Creek in the south. A smaller but important drainage, Prairie Creek, carries runoff from the surrounding topography and inflow from Lost Man, Little Lost Man, and Boyes creeks. The Smith River flows through Jedediah Smith Redwoods State Park at Hiouchi where it receives tributary flow from Mill Creek just downstream of Stout Grove. The Klamath River is the largest river in the north coast area, encompassing 15,000 square miles (38,850 square kilometers) of drainage area in California and Oregon; it flows through a

narrow strip of RNSP prior to joining the Pacific Ocean. Redwood Creek flows to the Pacific Ocean from the southeastern portion of RNSP where it receives tributary flow from Prairie, Coyote, Copper, and Bridge creeks. There are no natural ponds or lakes within the park units, however there are several small man-made livestock and fire suppression ponds in the Bald Hills, on the west side of the Redwood Creek basin (along the West Side Access Road), and two ponds associated with abandoned lumber mills (Marshall and Lagoon Creek). A portion (western half of the water and shoreline) of Freshwater Lagoon, southwest of Orick, is located within the parks boundary.

Floodplains are not well developed within most of the parks drainages as they are small and steep; some floodplains have developed at the mouths of larger rivers and in less steep topography as occurs on the Klamath and Smith rivers and Redwood, Mill, and Prairie creeks. Similarly, wetlands occur as narrow bands of riparian plant communities within most of the parks except in large estuaries as occur at the mouths of the Klamath River and Redwood Creek.

1.3.3 Vegetation and Flora

RNSP is ecologically diverse due to its relief and system of creeks and rivers, geologic composition, high soil and vegetation heterogeneity, and presence of near-shore ocean, bay, and estuary environments.

Old-growth coastal redwood forest characterized by coast redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*) grows on approximately 30% of the parks, the majority of which occurs within the three state parks boundaries. Coast redwoods are the tallest known trees on earth, attaining heights of 200 to 300 feet (60-90 m) or more, and reaching ages of more than 2,000 years. Associated conifers include grand fir (*Abies grandis*) and Sitka spruce (*Picea sitchensis*) in lowland and coastal areas and western hemlock (*Tsuga heterophylla*) in moist habitats. Hardwood tree species commonly occur within the subcanopy or may become the dominant cover in some stands. They include tanoak (*Lithocarpus densiflorus*), Pacific madrone (*Arbutus menziesii*), bigleaf maple (*Acer grandidentatum*), California bay laurel (*Umbellularia californica*), red alder (*Alnus rubra*), golden chinquapin (*Chrysolepis chrysophylla*) and western redcedar (*Thuja plicata*). Common understory shrubs include Pacific rhododendron (*Rhododendron macrophyllum*), evergreen huckleberry (*Vaccinium ovatum*), salal (*Gaultheria shallon*), and species of blackberry (*Rubus* spp.) and currant (*Ribes* spp.). The herbaceous understory is characterized by oxalis (*Oxalis oregana*) and sword fern (*Polystichum munitum*).

Second-growth stands of forests are characterized by Douglas-fir which becomes re-established following fire or logging more quickly than do coast redwoods. It is common to have residual old-growth trees of several species remain within logged stands. Understory development rarely occurs in these stands, except near streams, roads, or in gaps in the forest canopy where sunlight can penetrate to the ground.

Dry forest communities have become established in the Redwood Creek basin along the ridges from Slide Creek to Coyote Creek. Represented is mixed evergreen forest characterized by Douglas-fir, tanoak, and Pacific madrone; common associates include California bay laurel, bigleaf maple, chinquapin, canyon live oak (*Quercus chrysolepis*), and poison oak (*Toxicodendron diversilobum*).

Little Bald Hills include an area of about 1,500 acres (607 hectares) of serpentinite soils in the northeastern portion of the parks. Most of the vegetation stands here provide sparse-to-low cover because the soils have high concentrations of heavy metals, including magnesium, and there is low nutrient availability due to high pH and poor water-holding capacity. Many of the plant communities established here are comprised of unique species adapted to the serpentinite soils.

Dry ridgetops support scattered Jeffrey pine (*Pinus jeffreyi*) with an herbaceous understory of Idaho fescue (*Festuca idahoensis*). Adjacent slopes support chaparral characterized by species of manzanita (*Arctostaphylos* spp.), golden chinquapin, rhododendron, huckleberry oak (*Quercus vacciniifolia*), and a shrubby form of tanoak (*Lithocarpus densiflorus* var. *echinoides*) interspersed with stands of knobcone pine (*Pinus attenuata*) and Port Orford-cedar (*Chamaecyparis lawsoniana*). Knobcone pine forest stands are typically dense in terms of canopy cover and contain small-diameter, mostly even-aged trees that are subject to frequent fires. Knobcone pine stands represent a successional stage that in the absence of fire revert to Douglas-fir, Pacific madrone, and tanoak forest stands.

Bald Hills include an area of about 4,200 acres (1,700 hectares) located along the ridgetops dividing the Redwood Creek and Klamath River drainages. A complex mosaic of plant communities including coniferous forest, Oregon white oak (*Quercus garryana*) woodland, and grassland types occur in the Bald Hills (Figure 2). This area supports the most extensive grassland/woodland complex within the park units; they are vulnerable to encroachment by Douglas-fir and other conifers which are managed by prescribed burning and cutting.



Figure 2. Mosaic of grassland and Oregon white oak communities in Bald Hills.

Oregon white oak characterizes Bald Hills woodland stands in association with California black oak (*Quercus kelloggii*) in the overstory and with an herbaceous understory. On rocky sites and near stream channels the woodland canopy may include California bay laurel, Pacific madrone, and bigleaf maple trees and the understory may include several shrub species.

While native grass species comprise two-thirds of the composition of the grassland communities of the Bald Hills, nonnative grass species dominate the stand cover. The common native grasses and graminoids include California oatgrass (*Danthonia californica*), blue wildrye (*Elymus glaucus*), and the sedge (*Carex tumicola*).

Coastal scrub has become established in narrow bands on ocean-facing bluffs above the coastal strand. Shrub stands are characterized by evergreen shrubs, wind-pruned trees (red alder and Sitka spruce), and low-growing shrubs mixed with herbaceous forb and grass species. Characteristic shrub species include coyote brush (*Baccharis pilularis*), salal, salmonberry (*Rubus spectabilis*), lupine (*Lupinus* spp.), poison oak, and oceanspray (*Holodiscus discolor*). These shrubs are all capable of regeneration following fire via crown sprouts and root sprouts, while the tree species are typically removed from the canopy following burns. Patches of grasses are characterized by orchardgrass (*Dactylis glomerata*), fescue (*Festuca* spp.), and reedgrass (*Calamagrostis* spp.).

Coastal grassland or prairie communities have become established along Major Creek, at DeMartin, and on Crescent Beach. These perennial grasslands include both native and introduced stands that have diminished in size due to shrub and tree encroachment resulting from various forms of disturbance and lack of fire.

The coastal dunes and beaches represent a challenging habitat for plant establishment with wind and salt-spray and the unstable sandy soils/deposits may be washed by waves during high tides and storms. It is characterized by low-growing, salt-tolerant plants including American dunegrass (*Leymus mollis*), sand verbena (*Abronia latifolia*), and sea rocket (*Cakile maritima*).

1.3.4 Fauna

Mammals common to the coniferous forest habitats include black bear (*Ursus americanus*), red tree vole (*Arborimus longicaudus*), flying squirrel (*Glaucomys sabrinus*), dusky-footed woodrat (*Neotoma fuscipes*), and many small rodents. In the Bald and Little Bald hills, the mountain lion (*Puma concolor*), deer (*Odocoileus* spp.), bobcat (*Lynx rufus*), species of shrew (*Sorex* spp.), and deer mice commonly occur. Coastal scrub and grassland supports Roosevelt elk (*Cervus roosevelti*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), and species of voles (*Microtus* spp.). A variety of marine mammal species occur in Pacific Ocean habitats including whales, dolphins, porpoise, seals, sea lions, and the sea otter (*Enhydra lutra*); seals and sea lions likely haul-out on parks beaches and strands.

Birds common to the coniferous forest habitats include the Northern pygmy owl (*Glaucidium gnoma*), pileated woodpecker (*Dryocopus pileatus*), woodpecker species, ruffed grouse (*Bonasa umbellus*), varied thrush (*Ixoreus naevius*), winter wren (*Troglodytes troglodytes*), chestnut-backed chickadee (*Parus rufescens*), dark-eyed junco (*Junco hyemalis*), and a variety of neotropical migrants

such as warblers, flycatchers, and swallows. In the Bald and Little Bald hills, the red-tailed hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), blue grouse (*Dendragapus obscurus*), California quail (*Callipepla californica*), woodpecker species, lazuli bunting (*Passerina amoena*), black phoebe (*Sayornis nigricans*), American goldfinch (*Carduelis tristis*), pine siskin (*Carduelis pinus*), red crossbill (*Loxia curvirostra*), red-breasted nuthatch (*Sitta canadensis*), and western meadowlark (*Sturnella neglecta*). The Bald Hills oak woodlands are an important fall migration stop-over for the Lewis's woodpecker (*Melanerpes lewis*). Coastal scrub and grassland supports the band-tailed pigeon (*Columba fasciata*), turkey vulture (*Cathartes aura*), wrentit (*Chamaea fasciata*), Allen's hummingbird (*Selasphorus sasin*), and song sparrow (*Melospiza melodia*); migratory birds using the coastline during migration in the Pacific Flyway occur in these habitats during the spring and fall seasons. A variety of shorebirds and ocean-going seabird species occur near/in Pacific Ocean habitats including gulls, sandpipers, plovers, terns, ducks, geese, brant, swans, pelicans, auks, puffins, and murrelets.

Amphibians and reptiles common to the coniferous forest habitats include the rough-skinned newt (*Taricha granulosa*), Pacific giant salamander (*Dicamptodon tenebrosus*), slender salamander (*Batrachoseps attenuatus*), ensatina (*Ensatina eschscholtzii*), and Del Norte salamander (*Plethodon elongatus*); wandering salamanders (*Aneides vagrans*) use large epiphytic fern mats in the canopy of old-growth coast redwood trees. In the Bald and Little Bald hills, amphibians are restricted to scattered springs and seeps near lower slopes and the gopher snake (*Pituophis catenifer*) and western fence lizard (*Sceloporus graciosus*) commonly occur on dry uplands. Small coastal streams provide habitat for the northern red-legged frog (*Rana aurora*). Sea turtle species use coastal waters and beach habitats.

Rivers and streams flowing through coniferous forest stands support coastal cutthroat trout (*Oncorhynchus clarkia clarkii*), resident rainbow trout (*Oncorhynchus mykiss*), three-spine stickleback (*Gasterosteus aculeatus*), and Sacramento suckers (*Catostomus occidentalis*). Many fish and related species use near-shore and Pacific Ocean waters, including sharks, rays, skates, lampreys, sole, smelt, surfperch, sculpin, and rockfish.

1.3.5 Natural Resource Concerns

A portion of the land within the parks has been logged as reflected in the distribution of second-growth forest stands characterized by Douglas-fir dominance. It is common to have residual old-growth trees of several species remain within logged stands. Logged second-growth stands within the parks have been planted in aerial seeding programs and have no natural precedence in the coast redwood region. Therefore, there is no natural fire regime from which to predict the ecological succession. A 300-acre escaped prescribed fire burned within an adjacent 35-year-old second-growth stand dominated by Douglas-fir in 2003; monitoring has been initiated to identify long-term fire effects.

The parks region has been subjected to naturally-ignited and human-ignited fires for millennia; fire has had an ecological role in old growth forest types with the mean fire interval estimated to range from 5-to-350 years or more, depending on forest stand location. In RNSP, the fire return interval in old growth coast redwood stands can vary from 5-250 years or more. On the interior ridges of

Redwood Creek, Douglas-fir is the characteristic conifer in mixed evergreen-hardwood forests and the fire interval likely occurred at 5-25 year frequencies in these stands (USDI-NPS 2010).

Mature coast redwood trees are very resilient to fire due to thick bark, great height, and ability to sprout from the root crown or from dormant buds under the bark of the bole and branches. These adaptations allow coast redwood trees to survive cool-to-hot fires. Douglas-fir can survive moderately intense fires due to thick, corky bark on the lower bole and roots which protects the cambium from heat damage. Also, the tall Douglas-fir trees have the foliage concentrated on the upper bole where it is difficult for fire to reach the crown; however, these trees are not typically free of lower branches (up to a height of 30-35 feet) until they exceed 100 years of age.

When crown or ground fires kill Douglas-fir canopy trees, western hemlock, grand fir, and tanoak may become established and dominate the burned area. Western hemlock occurs in all stages of forest succession following a fire but is most abundant on moist sites. It is an aggressive pioneering tree due to rapid growth in full overhead light and adaptability to a variety of seedbed conditions. Grand fir is also fast-growing and seedlings become established in light litter and on mineral soils. Tanoak trees are long-lived and tolerate shade well; openings in the forest canopy resulting from fire increase available light allowing tanoaks to grow taller. Generally, tanoak trees are fire-sensitive and susceptible to fire mortality however they resprout following fire via dormant buds located on regenerative tissues called burls or lignotubers. If fires are not severe, nearly all tanoak trees resprout during the first post-burn growing season.

The knobcone pine trees established in the Little Bald Hills are successional and give way to Douglas-fir – Pacific madrone – tanoak stands in the absence of fire. However, knobcone pines are an obligate fire species and are subject to frequent fires because of the association with other fire-dependent vegetation, xeric site conditions, and early senescence which increases the available fuels. The last known fire in this stand was about 1940 (based on fire scar examination and post-fire regeneration). The discontinuous distribution of serpentinite exposures prevents all the knobcone pines in an area from being killed by one fire. Attributes of knobcone pines that contribute to its obligate fire species status include: closed-cone habit; open, multi-trunked growth form; establish well on soils affected by fire (high pH, increased phosphorus and nitrogen, removal of litter and ground cover, soil erosion); and released seed quickly germinates with late winter or early spring rain.

The Bald Hills grasslands have been subjected to human-caused fires for several millennia, thus influencing the ecological processes. The largest grasslands here were likely contiguous until intentional burning ceased and coupled with intensified land use and disturbance associated with logging and ranching, allowed conifers, particularly Douglas-fir, to invade the grasslands, causing vegetation type conversion, or at the very least separating them into smaller grassland areas.

For a 43-year period (1960-2003) a total of 333 wildfires occurred within the RNSP boundary. Of these, 169 resulted from escaped or abandoned campfires, 56 were caused by smoking or were of unknown origin, 76 were lightning-caused, 23 were escaped fires from logged slash or debris burns, and nine were incendiary fires. Between 1980 and 1991, 26 prescribed burns were conducted in the

parks, covering 427 acres; from 1992 to 2003, 60 prescribed burns were conducted totaling 9,824 acres primarily in the Bald Hills; and areas treated using prescribed fires and mechanical fuel reduction in successive years from 2005-2009 were: 1,224 acres, 2,416 acres, 445 acres, 2,307 acres, and 688 acres.

The old-growth and second growth forests are typically too shady for nonnative plant species to become established however dense infestations of English ivy (*Hedera helix*) occur in some forested stands. Common exotic plant species that have become established along roads and in open sites include Scotch broom (*Cytisus scoparius*), Himalaya blackberry (*Rubus armeniacus*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), hairy cat's-ear (*Hypochaeris radicata*), poison-hemlock (*Conium maculatum*), foxglove (*Digitalis purpurea*), and pampas grass (*Cortaderia jubata*). Nonnative grass and forb species common to the Bald Hills include tall oatgrass (*Arrhenatherum elatius*), sweet vernal grass (*Anthoxanthum odoratum*), velvet grass (*Holcus lanatus*), dogtail (*Cynosurus echinatus*), soft chess (*Bromus hordeaceus*), plantain (*Plantago lanceolata*), and sheep sorrel (*Rumex acetosella*).

Post logging recovery, ongoing fire management, and potential impacts of non-native species are all surrounding landscape level natural resource concerns that directly affect the vegetation within the parks. The current size and configuration of the existing federal and state parks provides for effective management influence on these landscape processes. The future development of the vegetation within the parks boundary will be subject to these landscape scale influences particularly at the watershed scale.

1.4 Project Schedule

Based upon past NPS I&M mapping efforts in Katmai National Park & Preserve and Wrangell-St. Elias National Park and Preserve, as well as an ongoing effort in Lassen Volcanic National Park started in June, 2006 the NPS awarded Geographic Resource Solutions (GRS), Arcata, California, a sole source contract in 2008 through the GSA to provide mapping services. These services would result in map data sets at both the pixel and stand levels populated with vegetation and land cover information that would include U.S. National Vegetation Classification (USNVC) alliance and association type estimates, as well as the species specific cover estimates that supported the USNVC assignments. Additional information would include estimates of tree size and stocking, in terms of trees per acre.

This project was initiated in the spring of 2008 and originally was scheduled for completion by the end of June, 2010. Due to unforeseen delays in the completion of the vegetation classification that provided the foundation for this project's mapping efforts the project was completed in June, 2013.

1.5 Scope and Products

The extent of the project area was RNSP lands and a one-mile buffer area surrounding the parks. The total project area was 182,433 acres (73,828 hectares), whereas the park boundaries comprised 142,062 acres (57,491 hectares), including submerged areas and barren lands, which is about 78% of the project area. The additional buffer area was included to potentially enhance field data collection efforts and include areas immediately adjacent to the parklands which might contain vegetation and

land cover types more suitable for sampling and use as image classification training areas during this project. In addition, this buffer also provided some flexibility in coverage of the RNSP project area, as park ownership boundaries had the potential of changing during the course of the project.

The project would include a vegetation classification that meets the U.S. National Vegetation Classification standards and fulfills the vegetation classification and mapping requirements of the NVMI and RNSP for the time period of 2007. The vegetation/land cover mapping effort is based upon the Discrete Classification Mapping Methodology developed by Ken Stumpf and John Koltun of Geographic Resource Solutions of Arcata, CA. GIS mapping databases would be delivered in ArcGIS Geodatabase format. The minimum mapping unit (MMU) would be 0.5 hectares. Types designated as “park specials” would be mapped to a smaller size than the 0.5 ha MMU in order to retain such features. All GIS and image data acquired for use in this project would be referenced to the UTM Zone 10 projection, NAD83 datum, and expressed in units of meters. The minimum map class accuracy for all vegetation and land cover alliances (classes) would be targeted at 80 percent at the 95% confidence level.

The deliverable map data sets encompass only those areas within the parks’ boundaries, since AA sampling and evaluation will only occur within the parks’ boundaries. Final map data set deliverables will also include field training site locations and associated descriptive data, the vegetation/land cover key used as the basis of these mapping efforts, and documentation for the map data set.

1.5.1 Vegetation Classification

The NPS Klamath Network contracted with Dr. Ayzik I. Solomeshch (AS) to perform the vegetation classification and provide definitions and descriptions of the vegetation classes along with a field key. Preliminary USNVC associations based on Dr. Solomeshch’s initial evaluation of 355 field sites (274 AS locations and 81 GRS locations) in the 2008-2009 vegetation classification field data set were initially presented in March 2011 (see Section 2.2). The development of a vegetation type key that would provide a set of rules and thresholds to guide the development of the type mapping efforts accompanied this classification information. These initial efforts evolved through seven iterations of vegetation type classification by Dr. Solomeshch and the subsequent review of this information with Leonel Arguello (RNSP) and Ken Stumpf from March, 2011 to April 2012. Version 7 of the vegetation type key was produced in April, 2012 at which time Ken Stumpf initially implemented the conversion of the key’s decision rules and thresholds into GRS’s software processes.

1.5.2 Discrete Classification Mapping Methodology (DCMM)

The RNSP contracted with Geographic Resource Solutions of Arcata, CA to perform the field data collection, image classification, and mapping services necessary to develop vegetation/land cover raster and vector map data sets. These mapping efforts would be based upon the application of GRS’s Discrete Classification Mapping Methodology (DCMM).

The primary goal of implementing the DCMM is to produce a vegetation map database that meets or exceeds the spatial and classification accuracy required by the NVMI and the RNSP utilizing Landsat TM satellite imagery and quantitative vegetation metrics.

The implementation of the DCMM has several features that were designed to enable the development of secondary and tertiary levels of information, typically not available from the implementation of traditional photo-interpretive applications. These included:

1. The development of comprehensive and quantitative vegetation and land cover descriptions that include discrete estimates of species composition and stand components. These estimates form the basis of canopy cover estimates for individual species, species groups (e.g. *Pinus* sp., *Rubus* sp., and aquatic herbaceous sp.), and major species classes or lifeforms (e.g. conifer, hardwood, shrub, graminoid, and forb).
2. The development of quantitative cover component estimates for different layers of types and stands, thereby providing additional cover estimates for all vegetation present or only in the top visible-from-above layer (“bird’s-eye” view). These estimates provide a more comprehensive description of cover composition, as well as canopy structure. In addition, the estimates provide information about the relationship of understory components to overstory components. Such information is instrumental in providing a complete and comprehensive description of the different vegetation types and stands.
3. The development of quantitative tree size estimates of the cover-weighted quadratic mean diameter (QMD) for individual species components, as well as averages for hardwoods and conifers. Estimates of tree size enable characterization of relative tree size, as well as canopy structure (cover by canopy layer). Such size estimates may be significant for resource management applications that involve identification of old-growth stands, wildlife habitat modeling, and fire fuel class modeling.
4. The development of ground surface condition estimates, including characterization of bare ground, rock, litter, woody debris and other ground surface conditions that are associated with the specific vegetation/land cover characteristics being mapped. This information may be significant in fire fuel class modeling.
5. The development of fine and coarse woody debris count estimates based upon the integration of the FireMon sampling protocol with GRS’s line-transect field sampling methodology. This information may also be significant in fire fuel class modeling.
6. The development of land-cover data sets in both a polygon/stand and pixel/raster formats. Polygons represent aggregations of individual pixels which when combined based upon their similarity of vegetation and landscape features meet the project MMU size limits. Because the core data set is in a raster (pixel) format, and the discrete information of each pixel is retained the pixel data can be reprocessed in a number of ways to meet the requirements of any MMU size limit or aggregation strategy. For example the data can be reprocessed to show all occurrences of a particular shrub no matter what USNVC association or alliance it was originally assigned to.

1.5.3 Implementation of the Image Classification Map Data Sets

Vegetation data sets are developed to provide information which when evaluated by park managers and resource specialists enables them to formulate alternatives, make decisions, and manage the resources entrusted to them in an efficient and productive manner. The data sets developed by using

the DCMM enable a greater range of information that can be used to make well informed decisions regarding the vegetation and land cover features found within the RNSP parklands. The data sets developed for this project will be in two formats. The first is in a raster format that will represent the non-aggregated DCMM pixel classification map data set; the second is in a vector format that will represent the aggregated pixel classification map data set as a stand or polygon map data set. These map data sets will be installed and applied at the offices of the Redwood National and State Parks. Staff from GRS, and the park will work together during a one-day seminar to see how the digital vegetative map databases can be applied to real-world issues impacting the park, such as fire management, stand health, visitor use, or resource development.

1.6 Legacy Data

1.6.1 Vegetation Sample Data

Vegetation/land cover field data similar to that needed for implementation of the DCCM has been collected in the RNSP project area. During the 1992-94 Timberlands Task Force Klamath Province California Wildlife Habitat Relationships (WHR) Mapping Project performed by GRS for the California Department of Forestry and Fire Protection GRS collected field data at 43 field sites within or very close to the RNSP parklands. However, these field data only described cover from vegetation/land cover features thought to contribute reflectance to the satellite imagery (a bird's-eye view) and therefore represent an incomplete description of the vegetation/land cover features present in all the canopy layers of the sampled sites. In addition, these data were collected 15 years prior to when the satellite imagery used in this project was acquired and might not be an accurate reflection of the current status of all the field sites. As a result, these field data were not used during this project.

1.6.2 Vegetation Maps

The following datasets were identified as legacy data for RNSP at the start of this mapping project. All existing data will be assessed using the national guidelines (TNC 1996) to determine the utility of the information.

- Current and past FMH data
- Current vegetation map of RNSP
- Mahoney Old Growth Redwood Classification
- Belsher Coastal Shrub Classification
- Sugihara/Reed Oak Woodland Classification
- Little Bald Hills Vegetation Study
- Second Growth Forest data (RNSP staff)
- CALFIRE Timberlands Taskforce WHR Mapping

1.6.3 Digital GIS Data

The park has access to a variety of historical GIS data and other ancillary data that might aid in modeling vegetation. These data sets were delivered to GRS in spring of 2008 on an external drive for use during this mapping effort.

1.6.4 Aerial Photography

The park has access to a variety of historical aerial photographs and satellite images. Recent 2005 and 2009 National Agriculture Imagery Program (NAIP) panchromatic imagery was acquired. The 2005 imagery played a significant role in this project's field data collection efforts as it was used to provide a more detailed image backdrop on GRS field maps. The 2009 imagery provided a more recent representation of the parklands and recent management activities.

The legacy data review involved the pertinent data sets and sources identified with the RNSP staffs to enable the project to best describe the vegetation based on past knowledge and 2007-2012 sampling efforts. Efforts prioritized historical records and sources to applicability, currency and relevance to 2012 conditions, using ancillary data to enable a robust discussion of the vegetation conditions.

Chapter 2 – Identification and Classification of Plant Communities

2.1 Methodology

A goal of this project was to produce a vegetation dataset meeting the national NPS standards and to enable or assist Park management decision making. The chosen method was to combine the field sampling requirements of the vegetation classification effort with the field sampling requirements necessary for the remote sensing efforts. Past image classification efforts performed by GRS have shown that vegetation classification field data collection efforts most often produce results that cannot be used to provide a comprehensive data set for image classification efforts. This is because the vegetation classification sampling efforts often do not consider the spectral variability or size of potential field sites when determining where to collect vegetation classification field samples. For this reason GRS implemented their stratified field sampling methodology that would distribute field sample sites throughout the project area across major vegetation and land cover classes that are capable of being mapped during this project (Stumpf, 2003). It was recognized that sampling the project area in this manner would likely miss some very small or localized vegetation types and might tend to generalize some of the small types into surrounding larger types. However, because this project had a minimum mapping unit (MMU) size of 0.5 hectares or 1.2 acres and mapped information would be based upon the classification of satellite imagery the generalization of these very small types would not significantly impact the vegetation mapping efforts. The benefits of combining field sampling needs into one effort would significantly reduce project data collection efforts and costs while not sacrificing the quality of the resulting map data set.

2.1.1 Project Area Stratification and Sample Area Selection

GRS's stratification methodology involves unsupervised classification of the satellite imagery that will subsequently be used as the basis of image classification efforts (see Section 3.1) into strata that represent significantly different, but as yet unknown, vegetation/land cover types. In this case, masks were developed and applied to limit the spectral variability found within any particular portion of the imagery and enhance the identification of separable classes throughout the project area. This ensured that the clustering parameters used in unsupervised classification efforts result in high homogeneity of classes.

For this project, area of interest (AOI) and Normalized Difference Vegetation Index (NDVI) masks were applied during the stratification process. Application of the AOI mask limited the development and processing of training data sets so that training data would be representative of the range of land cover types that are present in the project area. It excluded types outside the project area that may increase the variability of the land cover data. The NDVI mask is applied in an attempt to separate vegetated from non-vegetated types. Examples of non-vegetated areas would be large water bodies, sandy beaches near the shoreline, and talus slopes. Using the NDVI mask results in two maps from which the locations of potential training sites may be generated. Variability in the spectral data is reduced and confusion between classes is minimized in this way.

The principal objective of this task was to develop a set of candidate training areas that would form the basis of field sampling efforts and maximize field data collection efforts during the 2008 summer field season. This would be accomplished by eliminating the collection of data from invalid or spectrally heterogeneous areas and sub-minimum size sample areas and preventing redundant oversampling of frequently occurring areas of common types. At the same time, an initial training data set representative of the project area being mapped was developed that represented the diversity of the major land cover types present and the geographic distribution of those types.

Unsupervised classification processes (Iterative Self-Organizing Data Analysis Technique, or ISODATA) were then used to create a pool of potential candidate field training areas for the entire project area. ISODATA statistical sampling iterations were performed on the masked project area until the number of resulting ISODATA classes (isoclasses) stabilized at approximately 50-60 classes. This process identified many significantly different classes, where each class represents a grouping of spectrally similar pixels which are spectrally similar (homogeneous) and represent different vegetation/land cover characteristics that may identify a different type. Initial efforts identified that there was very little area within the project area that could be characterized as “unvegetated”. As a result, the unsupervised classification of the “unvegetated” portion of the image proved fruitless as it basically identified water classes in the ocean and apparently barren classes in the surf zone and on the beaches near the surf zone. ISODATA classification efforts were then focused on the vegetated portion of the project area. A total of 87 isoclasses were recognized for field sampling across the entire project area.

These image stratification data sets were then processed and pertinent database information was developed to guide the selection of potential candidate field training areas (groups of the same isoclass) for field sampling. Processing the data set in grid format yielded a data set of isoclass type areas, each having a unique identifier and pixel frequency (area). Each area is defined as a group of contiguous pixels all having the same isoclass number. These isoclass data were loaded into a database table for processing. Pixel area values were used to remove isoclass areas that were too small to sample, as well as to describe the frequency distribution of the project area by isoclass. The frequency distribution of pixels by isoclass was generated by simply summing the pixel frequency by isoclass value. This information was useful in the identification of the relative abundance of the different classes and the identification of both common and scarce isoclasses, as frequently occurring isoclasses are readily distinguished from scarce isoclasses. Rare isoclasses were identified and targeted for sampling so they would be included in field sampling efforts.

The next step in the field sampling area selection process was to remove classified areas thought to be too small to sample by implementing a minimum sample area filter. The project’s minimum mapping unit size (0.5 hectares or about 6 pixels) is smaller than the typical minimum sample area desired for an image classification training area sample. The most important aspects of this minimum size filter are that a resulting candidate sample area is large enough to use as a supervised image classification training area, the area can be easily located in the field by the field crew, the area can be distinguished from the surrounding land cover types, and the area is relatively homogeneous with respect to the vegetation present in the sample area (sample areas comprised of multiple vegetation

types are undesirable, unless they comprise a complex of types too small to be mapped individually). For this project, a minimum size training area filter of approximately 6 acres or about 30 pixels was implemented. Frequency by class is easily identified using the following query:

```
Select isoclass, count(*) from candidate_trsite where pix_count(*) >= 30
```

Through a review of the results, abundant or rarely occurring isoclass areas were identified as they had either high and low pixel frequencies. Areas meeting the minimum size were flagged in the database by performing a simple update of the isoclass database based on the size attribute of each contiguous area:

```
update candidate_trsite set tr_status = '30' where pix_count(*) >= 30
```

For any isoclass area lacking a sufficient number of candidate areas (5), the minimum size criterion was decreased to include smaller candidate areas until a sufficient number of areas were identified in the candidate training site data base:

```
update candidate_trsite set tr_status = '15' where pix_count(*) >= 15 and tr_status != '30'
```

Some classes in this project were so small in size that the lower area limit for these classes was dropped all the way to 4 pixels, which is less than the MMU of 0.5 hectares or 1.2 acres.

Rare or infrequently occurring types were identified as follows:

```
update candidate_trsite set tr_status = 1 where isoclass in (select distinct isoclass from candidate_trsite group by isoclass having count(*) < 5)
```

Information regarding the scarcity of isoclass areas was most useful in identifying and prioritizing field sample areas that must be included in the field sampling plan to assure they were included the field sampling and not overlooked. These scarce or rare areas were often the basis of field sampling efforts as frequently occurring areas could be sampled in many places but the rare or scarce areas did not provide such opportunity.

The next step in this process was to move the candidate field sample data from the grid world into the vector world, in order to process and manipulate the candidate field sample area data in a graphic context. To accomplish this conversion process, two steps were necessary. First, the isoclass map was reclassified to form a candidate area grid map – the isoclass value of all pixels in areas that were not identified as possible candidate field sample units were reset to a value of 0 (NODATA), while all other pixel isoclass values remained the same. The resulting isoclass grid map represented only those areas that had been determined to meet the minimum size and spectral homogeneity requirements for candidate field training data collection sites. This candidate area grid was then converted to a vector database representing the candidate sample areas. Other data, such as ISODATA class labels, were developed to enhance the candidate field sample site information. These area boundaries and corresponding labels were then overlaid on the imagery and plotted. The resulting database represented the initial set of candidate field sample training areas. A sample map is shown in Figure 3.

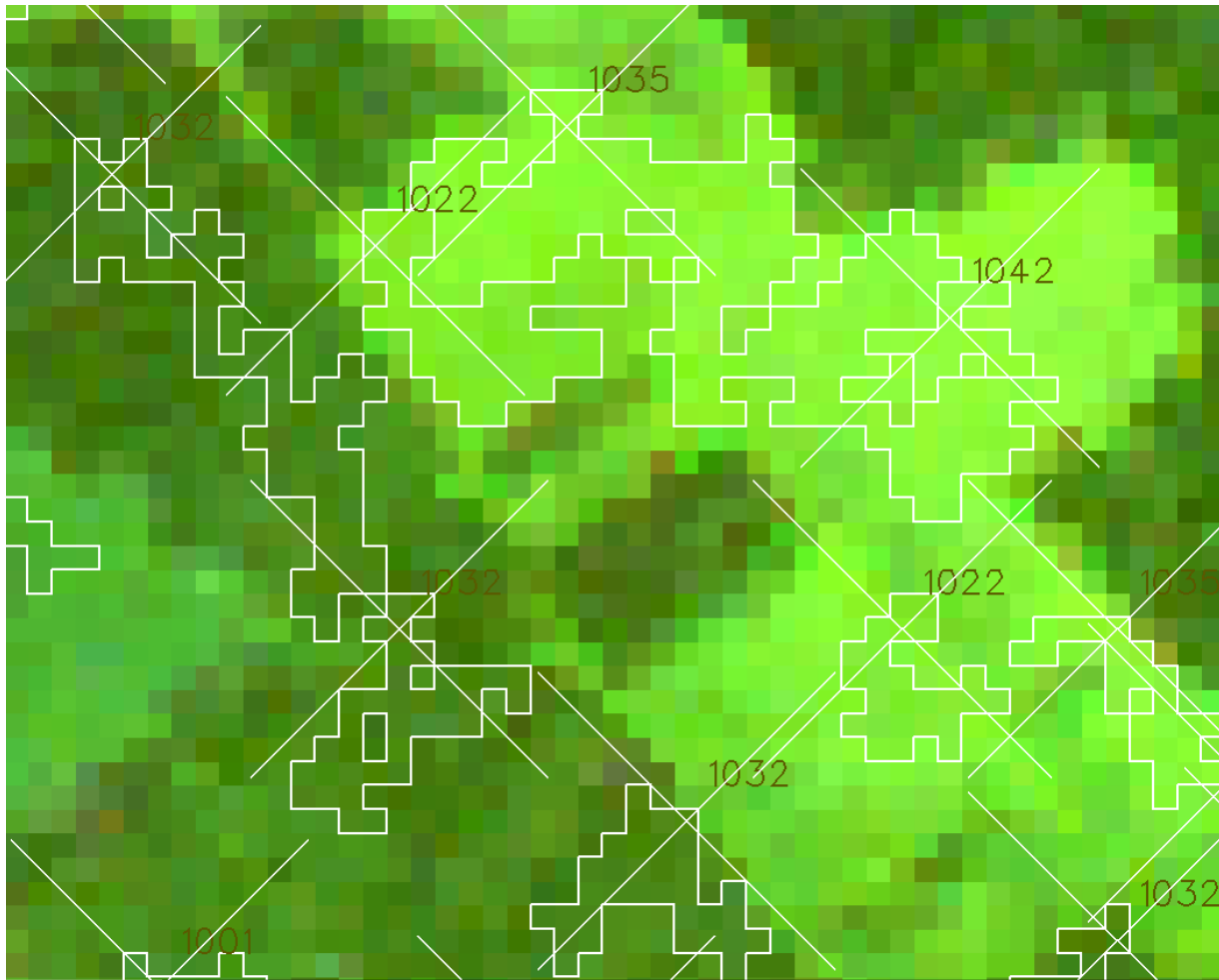


Figure 3. Candidate field sample area location map

The results of the stratification process represented the variety of the land cover classes present in the project area. To assure that field sample areas were selected throughout the project area, rather than clustered in any one particular portion of the park, no more than one field sample area of each class was included in field sampling schedules for any particular region of the project area, unless that was the only region in which sample areas of that class occurred. To accomplish this goal the project area was divided into seven parts and each part was treated as a separate sampling region. Isoclasses that basically occurred in only one or two regions, such as isoclass 1018, which represented a *Quercus garryana* type found only in the Bald Hills region, were sampled multiple times in that region, as that was the only region in which the type occurred. Overall, there was a desired sampling goal of no more than seven samples per isoclass, one sample area per region if possible.

Field sampling plans were developed on a weekly basis using the candidate field sample training site data set to sample different portions of the park and minimize field travel. Field crews either departed from the temporary residences at Orick, park campgrounds, or backcountry campsites to initiate their daily sampling efforts. The weekly plans that were developed and used to guide field sampling efforts contained information pertinent to locating and sampling each field sample area. For each

sample area a field location was identified at which field sampling efforts would be initiated for the area. The plan included the geographic location of each sample site location, as well as field site sample transect point distances, orientation, and configuration. Site location information was loaded into Garmin Map 76S global positioning system (GPS) units and used by field crews as target locations for field site data collection efforts. Weekly sampling plan sites were annotated on field maps and broken into daily plans for implementation by field crews.

2.1.2 Field Data Collection Methods

Field data collection schedules contained information pertinent to the identification of the individual sample sites such as the isoclass, aspect, elevation, and directional placement and configuration of the line point transect to be used in sampling the site.

Field data collection efforts involved consultation of maps and schedules to determine daily efforts. Sample sites to be visited were identified and potential navigational routes were considered. In choosing a navigational route, safety and efficiency standards were key components to making a decision. Those sites that were farthest away or on difficult terrain were often visited early in the day to ensure that all distant sites would be sampled and closer more accessible sites were sampled as crews returned back to their starting location, thereby making the day's work efficient and the week's sampling goal closer to being realized (in this way, if a site could not be sampled as scheduled, it was close to points of access and was much easier to integrate into another day's schedule). With the aid of GPS, compass, and maps the crews navigated to the proper locations of the field sample sites. All field site locations were confirmed with GPS waypoints recorded by the field crew at each sample site and field crews verified that sampling efforts at that site would stay within the field sample area, as they viewed the sample area on the map and in the field.

Each field crew was comprised of a Field Botanist familiar with the vegetation of the RNSP lands and a Field Data Technician. Field crews implemented line-point transects to develop cover descriptions of the different species and landscape features found in the different vegetation community layers of the land cover types being sampled. A transect in the form of a figure-eight comprised of 100 points was initially used in training site polygons large enough to accommodate this type of transect. A transect in the form of an equilateral triangle that was comprised of 50 points was used in training site polygons that were smaller. As the project progressed, the 50-point triangular transects were used to decrease the amount of time sampling each area. In a few rare cases a linear transect was used to sample narrow linear features like the riparian vegetation along a stream channel. The distance between points of the transect was typically wider apart (12 to 15 feet) for forested vegetation types than when sampling either shrub (6 feet apart) or herbaceous sample sites (3 feet apart). All these different configurations were used to generate estimates of cover for different species and landscape features. While these different configurations do not impact estimates of the expected value of the cover estimates (mean), they will impact estimates of the dispersion of the sample population from the mean; samples with fewer points will result in higher variances/standard deviations and the estimates of the mean, while unbiased, may have wider confidence limits. Some examples of these different transect configurations are shown in Figure 4.

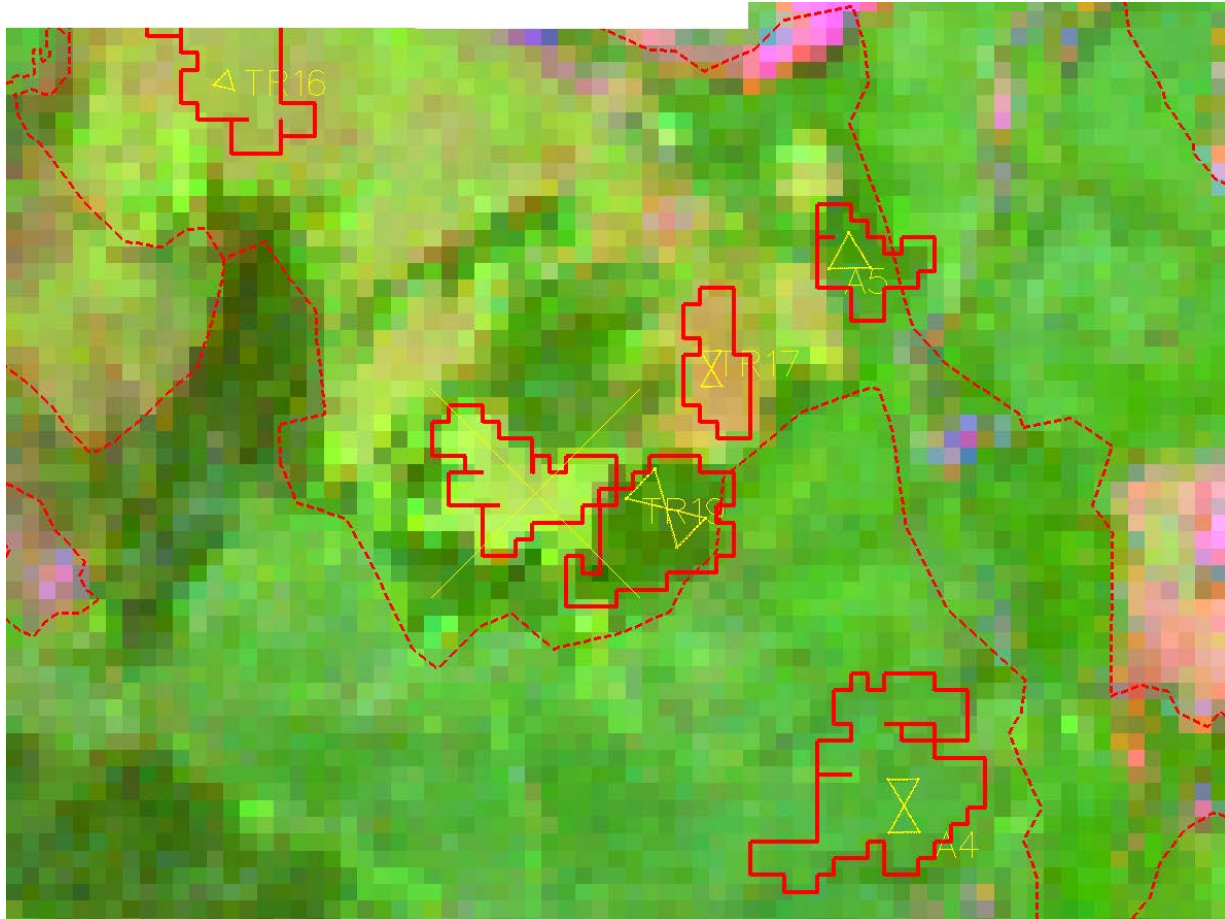


Figure 4. Examples of 100- and 50-point linear transect configurations.

Transect data were recorded on ASUS handheld computers running GRS's *TransIn* software in accordance with the definitions included in the GRS RNSP Field Data Collection Manual (GRS, 2008). Transect start points and corners were recorded with a GPS to confirm the sample transects were accurately located. At least two digital image representative of the area being sampled was collected. In many cases, four or more images were collected to represent different directions of the line-point transect sample. Site characteristics such as slope, elevation and aspect were recorded. In addition, field crews assigned type, cover, and size characteristics to the sample area prior to initiating the transect sampling; these assignments were subsequently reviewed and modified, if necessary, following their data collection efforts. Transect point characteristics were recorded as the crew members implemented the transect sample. Point characteristic data included information such as the 'layer' of each point feature, the genus (and if possible the species) of vegetation, diameter and crown radius of trees, and ground surface conditions. At specific point locations on each leg of the transect, Brown's transects were established, in order to sample the soil litter profile, coarse woody debris, and fine woody debris in accordance with the NPS Fire Monitoring (FireMon) Program protocols. In addition to recording sample site features encountered at each point along the transect, crews also surveyed the sample area for plants that were present at the site but not encountered on any of the transect points. These additional plants were recorded as "traces". Traces were recorded in

two ways. First, traces were identified in a relevé sized area (1000 m² for tree types, 500m² for shrub types, and 200 m² for herbaceous types) along the first leg of each transect. Then new traces found as the transect sample was continued after the first transect leg were also recorded. These traces were recorded with a different canopy position code so they could be distinguished from the traces that were recorded later during the sampling procedures. All unknown plant species encountered on transect points and any unknown “trace” plant were collected in zip-lock bags and labeled with the sample site and point number for identification later, so as not to delay or slow field sampling efforts.

In some instances, after successfully navigating to the field site or very close to the site, it was not possible for field crews to implement a transect sample at a field site due to either safety concerns or limited access. In these instances, when the field crew could observe the site and see the different vegetation and landscape features, an ocular estimate was implemented in place of a transect sample. At a minimum field crew members developed estimates of vegetative land cover based on an aerial (“bird’s-eye”) view of the site. All site characteristics and plant species were addressed. Images and site location points were collected. Unknown plants were collected for subsequent identification.

The work plan called for field crews to note additional sample site features, such as stream crossings, old roads, or type changes as the transect sampling was implemented. Crews were to identify in *TransIn*’s comments section any anomalous sample areas or portions of sample areas that might be inappropriate for sampling due to their heterogeneity of apparent types as seen on the ground. Such areas would be sampled separately, or the transect data could be segregated to represent different areas if the sample area was actually been a complex of multiple types and the points at which changes occurred were noted. Less than five sites were identified as anomalous sample sites during field data collection efforts.

On many of the 87 field sites sampled by the field crew that included Dr. Solomeshch, a full relevé sample was typically established in a manner completely independent of the transect sampling methodology, with the exception that the transect starting point was typically the starting point for the relevé, the relevé’s orientation was the same as the first leg of the transect, and the transect leg went completely through the middle of the relevé. Relevé data were collected using the California Native Plant Society (CNPS) Rapid Relevé sampling procedures based upon ocular estimates of species cover by canopy layer. 81 relevé sites were sampled in this manner. Dr. Solomeshch sampled an additional 274 sites using the CNPS methodology independent of GRS’s field sampling efforts resulting in a total of 355 relevé field sites (AS sites).

GRS field staff made efforts to meet or exceed daily survey schedules. However, weather conditions and other access restrictions did not always allow for complete sampling of the scheduled areas or sites. Opportunistic sampling was implemented whenever feasible in order to supplement scheduled sampling efforts. Opportunistic sampling was implemented in two ways. The first way involved locating an alternative isoclass training area shown on field maps that was spectrally equivalent (i.e., same isoclass code) and near to scheduled areas that the field crew could not sample. The second type of opportunistic sampling involved spotting and sampling unscheduled areas while navigating to other sample locations. These unscheduled opportunistic sample areas were not necessarily

delineated on the field maps as a spectrally homogeneous area and may not have been assigned an isoclass code. However, these areas were visually estimated to be large enough to sample and appeared homogeneous enough to qualify as valid sample areas. These areas also tended to be land cover types known to be ‘rare’ or missing in the land cover matrix. Examples include the *Typha latifolia* dominated areas or “old growth” hardwood dominated areas. These areas comprised too little area to be identified as a separate distinguishable stratum and were sampled when encountered during field sampling efforts, if they were determined to be sufficiently large enough for a field training site.

Upon conclusion of weekly field data collection efforts, the sample area data were reviewed relative to their type information, as described by the field crew and the number of areas sampled by general type was recorded in a land cover type matrix, thereby indicating the frequency of samples by estimated land cover type and isoclass. In addition, the field sample area status was updated to indicate the area had been sampled and a report indicating the count or frequency of sample areas by isoclass was produced to reflect the current status of field sampling activities. This information was used to monitor efforts and identify “scarce” classes still in need of additional sampling. As scarce or rare classes that lacked samples were identified, field crews were directed to take an opportunistic sample in that type in the event that a suitable area was located and recognized in the field. Subsequent data collection efforts were adjusted daily in an effort to thoroughly satisfy the necessary sampling (coverage) of the different strata represented in land cover type/isoclass matrix within the 2008-09 field data collection seasons.

2.1.3 Unknown Plant Identification

When field crew staff encountered any unknown plant species, the unknown species was collected for subsequent identification. In some cases photos were also taken of the plants in their native environment. A total of 1471 unknown specimens were reviewed by GRS field crew botanists upon their return from the field and catalogued into an Excel spreadsheet to facilitate subsequent identification and update procedures. Plants that were not immediately identifiable were placed in plant presses and preserved for subsequent identification by other knowledgeable botanists, such as Dr. Solomeshch. In addition to GRS field crew botanists and Dr. Solomeshch, some RNSP staff also reviewed and identified some of the unknown plant specimens. Many of unknown plant species were eventually identified. Of the 1471 recorded specimens, 779 were identified to species, 442 were identified to genus, 37 were identified to family, and 213 were not identified. Field data were then updated to reflect the identification of the unknown species and the field data set was completed by the end of June, 2012.

2.1.4 Data Entry

GRS field data were collected on ASUS A626 handheld computers using GRS’s **TransIn** data collection software. Field data from each sample site was stored in comma delimited files. Data from these units was transferred to SD cards and downloaded to GRS’s computer system in Arcata. These files were then processed by GRS’s **transSum** software and imported directly into a relational database tables that represented the field sample areas and the point data collected in those areas. All transect point feature data were reviewed relative to RNSP project species codes and data standards

as the data were processed. Any suspect data records were identified and corrected. Following the correction of any erroneous data, species cover composition by layer data (cover matrices) were developed on an area specific basis.

2.1.5 Field Data Collection Results

The GRS field data collection efforts resulted in a total of 445 field samples. 325 field sites were sampled using the line-point transect sampling methodology, 108 field sites were sampled by developing ocular estimates of land cover/botanical features, and 12 sites were visited but the sample data was not used, resulting in 433 usable GRS field samples. Dr. Solomeshch developed ocular cover estimates at 355 sample sites, 81 which were at the same locations as GRS field sample sites. Botanical field data was collected at a total of 707 unique field sites. All of these field data were subsequently loaded into relational database tables. All these data were processed using GRS's quality control routines to identify any invalid species information, which was subsequently corrected. All field site locations were input into a geographic information systems (GIS) layer to represent the spatial locations of these sites. Scripts were developed to access the data and output cover information in a variety of formats so that these data could be processed and extracted for analysis.

2.2 Analysis

Dr. Solomeshch input the plant cover data from the 355 AS relevé field sites on which he estimated cover data to enable processing with his software. TWINSpan and other analytical tools were used to identify vegetation types/classes that could potentially be recognized in the RNSP map data set. Initial vegetation classification efforts recognized 56 associations (equivalent to associations of USNVC (2015) and/or of Sawyer et al. 2009)) that included 19 forestland types, 10 shrubland types, 10 dry and mesic herbaceous types, 10 wetland herbaceous types, and 7 dune herbaceous types. From the spring of 2011 through the spring of 2012 the vegetation classification evolved through four iterations while the associated classification key went through seven versions. Results of these classification iterations and new versions of the key were reviewed by Leonel Arguello (RNSP) and Ken Stumpf (GRS). Initial vegetation classification efforts tended to cluster some sample area data and a few vegetation classes were thought to be overly broad and too general in representing the wide variety of vegetation found in the Park. In addition, GRS field data identified some potential classes that appeared to be missing from the vegetation classification and key. After each classification iteration or new version of the key, Leonel Arguello and Ken Stumpf worked with Dr. Solomeshch to further differentiate the generalized classes into what were thought to be identifiable and "known" classes within the park. Subsequent classification efforts worked to a large extent to identify many of the major classes that were thought to be present in the Park.

In April, 2012 Ken Stumpf began conversion of the key into program instructions that would be used to assign the preliminary USNVC type designations to all field data sites. During this effort a significant number of field sites were identified that fell through the key, due to either missing decision rules or rules that were too restrictive. After consideration of the vegetation classification, the field data that had been collected, and the mapping that would be based upon the vegetation classification and key, Ken Stumpf implemented a set of changes to the key to resolve many of the

issues that had been identified in the most recent version of the key. Changes primarily involved the addition of several types found in the field data that were missing from the key and the addition of decision rules and type names to represent some alternative type designations that could be applied to field data that did not meet all of the key criteria. By March, 2013 these changes were implemented in one final version the Key so that image classification and mapping efforts could proceed. This version of the key is included in this report in Appendix A.

2.3 Results

In the final modified version of the key used for this mapping effort a total of 99 associations or types were recognized, including 44 forestlands types, 18 shrubland types, 15 dry and mesic herbaceous types, 11 wetland herbaceous types, 8 dune herbaceous types, and 3 additional types that represented sparse vegetation, barren areas, and bodies of water.

These 99 detailed type classes were subsequently generalized into 84 Generalized Associations, which would be too many classes for an accuracy assessment. Further generalization into alliances and super-alliances (groups of similar alliances) resulted in a total of 69 Generalized Alliances for the RNSP Project Area. A listing of these Detailed USNVC Associations, the Generalized Associations, and the Generalized (grouped) Alliances is shown in Table 1. Please note that association names are coded and they often contain one or more sets of character codes that represent the different species components of the different associations. The two-letter character codes typically reference the first letter of the genus and species of the scientific name of a specific plant species. For example, SS represents *Sequoia sempervirens* and PA represents *Pinus attenuata*.

Vegetation types as assigned from individual relevés by Dr. Solomeshch's are summarized and described in Appendix B. These types are described and assigned at the approximate level of Manual of California Vegetation (Sawyer et al. 2009) level of association and approximately at that of Generalized Alliance, as mapped for this project.

Table 1. Preliminary associations, generalized associations, and generalized alliances.

Category	Association (calc class)	Generalized Association	Generalized Alliance
Forestlands	Ss:tree/Vo:shrub	Ss:tree	<i>Sequoia sempervirens</i> Mature Forest
	Ss:tree/Pmu:herb	Ss:tree	<i>Sequoia sempervirens</i> Mature Forest
	Ss-Ama-Uc:tree	Ss-Ama-Uc:tree	<i>Sequoia sempervirens</i> Mature Forest
	Ss-Ame:tree	Ss-Ame:tree	<i>Sequoia sempervirens</i> Mature Forest
	Ss-Ld:tree	Ss-Ld-Mix:tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ss-Ar:tree	Ss-Ar:tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ss-Pm:tree	Ss-Pm:tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ss-OtC:tree	Ss-Mix:tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ar-Ss:tree	Ar-Ss-(Mix):tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ld-Ss:tree	Ld-Ss-(Mix):tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Ld-Ss-Oth:tree	Ld-Ss-(Mix):tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Pm-Ss:tree	Pm-Ss:tree	<i>Sequoia sempervirens</i> -(Other) Young Growth Mixed Forest
	Pm:tree	Pm-(Oth):tree	<i>Pseudotsuga menziesii</i> -(Other) Young Growth Mixed Forest
	Pm-Ar:tree	Pm-Ar:tree	<i>Pseudotsuga menziesii</i> -(Other) Young Growth Mixed Forest
	Pm-Oth:tree	Pm-(Oth):tree	<i>Pseudotsuga menziesii</i> -(Other) Young Growth Mixed Forest
	Ar-Pm:tree	Ar-Pm-(Mix):tree	<i>Pseudotsuga menziesii</i> -(Other) Young Growth Mixed Forest
	Pm-Ld-Ame:tree	Pm-Ld-Mix:tree	<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> Young Growth Mixed Forest
	Pm-Ld-Oth:tree	Pm-Ld-Mix:tree	<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> Young Growth Mixed Forest
	Ps:tree/La:herb	Ps:tree	<i>Picea sitchensis</i> Saturated Forest
	Ps:tree/Gs:shrub	Ps:tree	<i>Picea sitchensis</i> -(Other) Forest
	Ar-Ps:tree	Ar-Ps-(Mix):tree	<i>Picea sitchensis</i> -(Other) Forest
	Pa:tree/Lde:shrub	Pa:tree	<i>Pinus attenuata</i> Forest
	Pmo-Pc:tree/Lde-Qv:shrub	Pmo:tree	<i>Pinus monticola</i> Forest

Table 1. Preliminary associations, generalized associations, and generalized alliances (continued).

Category	Association (calc class)	Generalized Association	Generalized Alliance
Forestlands: (continued)	Pj:tree/Fi:herb	Pj:tree	<i>Pinus jeffreyi</i> Forest
	Psp-XX:tree/	Pin-Mix:tree	<i>Pinus</i> species Mixed Forest
	Xra-Ss-Ld:tree	Xra:tree	<i>Pinus radiata</i> × <i>attenuata</i> Forest
	Th-Ss:tree	Th-Ss:tree	<i>Tsuga heterophylla</i> Forest
	Cl-Pm:tree	Cl-Pm:tree	<i>Chamaecyparis lawsoniana</i> Forest
	OtC-CC:tree	XX-(Oth):tree	Other Conifer-(Other) YG Mixed Forest
	OtC-OtB:tree	OtC-OtB:tree	Montane Conifer-Hardwood Mixed Forest
	OtC-HH:tree	OtC-OtB:tree	Montane Conifer-Hardwood Mixed Forest
	OtC-CC:tree	OtC-OtB:tree	Montane Conifer-Hardwood Mixed Forest
	Ar:tree/Co:herb	Ar-(Mix):tree	<i>Alnus rubra</i> -(Other) Forest
	Ar:tree/Oth:herb	Ar-(Mix):tree	<i>Alnus rubra</i> -(Other) Forest
	Ar-Oth:tree	Ar-(Mix):tree	<i>Alnus rubra</i> -(Other) Forest
	Ama:tree/Hc:herb	Ama-(Mix):tree	<i>Acer macrophyllum</i> Forest
	Uc:tree/Co:herb	Uc:tree/Co:herb	<i>Umbellularia californica</i> Forest
	Qg:tree/Fc:herb	Qg-(Mix):tree	<i>Quercus garryana</i> Forest
	Qc:tree	Qc:tree	<i>Quercus chrysolepis</i> Forest
	Cc:tree/Xt:herb	Cc:tree/Xt:herb	<i>Chrysolepis chrysophylla</i> Forest
	Ld-Oth:tree	Ld-(Mix):tree	<i>Lithocarpus densiflorus</i> -(Other) Young Growth Mixed Forest
	OtB-Oth:tree	OtB-Mix:tree	Montane Hardwood Mixed Forest
	OtB-HH:tree	XX-(Mix):tree	Other Hardwood Mixed Forest
Shrublands	Bp:shrub/Pmu:herb	Bp-(Mix):shrub	<i>Baccharis pilularis</i> Shrubland
	Es-Ah:shrub	Es-Ah:shrub	<i>Eriophyllum staechadifolium</i> Shrubland
	Ge:shrub	Ge:shrub	<i>Garrya elliptica</i> Shrubland
	Gs:shrub	Gs:shrub	<i>Gaultheria shallon</i> Provisional Shrubland
	Lde:shrub	Lde-(Mix):shrub	<i>Lithocarpus densiflorus</i> Shrubland

Table 1. Preliminary associations, generalized associations, and generalized alliances (continued).

Category	Association (calc class)	Generalized Association	Generalized Alliance
Shrublands: (continued)	PA:tree/AC:shrub	PA:tree/AC:shrub	<i>Arctostaphylos columbiana</i> Shrubland
	PMo:tree/AC:shrub	PMo:tree/AC:shrub	<i>Arctostaphylos columbiana</i> Shrubland
	Qv:shrub	Qv-(Mix):shrub	<i>Quercus vaccinifolia</i> Shrubland
	Sh:shrub	Sal-(Mix):shrub	<i>Salix</i> Shrubland
	Sal-Sal-Oth:shrub	Sal-(Mix):shrub	<i>Salix</i> Shrubland
	Sl-Slu:shrub	Sl-Slu:shrub	<i>Salix lasiolepis</i> Shrubland
	Ru:shrub/HI:herb	Ru:shrub/HI:herb	<i>Rubus</i> Shrubland
	Rp:shrub	Ru-(Mix):shrub	<i>Rubus</i> Shrubland
	Ra:shrub	Ru-(Mix):shrub	<i>Rubus</i> Shrubland
	Rs:shrub	Ru-(Mix):shrub	<i>Rubus</i> Shrubland
	Rub-XX-Oth:shrub	Ru-(Mix):shrub	<i>Rubus</i> Shrubland
	OtS-XX:shrub	XX-(Mix):shrub	Xxxxxx xxxxxxxxxxxx Shrubland
	OtS-ss:shrub	OMS-Mix:shrub	Other Mixed Shrubland
Herbaceous	Cp/Fi:herb	Fi:herb	<i>Festuca idahoensis</i> Grassland
	Df-Eg:herb	Df-Eg:herb	<i>Dudleya farinosa</i> Provisional Herbaceous
	SSp-Tg:herb	SSp-Tg:herb	<i>Sedum spathulifolium</i> Provisional Herbaceous
	Hi-Cb:herb	Hi-Cb:herb	<i>Hirschfeldia incana</i> - <i>Chenopodium botrys</i> Herbaceous
	Ho-So:herb	Ho-So:herb	<i>Heterotheca oregona</i> Herbaceous
	Ma-Oth:herb	ORC:herb	Other Riverine Herbaceous
	Ae-Ce:herb	Ae-Ce:herb	<i>Arrhenatherum elatius</i> - <i>Cynosurus echinatus</i> Grassland
	Ag-TR-PV:herb	Ag-TR-PV:herb	<i>Agrostis (gigantea, stolonifera)</i> - <i>Trifolium repens</i> - <i>Prunella vulgaris</i> Herbaceous
	Ag-As:herb	Ag-As:herb	<i>Agrostis gigantea</i> - <i>Agrostis stolonifera</i> Grassland
	HI-HI:herb	HI-Mix:herb	<i>Holcus lanatus</i> - <i>Anthoxanthum odoratum</i> Grassland
	HI-Oth:herb	HI-Mix:herb	<i>Holcus lanatus</i> - <i>Anthoxanthum odoratum</i> Grassland

Table 1. Preliminary associations, generalized associations, and generalized alliances (continued).

Category	Association (calc class)	Generalized Association	Generalized Alliance
Herbaceous: (continued)	OCH:herb	OCH:herb	Other Coastal Herbaceous
	OtG-XX:herb	OGC:herb	Other Grassland
	OtH-XX:herb	OHC:herb	Other Herbaceous
	AmA:herb	AmA:herb	<i>Ammophila arenaria</i> Grassland
	Cm:herb	Cm:herb	<i>Cakile maritima</i> Herbaceous
	Lm:herb	Lm:herb	<i>Leymus mollis</i> Grassland
	Ac:herb	Ac:herb	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous
	Al-Eg:herb	Al-Eg:herb	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous
	Cs:herb	Cs:herb	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous
	Tc:herb	Tc:herb	<i>Abronia latifolia</i> - <i>Ambrosia chamissonis</i> Herbaceous
	ODC-XX:herb	ODC:herb	Other Dune Herbaceous
	Co:herb	Co:herb	<i>Carex obnupta</i> Herbaceous
	Co-DeC:herb	Co-DeC:herb	<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland
	Cv-DeC:herb	Cv-DeC:herb	<i>Carex (utriculata, vesicaria)</i> Herbaceous
	Go:herb	Go:herb	<i>Glyceria occidentalis</i> Provisional Herbaceous
	Nl:herb	Nl:herb	<i>Nuphar lutea</i> Provisional Herbaceous
	pa:herb	pa:herb	<i>Phalaris arundinacea</i> Herbaceous
	Pn:herb	Pn:herb	<i>Stuckenia-Potamogeton</i> Herbaceous
	Sa:herb	Sa:herb	<i>Sparganium (angustifolium)</i> Herbaceous
	Sm:herb	Sm:herb	<i>Scirpus microcarpus</i> Herbaceous
	SSu:herb	SSu:herb	<i>Scirpus subterminalis</i> Herbaceous
	Tl:herb	Tl:herb	<i>Typha latifolia</i> Herbaceous
	OtA-Oth:herb	OAC:herb	Other Aquatic Herbaceous
Other:	SvgX:other		Sparse Vegetation
	H2O:other		Water
	Bar:other		Barren

Chapter 3 – Discrete Classification Mapping Methodology

3.1 Image Data Acquisition and Review

Two Landsat TM-5 scenes were processed during this project, however only one was classified to make the final project image classification map. Cloud cover was an issue when searching the Landsat archives for usable imagery, as nearly all coastal scenes in the RNSP vicinity have some cloud cover, in particular fog along the coast and up the river valleys.

At the start of the project, GRS identified two scenes for possible use in this project. The first scene, Landsat TM5 scene (TM4631a; refer to Table 2) was acquired April 30, 2007. The second scene, Landsat TM5 scene (TM4631j; refer to Table 2) was acquired June 17, 2007. Both scenes were delivered to GRS in NLAPS format, and each contained all seven spectral bands (1, 2, 3, 4, 5, 6, and 7). Resampling of the imagery during processing by the EROS Data Center was performed using the nearest-neighbor algorithm, as this process does not degrade image quality (spectral quality) by distorting pixel values as does the cubic convolution algorithm. The image bands were translated into Intergraph/Image Analyst-compatible TIFF format files for review and evaluation of actual coverage and quality. No digital elevation data were delivered with this scene. All project imagery and data layers/sets developed throughout the project were created in or re-projected to match the original imagery projection parameters which were UTM Zone 10 NAD83 meters.

Table 2. Landsat imagery evaluated and processed during the Redwood National and State Parks vegetation classification and mapping project.

Scene	Path	Row	Date	GMT	Sun Elev.	Sun Azimuth	Pixel Size (m)
TM4631a	46	31	4/30/2007	18:51:54	57.98	140.70	28.5
TM4631j	46	31	6/17/2007	18:51:15	64.56	129.03	28.5

Initial evaluation of the June imagery revealed that the TM4631j imagery was distorted by “striping.” This image defect apparently occurred during post processing of the imagery by the EROS Data Center. This imagery was reordered and redelivered to GRS. Subsequent review of the reprocessed imagery now revealed a small spatial offset of slightly more than a pixel (~40m) from its true position on the earth. This spatial offset was significant enough to warrant reprocessing by the EROS Data Center. The TM4631j scene was reprocessed and redelivered to GRS in early May and the reprocessed imagery was now correctly positioned and showed no evidence of “striping.”

Evaluation of the April imagery relative to the June imagery and the project area confirmed the need to utilize the June imagery as the primary image data source for this project’s classification efforts. GRS’s review indicated apparent spectral differences in hardwood stands at elevations higher than about 1000 feet or about 300 meters. It became apparent that at the time of image acquisition on April 30, 2007 the hardwood trees at the higher elevations had not fully “leafed out” and appeared to be without foliage. The apparent deciduous state of the hardwood trees impacted areas vegetated by either *Alnus rubra* or *Quercus garryana* and precluded the use of this imagery for any classification purposes.

After reviewing the imagery and determining image-specific acquisition information regarding the sun elevation and azimuth angle, GRS proceeded to process the imagery in preparation for training area development and classification applications. This preparation involved the correction of the images for differential illumination due to the topographic influences of slope and aspect.

3.2 Image Classification Methodology

3.2.1 Image processing-illumination correction

Integral to the image classification workflow is the use of imagery that has been corrected with respect to differential illumination resulting from the influences of slope and aspect. During past projects, several methods of image normalization have been evaluated. It was decided that we would use the Backwards Radiance Transformation Correction (BRTC) based on a non-Lambertian assumption and a Minnaert constant (Civco 1989; Colby 1991) to correct the imagery. This technique uses estimates of slope and aspect from a co-registered digital elevation model (DEM), and the image acquisition sun-angle and azimuth parameters to correct the images for differential illumination caused by the terrain relative to the sensor. This correction method minimizes the effect of aspect and slope, but maintains the signatures of the different land cover types, thereby resulting in more accurate classification information (Geographic Resource Solutions, 1993). In addition to improving the consistency of the classification, it has been determined that the illumination correction often results in the reduction of the number of training sites required to classify a given land cover condition (Stumpf, 2000). This is a significant factor when undertaking data collection efforts in very rugged and inaccessible areas, such as the Redwood National and State Park lands to be mapped during this project.

3.2.2 Image Processing Mask Development and Use

Unfortunately, image classification is not a perfect science. Classification processes often need some type of guidance in order to achieve the best results possible. Such guidance often comes in the form of masks that are used to limit the misclassification of imagery that can occur by applying spectral training classes to portions of the imagery where it is known that those vegetation and landscape features represented by those classes do not occur. Four different types of masks were developed and applied during image classification efforts to limit the application of spectral data to particular portions of the imagery and enhance the identification of separable classes throughout the project area. In addition, masks ensured that the clustering parameters used in unsupervised classifications would result in higher homogeneity of classes (strata). Masks developed and used during this project represented the area of interest (AOI), Normalized Difference Vegetation Index (NDVI), riparian areas, and ecotype regions. A brief description of each mask and its application follows.

The AOI mask represented the project area and a one-mile wide buffer area along the perimeter of the park boundaries. This mask ensured that the processing and application of training data set information were representative of and limited to the entire range of land cover types that are present in the project area. Its use excluded types outside the park that may have increased the variability in the cover data represented by the imagery.

The NDVI mask would be used to separate vegetated from non-vegetated classes or types. Examples of non-vegetated areas would be rivers and other water bodies and barren areas, such as slides, the

surf zone, and sandy beaches near the surf zone. The use of the NDVI mask would normally result in the development of two different maps from which the locations of potential spectral training areas may be generated, each representing a different set of land cover characteristics. Variability of the spectral data is typically reduced and the confusion between classes is minimized resulting in the definition of more separable classes. However, after developing and applying the NDVI mask, the “unvegetated” portions of the project area were found to represent such a small portion of the total project area and have so little impact on the initial classification efforts that the NDVI mask was not used during this mapping effort.

A riparian area mask was developed by buffering all water bodies and USGS streams and rivers mapped in the USGS 1:24000 digital line graph (DLG) data set. These hydrologic features were buffered as distinct zones up to 5 pixels wide to estimate the proximity of different locations in the satellite imagery to water features. This mask was developed and used in an attempt represent potential riparian areas and to give preference to the classification of spectral training classes representing riparian types within these riparian areas during image classification efforts and limit the application of non-riparian vegetation types within the riparian buffer zones. In other words, riparian classes would be applied in these zones to classify the imagery before non-riparian training classes were applied to classify pixels that remained unclassified after the riparian classes were applied.

An ecotype mask was developed to reflect some of the different regions of the project area that were observed supporting distinctly different vegetation types. This mask would be used to limit the application of certain training classes to the specific ecotype regions in which those classes were observed during the field sampling efforts or known to occur. This ecotype mask represented distinct eight ecotype areas. These eight ecotype areas represented the water (ocean) and low coastal beaches, dunes, and lowlands at or near the base of the coastal bluffs and cliffs; coastal bluffs and uplands dominated by alder and Sitka spruce; interior redwood lands; the Little Bald Hills and Rattlesnake Ridge areas dominated by Douglas-fir, Jeffrey pine, western white pine, and knobcone pine; the Bald Hills vicinity dominated by Douglas-fir, Tanoak, Oregon white oak and prairies; the *Pinus radiata* X *attenuata* plantation(s) in the Tom McDonald Creek drainage; and the 2003 Xowannutuk Fire in the Harry Weir Creek drainage of Redwood Creek; and the stream channels and river beds of the Smith River, Klamath River, and Redwood Creek. Each of these ecotype areas was represented by somewhat different plant communities, some of which only occurred in one of the specific ecotype areas. The purpose of the ecotype area mask was to limit the area(s) in which different spectral training class information could be applied during image classification efforts, so that those spectral training classes with limited extents were not applied to portions of the imagery/project area in which they were known not to exist.

Delineation of these regional boundaries was based upon a review of all field data that was collected, interpretation of high resolution NAIP 2005 aerial photography, and the classes identified during initial image classification efforts. These ecotype regions were used to limit the application of spectral training classes to portions of the project area where those classes were either observed or expected to be present. All but one of these ecotype regions were relatively small and represented between 0.1% and 4.7% of the total project area. The exception was the interior redwood region

which was very large and represented 82.3% of the project area. A summary of the different ecotype zones represented in this mask are shown below in Table 3.

Table 3. Ecotype mask zones.

Zone	Description	RNSP Acreage	Percent of RNSP Area
1	Water and beaches, dunes, and associated lowland areas	6,420.6	4.6%
2	Coastal bluffs and highlands	6,541.0	4.7%
3	Interior redwood region	115,606.1	82.3%
4	Little Bald Hills and Rattlesnake Ridge vicinities	4,760.5	3.4%
5	Bald Hills vicinity	4,686.8	3.3%
6	<i>Pinus radiata</i> X <i>attenuata</i> plantations	318.7	0.2%
7	Xowannutuk burn area	197.7	0.1%
8	River channels and beds	2,002.5	1.4%
	Totals	140,533.9	100.0%

3.2.3 Image Classification Training Data Set Development

An image classification training data set is a collection of training classes that have each been developed to represent some particular feature or characteristics to be identified in the satellite imagery when that training data set is applied by the classification process. GRS used both supervised and unsupervised classification techniques to develop land cover pixel classification maps. Both of these methods are dependent on spectral training sets. Training set development is a critical component of any classification effort. “Ground truth” information or land cover attribute data must be properly associated with each spectral data class to develop accurate and detailed land cover map data. If the attribute descriptions are not properly associated with the spectral data classes, then the resulting land cover map will be an inaccurate representation of the project area. Care must be exercised to properly relate the spectral data classes with the “ground truth” when developing each individual training class that will be used during classification efforts (a spectral data class is a training class).

A key component in GRS’s DCMM supervised methodology is that an individual training class is developed for each individual field sample area, rather than for groups of areas that are thought to represent the range of a particular land cover type class. This different approach forms the basis of the DCMM approach, as it tends to keep training class statistical variances small relative to the statistics for training classes formed from groups of areas and results in reduced statistical overlap and confusion of data that represent different land cover characteristics.

Under the DCMM it is imperative that image classification training data sets are developed that most accurately reflect the land cover types present in the project area, while at the same time minimizing confusion and uncertainty within the training class data. Training classes should reflect the areas described during field data collection efforts and exhibit small statistical variances within the spectral data of each training class. Training classes of this sort tend to minimize the overlap of spectral

statistics and confusion between training data representing different land cover features. Proper spatial registration of field data collection efforts and development of the appropriate size of the sample area are requirements for developing accurate training data. As training classes are developed they are reviewed to determine their validity. Review included the evaluation of confusion and classification fidelity for each training class. Only demonstrably valid classes should be used for classification and any remaining invalid classes are withdrawn and discarded, if possible.

3.2.3.1 Supervised Training Set Development Strategy

The **433** field sample areas in which field sites were surveyed during the 2008-09 field data collection efforts formed the basis for training set development efforts. All of these areas were reviewed as potential training areas. These areas were the areas that were primarily selected for sampling from the candidate site data set on the basis of their spectral homogeneity and size. Some field training areas were represented by ocular estimates of land cover composition. These were areas that were visited, but were not sampled using the transect cover sampling methodology for a number of reasons, that included steep slopes, inaccessibility, unsafe conditions, dense homogeneous shrubs, or the presence of easily identified characteristics (e.g. barren slides, wet beaches, or bodies of water). In addition, training area data were also developed for **23** supplemental (obvious) land cover classes, such as water and barren types, from training areas selected from the candidate field sampling database with the aid of aerial photography and satellite imagery. In this way, field crews were not slowed down by having to actually visit and survey field sites in training areas of these obvious land cover types. In addition, the 279 field sample areas described by Dr. Solomeshch using the relevé approach were also reviewed as potential training areas.

GRS first developed spectral training classes using those areas surveyed by ground crews, as these field sample areas were comprised of the full complement of descriptive information based on the line-point transect data collection methodology implemented at the field site. Areas based on ocular estimates or other opportunistic sites were added to training sets, if the areas contained at least 7 pixels and were sufficiently homogeneous to create a suitable training area having spectral statistics with low variances. Training areas for supplemental types such as water and barren types were then added during photo-interpretive efforts to finalize the classification training data sets and increase the breadth of their spectral range.

3.2.3.2 Supervised Training Site Development Techniques

Training areas within the training data set were created individually using region growing techniques, a neighborhood seeding method that used a 3x3 pixel initial seed window surrounding a point interactively selected on the image; this technique “grows” a homogeneous spectral area around the initial point in the seed window by evaluating adjacent pixels and determining that they fall within a user-specified level of statistical variation. Location of the initial point in each scene was determined by the approximate coordinate location of the field survey site, as indicated by a labeled point in the GIS training site coverage overlaid on the imagery. Training area pixel inclusion was determined specific to each scene using a statistical threshold of 2 standard deviations from the seed area mean spectral data. The maximum search area extent was limited to a 41x41 pixel area.

These basic parameters were initially applied while developing training areas at all training site locations. However, these parameters did not always produce a sufficiently large or homogeneous training area due to the heterogeneity of the pixel data and the shape of the area sampled. If an appropriately sized area could not be grown using these initial parameters, then the standards were relaxed or tightened as follows:

Option 1: Change the size of the seed area

The seed area could be enlarged to a larger size, such as 5x5, 3x5, or 5x3 pixel windows. This would increase the size of the initial training area. To increase the size equally in all directions, the 5x5 was used. For training areas that were irregularly (linear or oblong) shaped the 3x5 or 5x3 was used. Other sizes, such as 7x7, 3x7, 5x7, and so forth were also used to develop training statistics if the initial sizes did not yield satisfactory results.

Option 2: Change the statistical threshold

If changing the size of the seed area did not yield satisfactory results, then the seed area would be set back to an initial 3x3 pixel window and the pixel inclusion parameters would be relaxed to a threshold of 2.5 standard deviations. This higher standard deviation relaxes the statistical threshold and allows the training area to grow larger (while sacrificing lower variances). Conversely, if the problem was the area was too large (not localized enough), then the threshold can be set lower to 1.5 or 1 standard deviation(s) to tighten the statistical threshold resulting in smaller training areas.

Option 3: Change the statistical threshold and size of the seed area

Tightening or relaxing the statistical threshold while at the same time changing the size of the initial seed area (smaller to large) would sometimes enable the development of suitable training area statistics for small irregular shaped areas.

Option 4: Digitize the training area

As most field training areas were based on the candidate area selection process, region growing techniques were nearly always successful in developing training area statistics. However, some areas were not sampled based on the candidate area selection process (opportunistic samples) and region growing did not always result in a sufficiently large or homogeneous area. Such areas were typically characterized as very narrow areas of less than 3 pixels in width. In this case, the training area could be digitized based on the imagery and field data collected at that sample site. Digitized area statistics typically exhibit higher variances than areas developed during region growing.

Option 5: Use the ISODATA class boundaries

The last means of defining a training area was to use the ISODATA class boundaries from the candidate area data set to define the training area boundaries. This assumes that the ISODATA class statistics are similar to the statistics of the individual supervised classes, which is not always true. Higher than normal variances are often obtained using this approach. If a suitable training area

(minimum size, suitable statistical variances, and appropriate shape) could not be developed for a field sample area, that area would not be used in the spectral training data set.

Although the ideal training area size is thought to be quite large (greater than 30 pixels or approximately 6 acres), GRS used a minimum training area of 7 pixels in this project due to the degree of variation found in some of RNSP's land cover types and the need to develop areas with small spectral statistical variances. A summary of training area usage and size is shown in Table 4. Field sample areas for which spectral classes with suitable spectral statistics could not be developed were not used in GRS's image classification efforts. Overall, about 10% (50) of all the field training areas that were sampled were 2 acres (10 pixels) or smaller and more than 55% (255) of the field training areas were less than 6 acres (30 pixels). Areas this small most commonly occurred when training areas had to be developed for areas representing spectral classes or types that did not occur as large homogeneous areas, for areas that were not spectrally pre-qualified (opportunistic samples) as part of the candidate training area selection process, or for areas that were representative of very small or rare types that were sampled for the vegetation classification effort to represent the diversity of the vegetation in the park. Efforts were made to "train" all of these field sample areas and include as many of these small training areas in the image classification efforts as was possible without compromising the image classification efforts. Prequalification of field training areas does appear related to subsequent success in the development and use of the field sample area as a training class, as 97% of the prequalified GRS sites were successfully developed into training classes while only 8% of the opportunistically selected AS sample sites were successfully developed and used as training classes.

Table 4. Training area summary by usage, size, and source.

Source	Number Samples	Number Samples Used	% Areas Used	Average Size (Acres)	Number <2 Acres	% < 2 Acres	Number <6 Acres	% <6 Acres
GRS	433	420	97.0%	7.2	43	10.2%	231	55.0%
GRS_PI	23	19	82.6%	13.0	1	5.3%	5	26.3%
AS	279	23	8.2%	3.7	6	26.1%	19	82.6%
Totals	735	462	62.9%	7.3	50	10.8%	255	55.2%

Following the development of the training areas into spectral training classes, the training classes were portioned into eight different training data sets. Each training data set included training classes to be applied to the different ecotype regions present in the project area. While some training classes, like those representing different *Quercus garryana* stands, were only applied within one ecotype region, other classes like those representing different *Pseudotsuga menziesii*-*Lithocarpus densiflorus* or *Alnus rubra* stands were included in multiple training data sets.

3.2.3.3 Supervised Training Data Quality Control Review and Evaluation

The appropriateness of including a field training area as a training class in the spectral training data set was determined in two ways. One way involved a review of classification confusion reports that

described confusion between the training area or class signatures within each training data set. The second involved a review of the classification fidelity of each training area or class to determine if the weighted average vegetation/land-cover attributes of the pixels classified within each training area using the spectral training data set were comparable to the same land cover data descriptions (attributes) as the field site survey data descriptions that were acquired for each training area. If the weighted average attributes yielded results that indicated significant differences or data inconsistencies regarding a training class, then that specific class was reevaluated and the problem identified and resolved, if possible. Types of problems most readily identified using this approach were due to the improper location of the training area or the training site location (e.g. the spectral signature would be collected in the wrong area or the field ground-truth data were collected in the wrong location); excessively high spectral variances of a training class relative to other training classes; and spectral confusion between training classes representing very dissimilar land cover types. Typically, such problems can be resolved by either correcting the erroneous training class data causing the problem or applying masks to limit the application of the spectral training class data to certain portions of the project area.

Unfortunately, both of these evaluations are only useful in the determination of whether or not the spectral training classes that have been developed provide results that are consistent with other spectral training classes in the spectral training data set. Neither of these measures necessarily indicates whether or not the training classes are an accurate representation of the true vegetation/land cover conditions. For instance, if the vegetation/land cover attributes at a specific area are incorrectly identified, or assigned incorrect cover estimates, these incorrect cover data will only be identified as incorrect or inconsistent if there is at least one other training class with similar, slightly overlapping spectral statistics that indicate that there is an inconsistency between the vegetation/land cover characteristics that characterize these slightly overlapping (confused) spectrally similar training classes. As a result, training classes that have totally non-overlapping spectral data and virtually no replication in the training data set will tend to have very high pixel fidelity, but this apparent fidelity may be misleading, if the underlying “ground truth” are inaccurate or incorrect or the spectral statistics are not representative of the training area. Therefore, it is possible that training classes lacking confusion and exhibiting high self-classification may still result in incorrectly mapped vegetation types/land cover characteristics if the underlying field data or spectral data are wrong or inaccurately estimated. As a result, large spectral training data sets with multiple training classes representing somewhat similar vegetation/land cover classes are desirable, as they help confirm the validity of the different training classes as being spectrally representative of the different vegetation/land cover characteristics being classified (mapped).

3.2.3.4 Training Class Confusion Evaluation

Training classes were evaluated for spectral confusion in terms of their Jeffries-Matusita (J-M) distance, which is a reliable indicator of the distinctiveness of training classes (Swain and Davis 1978). A maximum J-M distance of 2.0 between two classes means that they are perfectly distinguishable from each other. A minimum J-M distance of 0.0 indicates that two classes are, as far as the classifier is concerned, spectrally undistinguishable from each other. In general, the probability of error in distinguishing two classes drops as their J-M distance increases. At a J-M distance of 1.4,

this probability of error is approximately 1%. Figure 5 shows the relationship of the J-M distance to the upper and lower limits of the probability of error.

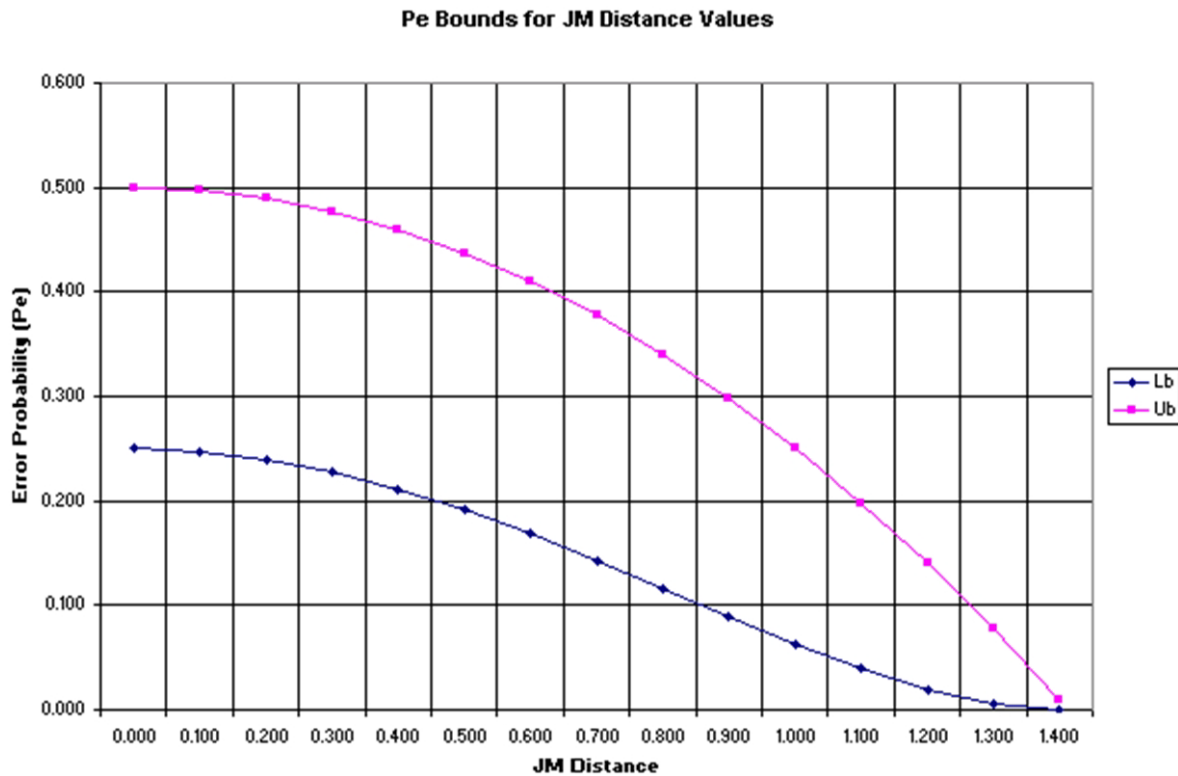


Figure 5. Probability of error and J-M Distance.

The Confusion Report used to evaluate training class confusion was generated for all training classes used in all of the training data sets. The target maximum J-M distance value for inclusion in the Confusion Report was set at a threshold of 1.5. Training sites related by J-M distance values below this threshold were included in the report and subsequently reviewed and evaluated by GRS.

Sample portions of the Confusion Report are shown in Figure 6. The data listed in this report are organized by individual training class and the confused training classes are listed in order of the GRS “calculated_class” value which represents the preliminary USNVC type call generated on the basis of each class’s species cover characteristics relative to the cover thresholds and definitions contained in the preliminary vegetation/land cover class key. For each training class, all potentially confused training sites are listed in order of the magnitude of the J-M distance separating the sites, along with the land cover characteristics of these potentially confused sites. The training set in which the confusion exists is also listed for each confused site. The training set name is based on a combination of the characteristics of the training set that distinguish it from other training sets, such as the ecotype region.

.....																			
Bad Confusion:																			
.....																			
Trsite_id:	90622		30	1032	802	Xra-Ss-Ld:tree		0	10	189	76	74	0	18	100	0	70	10	0
Training	Confused	J-M	Eco-	Iso	Cover	Calculated		Pct	Tree	Pct	Shr	Gram	Forb	Bar.	Oth				
Set	trsite_id	Dist	Type	Class	Type	Class		Cert	Size	Cover	Conifer	Cover	Cover	Cover	Cover	Cover	Aspect	Slope	Elev

4631jeSup3	70422	1.006	35	1032	101	Ss:tree/Vo:shrub		0	41	185	47	59	0	0	100	0	109	17	482
4631jeSup3	61822	1.135	30	1032	101	Ss:tree/Vo:shrub		0	40	182	72	82	0	0	100	0	14	9	1249
4631jeSup3	70113	1.169	30	1051	101	Ss:tree/Vo:shrub		0	30	121	23	99	0	0	100	0	105	9	1628
4631jeSup3	61901	1.289	30	1032	101	Ss:tree/Vo:shrub		0	37	154	74	79	0	0	100	0	160	22	701
4631jeSup3	70112	1.298	30	1032	101	Ss:tree/Vo:shrub		0	45	181	35	46	0	12	98	0	38	95	1784
4631jeSup3	61821	1.321	30	1032	101	Ss:tree/Vo:shrub		0	49	151	87	70	0	51	100	0	319	16	1259
4631jeSup3	90623	1.381	30	1051	803	Xra-Ss-Ld:tree		0	11	210	41	53	0	4	100	0	110	13	1440
.....																			
Good/Acceptable Confusion:																			
.....																			
Trsite_id:	70311		50	1031	6000	Ae-Ce:herb		0	0	0	0	0	66	40	100	0	245	12	2246
Training	Confused	J-M	Eco-	Iso	Cover	Calculated		Pct	Tree	Pct	Shr	Gram	Forb	Bar.	Oth				
Set	trsite_id	Dist	Type	Class	Type	Class		Cert	Size	Cover	Conifer	Cover	Cover	Cover	Cover	Cover	Aspect	Slope	Elev

Figure 6. Selected examples from the Redwood National and State Parks vegetation mapping confusion report.

The Confusion Report was reviewed to identify potentially confused training classes. Review involved identification of training classes confused with other training classes representing different vegetation/land cover characteristics, but was not based simply on qualitative type names or quantitative data limits, as there is tremendous potential overlap of fairly similar vegetation/land cover characteristics that may be named as different vegetation/land cover types due to the vegetation/land cover data being compared spanning one or more of the thresholds that define the vegetation/land cover types. In general, those classes that indicate significant differences are those that were not expected to be confused when one considered their descriptive species cover data (e.g. a high density forestland type with a wet herbaceous type).

Confusion between classes representing similar or equal vegetation land cover types or cover characteristics was considered as agreement of the different classes and therefore was acceptable confusion and confirmation of the validity of both their vegetation/land cover and spectral characteristics. This type of confusion was considered “good confusion,” as this sort of comparison confirmed that the overlapping spectral signatures would classify pixels of somewhat similar spectral and vegetation/land cover characteristics. Confusion or overlap of similar land cover types indicates that the supervised methodology is mapping “shades-of-gray.” The “good confusion” examples in Table 5 show how the confused training classes appear to be variants of the same basic vegetation/land cover type, rather than different dissimilar types; type names may vary slightly, as different classes may have levels of species composition that straddle rule thresholds and result in the assignment of slightly different type names. In these cases, any one of these “confused” types would likely still be a suitable representative class or type assigned to a confused pixel, as it would result in the assignment of very similar vegetation/land cover characteristics. In the case of the apparent confusion regarding the Mature Redwood Forest stands with different associated understory vegetation (*Polystichum munitum* (Pmu:herb) versus *Vaccinium ovatum* (Vo:shrub)), this confusion is somewhat expected, as the spectral values are based upon the visible canopy of the stands and the differences in understory are not likely making a significant spectral contribution through the tree crowns to be detected in the satellite imagery. On the other hand, confusion between vegetation/land cover classes of dissimilar or completely different land cover types or cover characteristics was considered undesirable or unacceptable confusion. This confusion represents “bad confusion,” as it indicates that the spectral training data set contains similar or overlapping spectral data for classes that have very dissimilar vegetation/land cover type characteristics on the ground. The example of “bad confusion” in Table 5 indicates a Xra-Ss-Ld:tree (*Pinus radiata* X *attenuata* YG Mixed Forest) site 90622 was confused with another class of the same type (site 90623), but was also confused with seven Mature Redwood Forest classes (Ss:tree/Vo:shrub) that were dominated by dense cover of large *Sequoia sempervirens*. These confused training sites represent different vegetation types and the mature redwood type classes are not a suitable replacement for the *Pinus radiata* X *attenuata* YG Mixed Forest class, if these classes are misapplied during classification efforts. In some cases this type of “bad confusion” can lead to the identification of situations for which the rules in the key are not working correctly. In other cases, such as this one, efforts must be undertaken to separate these training classes so they do not potentially result in misclassification of pixels during the image classification process.

The magnitude of the confusion, as indicated by the J-M distance, was also considered when evaluating confused training classes. J-M distance values greater than or equal to 1.3 were considered still viable for class separation, given a less than 10% chance of misclassification. In reality, class separation is still possible at lower J-M distances, but the probability of classification error is greater. In these cases, the nature of what classes were confused with each other became most important in evaluating the confusion. For the RNSP project area, if the confused classes were of fairly similar vegetation/land cover characteristics, GRS accepted the overlap of the spectral training class data, since the resulting classified pixel would likely still represent a similar vegetation/land cover type. However, if classes were sufficiently confused and the resulting vegetation/land cover type characteristics were too dissimilar, then the confused classes were reevaluated in attempt to resolve the confusion.

The first step in resolving the confusion was to check the location, shape, and size of the training areas involved in order to be certain that the spectral training data had been collected in the appropriate locations. If the training area polygons were correctly located and configured, then resolution required either removal of the badly confused class or segregation of the confused training classes into different training data sets that would be applied separately to the imagery during the classification process. The segregation of training class data into sets that were related to different ecotype regions is an example of how confusion between some of the different tree types could be resolved by limiting the application of the different training classes to the elevation zones in which these different vegetation/land cover types the classes represented were known to occur. The application of the ecotype mask that included a region representing where the *Pinus radiata* X *attenuata* YG Mixed Forest classes were known to exist limited and is an example of how training class data representing certain confused vegetation/land cover types could be segregated and applied only to specific portions of the project area.

After a complete review of the Confusion Report information there did not appear to be any significant confusion that could not be resolved through implementation of the ecotype region mask and segregation of the training data set in to multiple versions each reflecting the different ecotype regions that had been identified. This appears to resolve, as best as possible, the confusion that was apparent in the Confusion Report.

3.2.3.5 Classification Fidelity Report and Evaluation

An evaluation of how spectral confusion may affect the classification map output may also be determined by reviewing the classification fidelity data. All training classes were evaluated for classification fidelity. Each training class was processed to determine how well each individual training class' area was classified by comparing the land cover characteristics (attributes) of an area's classified pixels with the observed field characteristics (ground-truth) of the training site data collected to represent that training area. Classification fidelity is viewed in two ways. The first compares the number of pixels of the training area that were actually classed as that training class value to the total size of the training area. The second compares the land cover characteristics developed for the training area by summarizing the attributes of the classified pixels within each training area with the observed land cover characteristics of that training area. Confusion of spectral

signatures of different land cover types (“bad” confusion) will result in the infiltration of significantly different cover attributes into a training area’s polygon and cause significant changes of the calculated land cover attributes for the training area of a confused class. Confusion of type classes with similar attributes will result in infiltration of similar cover characteristics; this “good” confusion does not significantly change the land cover attributes calculated for the training area.

The Fidelity Report is used to evaluate classification fidelity. Using the DCMM approach many “shades-of-gray” are mapped representing many different types of vegetation/land cover. The Fidelity Report is to identify training classes in which the classification results of the training areas either match or do not match the ground truth representative of that same area. Areas that match exhibit classification fidelity. Training areas whose vegetation /land cover attributes do not match indicate classification problems, typically due to spectral confusion. Figure 7 shows a portion of the RNSP Fidelity Report. Formatted in a spreadsheet, this report shows fidelity data for different classes of the participating training data sets. The different training area vegetation/land cover attribute values shown in the report were developed by computing the weighted averages of the different classified pixels’ vegetation/land cover values for each training area. The Fidelity Report information and data includes the scene ID, training area ID, percent pure (self-classification), training area pixel count, calculated cover-type code, predominant cover component (species), and predominant component’s cover, as well as a break-down of the training area’s major lifeform cover composition. These estimated training area data were then compared to the ground truth vegetation/land cover information estimated for each training area to estimate the classification fidelity of each training class. Ground truth information included a generalized calculated field call based on the field data and the field-based cover components estimated for each area (also included in the table).

The following criteria were used to evaluate the pixel classification fidelity for each training area:

- **Self-Match** -- the level of self-classification (percent pure) of a training area – how many pixels of the training area were classified as that same class. The following percent self-classification limits were used to describe the degree of self-matching:

<u>Degree of Match</u>	<u>Self-Classification Limits</u>
Strong Match (M)	$\geq 75\%$
Near Match (mm)	$\geq 50\%$ and $< 75\%$
Slight Match (nn)	$\geq 25\%$ and $< 50\%$
Mis-Match (N)	$< 25\%$

- **Type-Match** -- the degree of matching vegetation/land cover class and component cover attributes for a training area based upon the application of its training class data.

- Area estimates that matched vegetation/land cover type classes and predominant species were considered a **Strong Match** (**M**).
- Area estimates that showed land cover class component values that differed from calculated values by no more than $\pm 10\%$ – these classes might not exactly match type class values, but still matched vegetation/land cover attributes and were also considered a **Strong Match** (**M**). These cases typically involved a comparison of cover values that are quite similar, but which may have spanned type or class thresholds or limits.
- Area estimates that nearly matched the general type values (missed a minor component) or matched the general type and contained no more than one vegetation/land cover type class component value that differed from calculated values by more than $\pm 25\%$ were considered a **Near Match** (**mm**) – these areas might not match class values in one category of vegetation/land cover, but still matched the general vegetation/land cover attributes.
- Area estimates that matched most of the general cover class attributes or contained attribute differences of more than $\pm 25\%$ cover in at least one cover component were considered a **Slight Match** (**nn**).
- Area estimates that did not match the general cover class attributes and contained individual attribute differences of more than $\pm 25\%$ in more than one cover component were considered a **Mis-Match** (**N**). These area estimates indicate that the attributes calculated based on the image classification are significantly different from the attribute identified during training field data collection efforts. The training areas needed further evaluation to determine if they could be used as training sites.

Training Data Set	trsite_id	Cover Type	Type Match	Self Match	%Self	# pixels Self	NVCS Association	Predominant Species	Pred Species % Cover	cover class	tree % cov	other veg cov	% conf cov	% hdwd cov	shr % cov	tsh % cov	lsh % cov	hrb % cov	aqu % cov	bar % cov	wat % cov	undf % cov
4631jeS3	61641	1101	M	nn	29.85%	20	Ss-Ld:tree	Doug-fir	60.7	4	165.4	66	79.4	20.6	42.4	0	0	23.6	0	98.9	0	0.2
TrainingCalc'd	61641	1102	M	nn			Ss-Ld:tree	Doug-fir	70.6	4	191.3	70.6	75.4	24.6	70.6	0	0	0	0	99.9	0	0
	61641						Basically Same				25.9				28.2			23.6				
4631jeS3	61642	3200	mm	mm	50.79%	64	OtB-Ld:tree	Tanoak	65.5	4	163.5	76.2	42.4	57.6	72.2	0	0	4	0	96.6	0	0.5
TrainingCalc'd	61642	3200	mm	mm			OtB-Pm:tree	Doug-fir	58.3	4	169.1	103.1	41	59	103.1	0	0	0	0	100.1	0	0
	61642						No majority species	CheckType							30.9							
	61642						Threshold - Alt															
4631jeS3	61651	2402	M	M	85.19%	23	Ld-Ss:tree	Tanoak	139.9	4	185.4	55.6	20.6	79.4	53.3	0	0	2.3	0	99.9	0	0.6
TrainingCalc'd	61651	3100	M	M			Ld-Oth:tree	Tanoak	150.7	4	186	53.4	16.8	83.2	52	0	0	1.4	0	100	0	0.7
	61651						Ss% from 4 -> 5.2	CheckType														
	61651						Threshold - Alt															
4631jeS3	61652	2401	M	mm	61.82%	34	Ld-Ss:tree	Tanoak	89	4	151.9	67.9	34.3	65.7	64.6	0	0	3.3	0	97.9	0	0.2
TrainingCalc'd	61652	2402	M	mm			Ld-Ss-Oth:tree	Tanoak	101	4	153	59	29.4	70.6	59	0	0	0	0	100	0	0
	61652						Missing components ...	CheckType														
	61652						Basically Same															
4631jeS2	61701	1500	M	M	96.15%	25	Pm-Ar:tree	Doug-fir	38.5	2	52.5	165.5	75.7	24.3	44.2	0	0	121.4	0	3.8	0	0
TrainingCalc'd	61701	1500	M	M			Pm-Ar:tree	Doug-fir	40	2	52	114	76.9	23.1	45	0	0	69	0	0	0	0
	61701																	52.4				
4631jeS3	61702	101	M	N	20.00%	21	Ss:tree/Vo:shrub	Redwood	78.7	4	148.9	126.2	77.8	22.2	60.6	0	0	65.5	0	98.2	0	0
TrainingCalc'd	61702	101	M	N			Ss:tree/Vo:shrub	Redwood	93	4	145	115	75.2	24.8	100	0	0	15	0	100	0	0
	61702														39.4			50.5				
4631jeS3	61711	1602	M	nn	44.04%	48	Ss-Pm:tree	Doug-fir	62	4	142.5	56.2	84.4	15.6	24.1	0	0	32.1	0	99.8	0	0.1
TrainingCalc'd	61711	1602	M	nn			Ss-Pm:tree	Doug-fir	62	4	133	35	88	12	18	0	0	17	0	100	0	0
	61711																	15.1				
4631jeS3	61712	1101	mm	nn	41.96%	47	Ss-Ld:tree	Doug-fir	56.1	4	138.2	60.6	81.6	18.4	21.9	0	0	38.7	0	99.6	0	0.2
TrainingCalc'd	61712	1602	mm	nn			Ss-Pm:tree	Redwood	54	4	122	30	80.3	19.7	8	0	0	22	0	100	0	0
	61712						Ld% from 24 -> 26%	CheckType			16.2				13.9			16.7				
	61712						Threshold - Alt															
4631jeS3	61713	1101	M	nn	27.37%	26	Ss-Ld:tree	Doug-fir	58.1	4	153.5	66.6	80.3	19.7	32.7	0	0	33.9	0	99.1	0	0.2
TrainingCalc'd	61713	1101	M	nn			Ss-Ld:tree	Doug-fir	62	4	138	68	72.5	27.5	30	0	0	38	0	100	0	0
	61713										15.5											
4631jeS2	61721	9900	M	M	100.00%	12	BarS:other	Bare Rock	95	12	0	6	0	0	3	0	0	3	0	95	0	0
4631jeS3	61721	9900	M	M	100.00%	12	BarS:other	Bare Rock	95	12	0	6	0	0	3	0	0	3	0	95	0	0
TrainingCalc'd	61721	9900	M	M			BarS:other	Bare Rock	95	12	0	5	0	0	3	0	0	2	0	95	0	0
	61721																					
4631jeS2	61722	4300	M	M	82.93%	34	Ra:shrub	Rubus Armeniac	84.2	6	0	101.3	0	0	90.8	0	0	10.5	0	9.6	0	0
4631jeS3	61722	4300	M	M	95.24%	40	Ra:shrub	Rubus Armeniac	89.5	6	0	101.9	0	0	94.9	0	0	7	0	0	0	0
TrainingCalc'd	61722	4300	M	M			Ra:shrub	Rubus Armenia	94	6	0	100	0	0	97	0	0	3	0	0	0	0

Figure 7. Portion of the fidelity report.

Figure 8 illustrates examples of Self-classification and Type Matches for two training classes shown in Table 6. The first example is the training class for training area 61722 in spectral training data set 4631jeS3. This training class has been assigned Self-classification and Type Match values of **M** because it is 95.24% self-classifying and the vegetation/land cover attributes and type of the training area match those found at training site 61722. This level of self-classification can be seen in Figure 8 in which 40 of the 42 pixels wholly contained within the training area boundary are the green colored pixels that represent training class 61722. Two pixels of one other pixel class (black) were assigned by the classification algorithm within this training area.

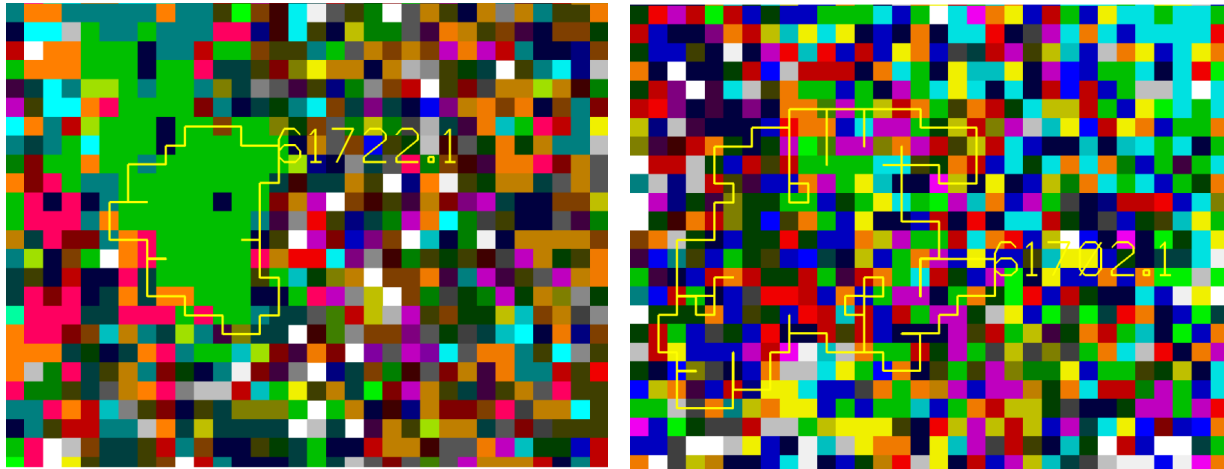


Figure 8. Examples of training area classification results.

On the other hand, in the training area for class 71702, (105 pixels) is assigned a match value of **N** for the Self-classification Match, as only 21 pixels (20%) are classified as the dark blue class 61702 while the other 84 pixels (80%) within this training area's boundaries are assigned other training class values. Since between 0 and 25% of the classified pixels match the training class number, this training class is assigned a "Mis-Match" value. However, this class is assigned a Type Match value of **M** because the weighted average vegetation/land cover attribute values and estimated USNVC type assignment based on the 21 class 61702 pixels and the other 84 similar "shades-of-gray" pixel classes assigned by the classification algorithm basically match the USNVC type and ground truth values estimated for that training area within the specified $\pm 10\%$ cover tolerances.

Some Type Match comparisons concerned comparison of values that are similar for most attributes, but not all of them, sometimes resulting in one different minor USNVC type component value. This sometimes happened when the field attributes and weighted averages spanned the threshold of an USNVC class name decision rule. In this evaluation general type match comparisons were sensitive to the type rules (thresholds), which included individual species components. Species thresholds often represented a fixed amount of cover and some type of relative dominance, such as the species cover was the majority of the cover present or the species was the most abundant in terms of cover. The manner in which some species cover estimates were slightly different from the ground-truth values resulting in the assignment of different USNVC types had to be considered during the fidelity

evaluation. Type differences are annotated in the Fidelity Report by the “**CheckType**” message in the Predominant Species column. This indicates a difference in USNVC Association or predominant species has occurred. When evaluating the training class for training area 61651 the “**CheckType**” message is present as the estimated USNVC type Ld-Ss:tree does not agree with the observed Ld-Oth:tree. While this might suggest initially that there is a slight mismatch of the type for this site, further review indicates that none of the cover by major lifeform features differ by more than 10% cover. Upon looking at the species-specific cover estimates in the report, it is apparent that the change is due to an increase in redwood cover from 4% to 5.2%. This minor increase of 1.2% cover results in a different USNVC type because the threshold for including redwood as a component in the USNVC type is set at 5%. The change from 4 to 5.2% crosses this rule threshold resulting in a different type name while the estimated cover by species is still very similar to the ground-truth values. For the purposes of this evaluation these cover estimates are comparable and this class is considered a **Strong Match** (**M**) during the fidelity evaluation. The same sort of situation also occurs when evaluating training area 61712. This training area’s estimated USNVC type name includes the “-Ld” designation instead of the “-Pm” designation because upon review of the detailed cover reports we find that the estimated cover of tanoak has increased from 24% to 26%, a level that is now higher than the rule threshold of 25% that determines whether tanoak will be included in the USNVC type name. This is such a small difference that this training class is also a Strong Match. One last example concerns training area 61642. In this case this is a predominantly hardwood stand and no tree species is present that provides the majority of the tree cover and the USNVC type falls into a “Montane Hardwood Forest” type. A review of the detailed cover reports indicate that the estimated cover values indicate a shift the species with the most cover from Douglas-fir (“-Pm”) to tanoak (“-Ld”). Douglas-fir declined from 58.3% cover to 53.5% while tanoak increased from 46.9% to 65.4%. This shift in cover that results in a change in a component of the USNVC type name represents more than a 10% difference and so the fidelity of this training class is only considered as a **Near Match** (**mm**).

In summary, training classes that met the first two type-match criteria for similarity (matching type class names and predominant features and/or $\leq 10\%$ cover difference) of the major type characteristics were considered strong type matches (**M**); sites showing class and attribute values that differed by more than 10 percent lifeform cover but less than 25 percent were considered as a Near Match (**mm**); sites of mostly similar class attributes that differed by more than 25 percent lifeform cover were considered a Slight Match (**nn**); and sites were deemed a Mis-Match (**N**) and unacceptable for the classification process if most of the lifeform cover and class attributes did not match. These mismatched sites (**N**) typically confirmed confusion of the subject class with another class. As mentioned previously, this apparent confusion was addressed by reviewing the aforementioned J-M Distance Confusion Report, assessing which sites contributed to the apparent confusion, and resolving or removing the truly confused (“bad”) training sites from the same spectral training data set, thereby avoiding the inclusion of confused training data in the image classification efforts.

Both types of matches were determined for each training class of the spectral training data set(s). Each separate line in the report describes the fidelity results of a training class within a training data

set. The degree of Self-Match was developed for each class based on the percent self-classification. In addition, a degree of Self-Match was determined for the site as a whole, based on the average of the percent self-classification values by training data set. As the sensitivity of the type call to the extremely low levels of species components was identified during fidelity testing, alternate type calls sensitive to the low critical species thresholds were developed in some cases when the cover values were very close to the decision rule thresholds. If the USNVC field call matched either the calculated type call or the alternate type call, a Strong Match (**M**) was assigned, as the cover data were basically the same, but were situated close to the rule threshold, but on opposite sides of that threshold.

Table 5 lists the summary of the “Match” Results based on the evaluation of all of the Fidelity Report training areas, for both Self-Matches and computed Type Matches.

Table 5. Fidelity test match results.

Match	Self-Test		Computed Type	
	#	%	#	%
M	255	55.2%	394	85.3%
mm	127	27.5%	65	14.1%
nn	60	13.0%	3	0.6%
N	20	4.3%	0	0.0%
Totals	462	100.0%	462	100.0%

Fidelity test results showed that the calculated type calls and attributes (Type Match) show a Strong Match (**M**) to the field data for 394 training areas or about 85% of the 462 training classification areas. 65 of the remaining 68 areas demonstrate a Near Match (**mm**) of the field data call and attributes, with many of these minor differences being due to the addition or exclusion of a minor species component in the calculated USNVC type call. These Near Matches appear to result largely due to the sensitivity of the type threshold rules to the different key species cover estimates and cases when small but > 10% cover differences result in slightly different USNVC type assignments. Such occurrences may be a manifestation of some of the difficulty in using image classification processes to consistently distinguish relatively low species-specific cover differences, like 10-15% cover, relative to the variances typically associated with spectral training data of this nature that also vary due to other factors such as canopy/crown size and canopy structure. The remaining 3 areas, or 0.6% of all areas were judged to have Slight Matches (**nn**) of the calculated type; all of these situations involved apparent confusion between areas designated as one of the *Pinus* species types and having Knobcone pine (*Pinus attenuata*) as the major pine species. In each case the estimated cover of Knobcone pine and the Douglas-fir and tanoak species also present shifted by between 3 and 20%, but these relatively minor shifts resulted in USNVC type changes. The Pine type rules in the key require that the major pine species be both the dominant (majority) conifer and the tree species having the most individual tree cover. The shifts in estimated cover for these three areas resulted in slightly different orders of cover dominance and corresponding

differences in USNVC type assignments. While these differences are not considered major type differences, they do indicate a possible need to revisit the Pine type rules in the key and determine if there are better ways to assign Pine types that result in a more consistent application of the rules. Rules of this nature based upon indicator species that also require some form of dominance of those indicator species, as either the majority of the cover (conifer, hardwood, or total) or the most frequently occurring species, may cause problems when used to assign types to multi-species mixed stands of this nature, due to the restrictive requirements that must be met. No areas indicated a Mis-Match (N) of type or cover attributes.

3.2.4 Supervised Training Set Development Results

735 field training areas that were surveyed during the 2008-09 field seasons or interpreted from aerial photography were included in the development of the initial spectral training data sets developed for this project. While land cover characteristics for all of these areas were developed based on field sample site data or photo-interpretive estimates, not all of these areas could be used as training areas in the final spectral training data sets used to generate the RNSP classification maps. After training data set development efforts and review of the confusion and classification fidelity reports GRS was able to develop statistically valid training classes for 462 of these 735 areas, or about 63% of the field training areas. The majority of areas that were rejected were opportunistically sampled and were simply too small in size to generate a valid training class or they lacked satisfactory spectral statistics (variances) to avoid causing classification problems due to confusion with other sites representing different land cover characteristics. The resulting image training set comprised of the 462 training classes was then partitioned into 8 subsets, each containing training classes that represented different vegetation/land cover features that were known to occur (based on the field data set) in different ecotype regions of the park.

3.2.5 Image Classification

GRS typically applies a hybrid classification methodology that uses both supervised and unsupervised techniques. Multiple pixel classification maps (class maps) are developed using a maximum-likelihood classifier using both supervised and unsupervised training sets with statistical thresholds of 90, 95, and 99%. The resulting supervised class maps are used to provide the foundation of the final class map, while the unsupervised class maps are used to fill in VOID pixels in the supervised class maps (all pixels are not classified when a statistical threshold less than 100% is used to perform the classification).

Supervised classifications efforts were performed on the July TM5 image (4631j) using bands 1, 2, 3, 4, 5, and 7 and the maximum-likelihood classifier. 18 different classification maps were developed for this image using the 8 supervised ecotype region training subsets at statistical thresholds of 90, 95, and 99%. The 95 and 99% pixel class maps were then merged into one class map to produce a comprehensive supervised classification map for each statistical threshold for each image or subset area. These raw classification grids were standardized to a common set of training class values by means of class lookup tables that matched each raw-grid value to its particular class id through each class' unique *gridval* value. This was achieved using custom GRS grid reclassification processing software. *Gridval* values that are less than 25,000 represent classes generated using the 95%

threshold, whereas *gridval* values between 26,001 and 50,000 represent classes generated using the 99% threshold. Just over 92% of the project area was classified as one of supervised classes; 81.5% of the area was covered by the 95% classification results and an additional 10.5% of the project area was added when the 99% classification results were merged into the 95% classification results.

The remaining VOID pixels in the classification map would be estimated using the 95 and 99% ISODATA classification maps that were developed during the initial stages of this project that were used to develop the candidate area stratification maps. Each of these maps contained 87 spectral classes across the entire project area. Both of these maps were overlaid with the ecotype region maps and the ecotype region values were assigned to isoclass values to develop sets of isoclass values specific to each ecotype region. All of these unique classes were assigned unique *gridval* values that represented the ecotype region, isoclass, and classification threshold. *Gridval* values for the 95% ISODATA classification ranged from 51101 to 52887 while *gridval* values for the 99% ISODATA classification ranged from 56101 to 57887. The 95% and 99% ISODATA classification maps were then merged into the merged supervised classification results. The 95% threshold ISODATA pixels provided coverage of an additional 5.5% of the project area while the 99% threshold ISODATA pixels provided coverage of an additional 2.1% of the project area. Following the merging of all 95 and 99% supervised and unsupervised pixels class maps 99.6% of the project area was classified leaving 0.4% or about 562 acres of unclassified or VOID pixels scattered throughout the project area.

3.2.6 Isodata Class Attribution

While the supervised classes have vegetation/landscape feature cover attributes that are represented by the ground truth field data collected at each field site, the unsupervised isoclass pixels have no such corresponding field data attributes; these attributes must be generated for each unique isoclass.

Development of isoclass attributes was accomplished by overlaying the 95% threshold ISODATA class map with the 90% threshold DCCM maximum-likelihood classification map. The overlay process resulted in an isoclass frequency distribution that enumerates the different supervised class values (*gridval*) that are associated (share the same location) with each unique isoclass. For each isoclass, GRS then developed species-specific cover estimates and USNVC Associations/Alliance type names by calculating the weighted average of the different vegetation/land cover characteristics based on the *gridval* frequency data developed for each of the isoclasses. Isoclass cover and type attributes were then individually reviewed class by class relative to the NAIP imagery and supervised classification map data to identify and correct any anomalous situations or data. After completion of this review and the correction or modification of anomalous attributes the resulting vegetation/ land cover attribute information was used to represent the different isoclasses merged into the final pixel classification map.

3.2.7 Pixel Modeling and Burning

Pixel modeling is sometimes implemented as a post classification process to resolve issues that may have occurred during classification efforts. An example of a modeling process is the identification of “terrain shadows” and removal of “water” pixels from very steep shaded dark slopes that have been classified as “water”. Pixel burning is used to alter pixel values to represent a new or different value. An example of pixel burning is when a map of water bodies is burned into the pixel classification

map to guarantee that all pixels in the water bodies will be shown as “water” types in the pixel classification map.

No pixel modeling efforts were implemented during this project. However, pixel burning was implemented to provide direction during the polygon map data set development efforts. Several features were burned into the pixel classification map in order to make them more clearly defined. These features represented three main types, none of which represent a significant vegetation type. Some “water” pixels were burned into the map. These were pixels in both the Smith River and Redwood Creek channels that by being changed to “water” would likely result in these water features appearing as contiguous features uninterrupted by other vegetation/landscape features associated with the gravel bars and other possible vegetation/land cover types that occurred within the river channels. The often narrow river channels and spectrally mixed pixels along the river channels resulted in a very heterogeneous pixel classification of many different and sometimes odd types that often interrupted the water channel. To provide definition to the river channels the pixels under a no-width line digitized on the Landsat and NAIP imagery to represent the center of the water channel in each river channel were changed to “water” type pixels. Some “barren” pixels were burned into the pixel classification map. These were pixels that were located along the centerlines digitized to represent the “barren” portions of the right-of-way of Highway 101 south of the Klamath River. Lastly, some miscellaneous “other herbaceous graminoid” type pixels were burned into the pixel classification map to represent some of areas of decommissioned roads. The pixels in these areas were extremely heterogeneous and represented a wide variety of types due to the spectral mixtures that occurred in these atypical areas. Centerlines of these areas were digitized using the Landsat and NAIP imagery as backdrops and pixels falling under these centerlines were changed to the “other herbaceous graminoid” type pixel.

3.3 Discrete Classification Pixel Mapping Results

While the image stratification of the project area for the purposes of the field sampling efforts included a 1-mile wide buffer around the Park, image classification results were only reported within the Park boundaries. Many of the lands immediately adjacent to the Park are either USFS or forest industry lands that represent managed lands that are significantly different from the RNSP lands. While some of the vegetation/land cover types sampled in the 1-mile buffer area were used to map RNSP lands, inclusion of these managed lands in the final map data set would have dramatically increased the diversity of land cover/vegetation types present in the image classification results and the image classification map data set. Consequently, the buffer area was not included in the resulting RNSP DCMM map data set.

The results of the merged pixel classification process represented by the grid coverage rns4631jm are shown in Figure 9 and Table 6. Figure 9 represents a portion of the pixel classification map in the Bald Hills and Redwood Creek vicinities. Table 6 represents the distribution of the area mapped by Generalized and Detailed USNVC Associations and Alliances. The rns4631jm raster data set included 707,795 pixels representing 57,490.6 hectares or 142,062.3 acres. This pixel classification map was extremely heterogeneous in spite of the fact that mature redwood stands dominated almost 30% of the park lands. A total of **339,327** unique contiguous (non-diagonal) groups of pixel types

were identified resulting in an average class map stand area (contiguous group of the same USNVC type pixels) of **0.17** hectares or **0.42** acres. This average is well below the minimum mapping unit size of 0.5 hectares or about 1.2 acres. Nearly **94%** of the park was mapped as one of the vegetation types whereas approximately **6%** of the park was mapped as one of the non-vegetated types. The predominant vegetation lifeform present in the park is forestlands, as nearly ninety percent of the park was classified as one of the forestland types.

89.2% of the park or 126,796 acres of the park were classified into Tree type classes. Approximately **75%** of the park was mapped as a coniferous forestland alliance and **12%** of the park was mapped as a hardwood forestland alliance. **0.9%**, or 1,322 acres were classified as Shrubland alliances, **3.7%** or 5,294 acres were classified as Herbaceous alliance pixels, **1.4%** or 2,053 acres were classified as Barren type pixels, **4.2%** or 6,035 acres were classified as Water, and **0.4%** or 562 acres was not classified and left as Unknown type pixels.

The forestland acres were mapped into 11 conifer alliances representing 33 conifer associations, 7 hardwood alliances representing 13 hardwood associations, and one mixed conifer-hardwood alliance representing one mixed conifer-hardwood association. The two most prominent tree alliances classified were the *Sequoia sempervirens*-(Other) Young Growth Forest (50,103 acres or 35.3% of the parklands) and the *Sequoia sempervirens* Mature Forest (42,268 acres or 29.8% of the park lands). The two major hardwood alliances classified were the *Alnus rubra*-(Other) Forest (7,071

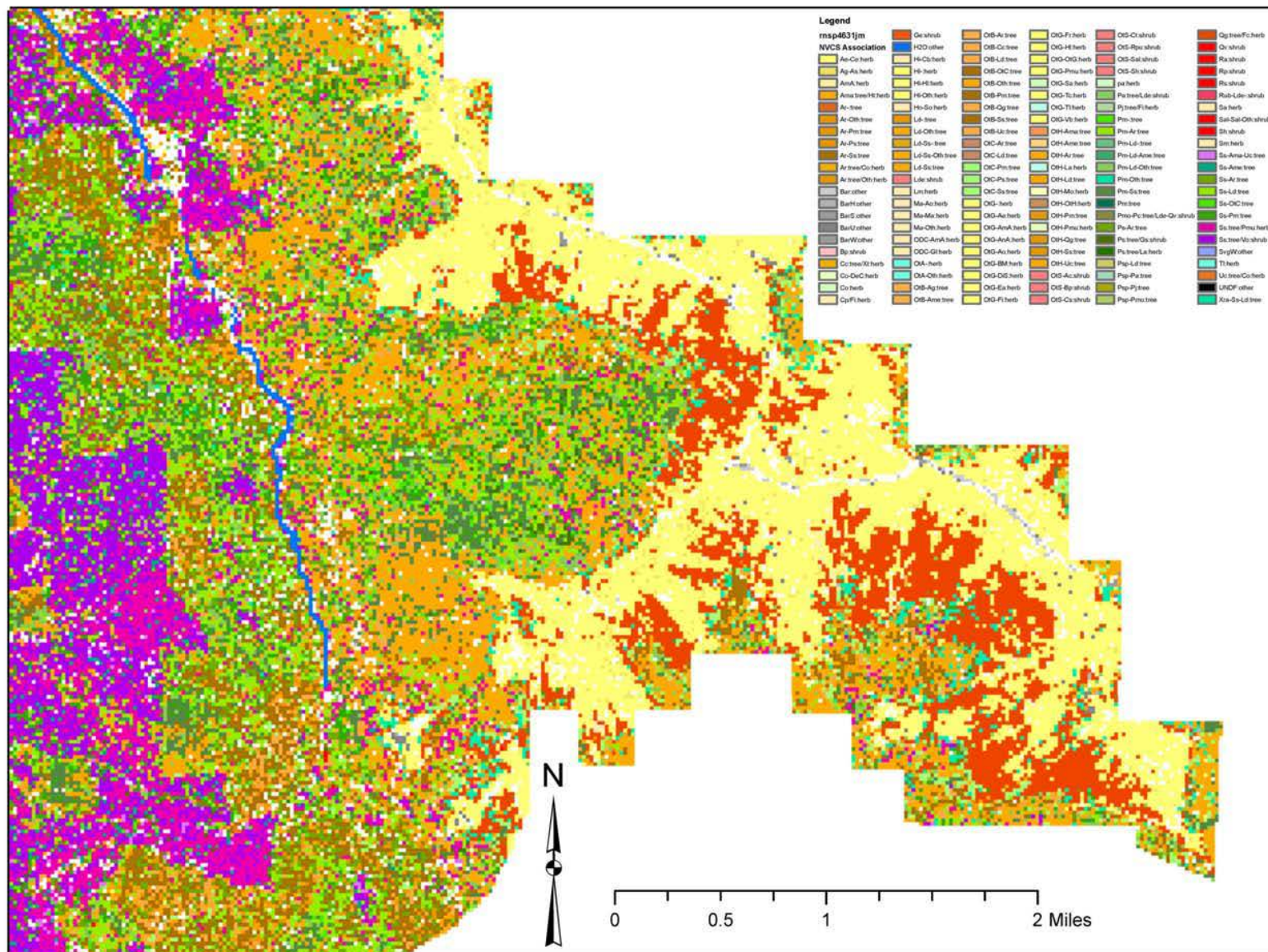


Table 6. Image classification pixel map (msp4631jm) - area summary by generalized alliance and association.

Generalized Alliance	Pixels	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Pixels	Acres	Hectares	% Total	Cumulative %
<i>Sequoia sempervirens</i> Mature Forest	210,593	42,268.4	17,105.4	29.8%	29.75%	Ss:tree/Pmu:herb	104,216	20,917.3	8,464.9	14.7%	14.72%
						Ss:tree/Vo:shrub	83,510	16,761.4	6,783.1	11.8%	26.52%
						Ss-Ama-Uc:tree	17,991	3,611.0	1,461.3	2.5%	29.06%
						Ss-Ame:tree	4,876	978.7	396.1	0.7%	29.75%
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	249,626	50,102.7	20,275.9	35.3%	65.02%	Ss-Ld:tree	65,491	13,144.8	5,319.5	9.3%	39.01%
						Ss-Ar:tree	17,433	3,499.0	1,416.0	2.5%	41.47%
						Ss-Pm:tree	43,250	8,680.8	3,513.0	6.1%	47.58%
						Ss-OtC:tree	16,628	3,337.4	1,350.6	2.3%	49.93%
						Pm-Ss:tree	48,249	9,684.1	3,919.0	6.8%	56.75%
						Ar-Ss:tree	27,516	5,522.8	2,235.0	3.9%	60.63%
						Ld-Ss:tree	10,078	2,022.8	818.6	1.4%	62.06%
						Ld-Ss-Oth:tree	15,510	3,113.0	1,259.8	2.2%	64.25%
						OtC-Ss:tree	5,471	1,098.1	444.4	0.8%	65.02%
<i>Picea sitchensis</i> -(Other) YG Mixed Forest	19,183	3,850.2	1,558.1	2.7%	67.73%	Ps:tree/Gs:shrub	7,354	1,476.0	597.3	1.0%	66.06%
						Ps-Ar:tree	5,222	1,048.1	424.2	0.7%	66.80%
						Ar-Ps:tree	4,144	831.7	336.6	0.6%	67.38%
						OtC-Ps:tree	2,463	494.4	200.1	0.3%	67.73%
<i>Picea sitchensis</i> Saturated Forest	992	199.1	80.6	0.1%	67.87%	Ps:tree/La:herb	992	199.1	80.6	0.1%	67.87%
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	6,843	1,373.5	555.8	1.0%	68.84%	Pm:tree	484	97.1	39.3	0.1%	67.94%
						Pm-Oth:tree	4,097	822.3	332.8	0.6%	68.52%
						Pm-Ar:tree	1,085	217.8	88.1	0.2%	68.67%
						Ar-Pm:tree	48	9.6	3.9	0.0%	68.68%
						OtC-Pm:tree	1,129	226.6	91.7	0.2%	68.84%
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG Mixed Forest	39,996	8,027.6	3,248.7	5.7%	74.49%	Pm-Ld-Ame:tree	1,510	303.1	122.6	0.2%	69.05%
						Pm-Ld-Oth:tree	38,486	7,724.6	3,126.0	5.4%	74.49%
<i>Pinus attenuata</i> Forest	2,200	441.6	178.7	0.3%	74.80%	Pa:tree/Lde:shrub	2,179	437.3	177.0	0.3%	74.80%
						Psp-Pa:tree	21	4.2	1.7	0.0%	74.80%
<i>Pinus jeffreyi</i> Forest	1,194	239.6	97.0	0.2%	74.97%	Pj:tree/Fi:herb	1,194	239.6	97.0	0.2%	74.97%
						Psp-Pj:tree	-	-	-	0.0%	74.97%
<i>Pinus monticola</i> Forest	1,895	380.3	153.9	0.3%	75.24%	Pmo-Pc:tree/Lde-Qv:shrub	1,777	356.7	144.3	0.3%	75.22%
						Psp-Pmo:tree	118	23.7	9.6	0.0%	75.23%
<i>Pinus radiata</i> × <i>attenuata</i> Forest	457	91.7	37.1	0.0%	75.30%	Xra-Ss-Ld:tree	330	66.2	26.8	0.0%	75.28%
						Psp-Ld:tree	127	25.5	10.3	0.0%	75.30%
Totals Conifer Forest	532,979	106,974.8	43,291.2	75.3%	75.30%	Totals Conifer Forest	532,979	106,974.8	43,291.2	75.3%	75.30%
Montane Conifer-Hardwood Mixed Forest	17,438	3,500.0	1,416.4	2.5%	77.77%	ItC-OtB/XX:tree	17,438	3,500.0	1,416.4	2.5%	77.76%
Montane Hardwood Mixed Forest	4,868	977.1	395.4	0.7%	78.45%	OtB-Mix:tree	4,868	977.1	395.4	0.7%	78.45%
<i>Acer macrophyllum</i> Forest	2,070	415.5	168.1	0.3%	78.75%	Ama:tree/Ht:herb	2,070	415.5	168.1	0.3%	78.74%
<i>Alnus rubra</i> -(Other) Forest	35,229	7,070.9	2,861.5	5.0%	83.72%	Ar:tree/Co:herb	686	137.7	55.7	0.1%	78.84%
						Ar:tree/Oth:herb	13,163	2,642.0	1,069.2	1.9%	80.70%
						Ar-Oth:tree	6,101	1,224.5	495.6	0.9%	81.56%
						OtB-Ar:tree	15,279	3,066.7	1,241.0	2.2%	83.72%
<i>Chrysolepis chrysophylla</i> Forest	80	16.1	6.5	0.0%	83.73%	Cc:tree/Xt:herb	80	16.1	6.5	0.0%	83.73%
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	33,773	6,778.6	2,743.2	4.8%	88.51%	Ld-Oth:tree	24,123	4,841.8	1,959.4	3.4%	87.14%
						OtB-Ld:tree	9,650	1,936.9	783.8	1.4%	88.50%

Table 6. Image classification pixel map (msp4631jm) - area summary by generalized alliance and association (continued).

Generalized Alliance	Pixels	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Pixels	Acres	Hectares	% Total	Cumulative %
<i>Quercus garryana</i> Forest	4,742	951.8	385.2	0.7%	89.18%	Qg:tree/Fc:herb OtB-QG:tree	4,721 21	947.6 4.2	383.5 1.7	0.7% 0.7%	89.17% 89.17%
<i>Umbellularia californica</i> Forest	559	112.2	45.4	0.1%	89.25%	Uc:tree/Co:herb OtB-Uc:tree	558 1	112.0 0.2	45.3 0.1	0.1% 0.0%	89.25% 89.25%
Totals Hardwood Forest	81,321	16322.0	6,605.3	11.5%	89.25%	Totals Hardwood Forest	81,321	16322.0	6,605.3	11.5%	89.25%
<i>Baccharis pilularis</i> Shrubland	1,148	230.4	93.2	0.2%	89.42%	Bp:shrub Oth-Bp:shrub	930 218	186.7 43.8	75.5 17.7	0.1% 0.0%	89.38% 89.41%
<i>Garrya elliptica</i> Shrubland	115	23.1	9.3	0.0%	89.43%	Ge:shrub	115	23.1	9.3	0.0%	89.43%
<i>Lithocarpus densiflorus</i> Shrubland	1,773	355.9	144.0	0.3%	89.68%	Lde:shrub	1,773	355.9	144.0	0.3%	89.68%
<i>Quercus vaccinifolia</i> Shrubland	595	119.4	48.3	0.1%	89.77%	Qv:shrub	595	119.4	48.3	0.1%	89.76%
<i>Rubus</i> Shrubland	2,050	411.5	166.5	0.3%	90.06%	Ra:shrub Rp:shrub Rs:shrub	700 419 931	140.5 84.1 186.9	56.9 34.0 75.6	0.1% 0.1% 0.1%	89.86% 89.92% 90.05%
<i>Salix</i> Shrubland	362	72.7	29.4	0.1%	90.11%	Sh:shrub Sal-Sal-Oth:shrub OtS-Sal:shrub	240 83 39	48.2 16.7 7.8	19.5 6.7 3.2	0.0% 0.0% 0.0%	90.09% 90.10% 90.11%
Other Mixed Shrubland	542	108.8	44.0	0.1%	90.18%	OtS-Cs:shrub OtS-Ct:shrub OtS-Rpu:shrub OtS-Sh:shrub	15 77 415 35	3.0 15.5 83.3 7.0	1.2 6.3 33.7 2.8	0.0% 0.0% 0.1% 0.0%	90.11% 90.12% 90.18% 90.18%
Totals Shrublands	6,585	1,321.7	534.9	0.9%	90.18%	Totals Shrublands	6,585	1,321.7	534.9	0.9%	90.18%
<i>Ammophila arenaria</i> Grassland	599	120.2	48.7	0.1%	90.27%	Am:herb	599	120.2	48.7	0.1%	90.27%
<i>Leymus mollis</i> Grassland	151	30.3	12.3	0.0%	90.29%	Lm:herb	151	30.3	12.3	0.0%	90.29%
Other Dune Herbaceous	1,471	295.2	119.5	0.2%	90.50%	ODC:herb	1,471	295.2	119.5	0.2%	90.50%
<i>Agrostis gigantea</i> - <i>Agrostis stolonifera</i> Grassland	961	192.9	78.1	0.1%	90.63%	Ag-As:herb	961	192.9	78.1	0.1%	90.63%
<i>Arrhenatherum elatius</i> - <i>Cynosurus echinatus</i> Grassland	8,714	1,749.0	707.8	1.2%	91.86%	Ae-Ce:herb	8,714	1,749.0	707.8	1.2%	91.86%
<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland	2,344	470.5	190.4	0.3%	92.19%	Co-DeC:herb	2,344	470.5	190.4	0.3%	92.19%
<i>Festuca idahoensis</i> Grassland	249	50.0	20.2	0.0%	92.23%	Cp/Fi:herb	249	50.0	20.2	0.0%	92.23%
<i>Holcus lanatus</i> - <i>Anthoxanthum odoratum</i> Grassland	3,633	729.2	295.1	0.5%	92.75%	HI-HI:herb HI-Oth:herb	1,692 1,941	339.6 389.6	137.4 157.7	0.2% 0.3%	92.47% 92.74%
<i>Heterotheca oregona</i> Herbaceous	725	145.5	58.9	0.1%	92.84%	Ho-So:herb	725	145.5	58.9	0.1%	92.84%
<i>Hirschfeldia incana</i> Herbaceous	7	1.4	0.6	0.0%	92.85%	Hi-Cb:herb	7	1.4	0.6	0.0%	92.85%
Other Riverine Herbaceous	326	65.4	26.5	0.0%	92.89%	Ma-Oth:herb	326	65.4	26.5	0.0%	92.89%
<i>Carex obnupta</i> Herbaceous	216	43.4	17.5	0.0%	92.92%	Co:herb	216	43.4	17.5	0.0%	92.92%
<i>Phalaris arundinacea</i> Herbaceous	223	44.8	18.1	0.0%	92.95%	Pa:herb	223	44.8	18.1	0.0%	92.95%
<i>Scirpus microcarpus</i> Herbaceous	133	26.7	10.8	0.0%	92.97%	Sm:herb	133	26.7	10.8	0.0%	92.97%
<i>Sparganium (angustifolium)</i> Herbaceous	67	13.4	5.4	0.0%	92.98%	Sa:herb	67	13.4	5.4	0.0%	92.98%
<i>Typha latifolia</i> Herbaceous	140	28.1	11.4	0.0%	93.00%	Tl:herb	140	28.1	11.4	0.0%	93.00%
Other Aquatic Herbaceous	122	24.5	9.9	0.0%	93.02%	OtA-Oth:herb	122	24.5	9.9	0.0%	93.02%

Table 6. Image classification pixel map (msp4631jm) - area summary by generalized alliance and association (continued).

Generalized Alliance	Pixels	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Pixels	Acres	Hectares	% Total	Cumulative %
Other Grassland	5,886	1,181.4	478.1	0.8%	93.85%	OGC:herb	5,886	1,181.4	478.1	0.8%	93.85%
Other Herbaceous	409	82.1	33.2	0.1%	93.91%	OHC:herb	409	82.1	33.2	0.1%	93.91%
Totals Herbaceous	26,376	5,294.0	2,142.4	3.7%	93.91%	Totals Herbaceous	26,376	5,294.0	2,142.4	3.7%	93.91%
Svg:other	-	-	-	0.0%	93.91%	SvgW:other	-	-	-	0.0%	93.91%
Barren:other	10,229	2,053.1	830.9	1.4%	95.36%	Bar:other	3,020	606.1	245.3	0.4%	94.33%
						BarH:other	3,350	672.4	272.1	0.5%	94.81%
						BarS:other	1,462	293.4	118.8	0.2%	95.01%
						BarW:other	2,397	481.1	194.7	0.3%	95.35%
Water:other	30,068	6,035.0	2,442.3	4.2%	99.60%	H2O:other	30,068	6,035.0	2,442.3	4.2%	99.60%
Unknown:other	2,799	561.8	227.3	0.4%	100.00%	Unknown:other	2,799	561.8	227.3	0.4%	100.00%
Grand Total	707,795	142,062.3	57,490.6	100.0%	100.0%	Grand Total	707,795	142,062.3	57,490.6	100.0%	100.0%

acres or 5.0% of the parklands) and the *Lithocarpus densiflorus*-(Other) Young Growth Mixed Forest (6,779 acres or 4.8% of the park lands).

The 1,322 shrubland acres were mapped into 7 shrubland alliances representing 15 shrubland associations. The two major shrubland alliances mapped were the *Rubus* Shrubland (411 acres or 31.1% of the shrubland area) and *Lithocarpus densiflorus* Shrubland (356 acres or 26.9% of the shrubland area); these alliances represented more than half of the shrubland type area.

The 5,294 herbaceous type acres were mapped into 19 herbaceous type alliances representing 20 herbaceous type associations. The three major herbaceous alliances mapped were the *Arrhenatherum elatius-Cynosurus echinatus* Grassland (1,749 acres or 33.0% of the herbaceous type area), *Holcus lanatus-Anthoxanthum odoratum* Grassland (729 acres or 13.8% of the herbaceous type area), and Other Grassland (1,181 acres or 22.3% of the herbaceous type area); these alliances represented approximately 69% of the herbaceous type area. Dune herbaceous types accounted for 446 acres or 8.4% of the herbaceous type area. Riverine herbaceous types accounted for 212 acres or 4.0% of the herbaceous type area. Aquatic herbaceous types accounted for 181 acres or 3.4% of the herbaceous type area.

Chapter 4 - Pixel Aggregation and Vector Map Development

As previously noted, the pixel classification map contained significant heterogeneity of the type classes with an average size stand of about 0.42 acres. This pixel map was going to have to be processed to aggregate the pixels together into stands that met the minimum mapping unit (MMU) size limit of 0.5 hectares or 1.2 acres. The aggregation of the pixel classification map into a vector coverage comprised of polygons or stands that all meet the MMU size limit was based upon the evaluation and processing of the pixel classification map with respect to its vegetation/land cover attributes and the type definitions. Pixels and groups of pixels (areas) were aggregated into polygons based on a set of rules that determined the similarity of a subject pixel/area to its adjacent pixels/areas. These rules were primarily based upon the estimated differences in species composition, in terms of the similar and different numbers of species present at the compared pixel locations and the cover composition of the pixel locations. In addition, tree size, total cover by lifeform, and the vegetation/land cover type were additional attributes used to estimate the similarity adjacent pixels/areas. The rules also included minimum mapping unit (MMU) size limits that guided the aggregation process which determined what pixels/areas would or would not be aggregated together to form larger areas or stands that all met the MMU size limits.

4.1 Aggregation Logic

The aggregation of pixels into polygons is based on three concepts:

1. Data, as both pixels and sub-minimum size mapping areas, should be aggregated based on an objective and quantitative set of hierarchical rules that merge sub-minimum size groups of pixels and areas into the most similar neighboring area. This hierarchical set of rules is quite similar to the vegetation classification process that is used to cluster field sites into types, as it is based on the relative similarity of the botanical and landscape features present or attributed to the different locations being evaluated.
2. Data aggregation should be compensating and not result in serious over-generalization of the map type information. The sum of the pixel areas by major type characteristic should be equal to the sum of the polygon areas by major type characteristic. This balance of area would tend to indicate that some type of bias was not introduced during the aggregation process. The hierarchical rules must be developed and implemented without bias towards any particular type or class. Naturally occurring small area types or features should not be dissolved out of existence and large frequently occurring types should not increase and dominate the map. Unfortunately, some degree of change does occur, unless all of the mapped pixels/areas already meet the MMU size limits and aggregation is not necessary. There is the possibility that there may be small naturally occurring types that are always less than the MMU, which may be lost (missing from the final map) if they must always be aggregated into other types to form the minimum 0.5 hectare (1.24 acre) minimum size stands. What is critical is that small types that may be lost due to aggregation are preserved by mapping them as 'park specials' with sizes less than the MMU limits. In general, it has been shown that as the pixel classification data are generalized into larger and larger polygons there will be movement of area from pure types into mixed types when viewed with respect to the total mapped area (Stumpf and

Koltun, 1992). There must be balance and depth in our map type definitions to represent the latitude of vegetation/land cover information that these different types can accurately represent without misrepresenting what is really on the ground.

3. Variations map types may evolve during the aggregation of pixels that reflect mixes or complexes of types that may not exist in the spectral training data set and the resulting pixel class map. These additional types are a byproduct of the aggregation process. These new mixes, which may be thought of as new complexes or variants of types may be developed as pixels of different vegetation composition are processed and aggregated into larger types that meet the MMU size limits. The easiest example of this situation is represented by an area comprised of two classes mapped in a checkerboard pattern. The checkerboard represents what will be aggregated into a stand that is comprised of a mixed complex of two type classes, red and black. This area should not be processed or modeled in such a way that it is represented as one of the original classes (an all red or all black type class) but rather it should be represented as a mixture of the red and black classes. For example, there are separate training classes that represent *Quercus garryana* Forest (Qg:tree/Fc:herb), all having a minimum of 46% tree cover; there are mixed grassland types (e.g. Ae-Ce:forb) with no *Quercus garryana* cover. These two types may occur adjacent to each other and there are sometimes small pockets of one or the other interspersed within the other type. There are no spectral training classes that represents a Qg:tree/Fc:herb Woodland or Forest with tree cover of < 45% in the spectral training data set used to produce the pixel classification map. However, new mixed stands were formed during the aggregation of these different types of pixel classes into polygons and they are mapped in the resulting DCMM polygon data set. Nearly 500 acres of lower density Qg:tree/Fc:herb or OtB-Qg:tree type stands were formed during the aggregation process. This included 147.5 acres of *Quercus garryana* stands with cover between 25 and 45% and 337.4 acres of *Quercus garryana* stands with cover between 10 and 24.99%. These lower density variants of the type classes were a byproduct of the aggregation process and its ability to compute new stand cover values and attributes as the pixels are aggregated into stand polygons.

The initial DCMM classification results contain location specific attributes that estimate the vegetation type, cover composition, average tree size, and species presence. These locations are in the form of individual data elements or pixels approximately 0.2 acres in size. Each of these individually classified pixels is viewed as an estimate of the vegetation/land cover characteristics of the area represented by that pixel. These individual data elements can be aggregated to form polygons or stands representative of groups of pixels having similar land cover characteristics. Most often, the homogeneous groups of pixels that are identified are below the minimum size mapping limits and do not constitute a valid size vegetation/land cover type by themselves. These sub-minimum size mapping units must be merged into or absorbed by one of their adjacent vegetation/land cover type areas. GRS has developed an aggregation program called **aggregate** to process all of the sub-MMU size (subject) areas and estimate which of the adjacent groups of pixels is most similar to the subject area or stand. The similarity of a group of stands is estimated by an ecological distance vector. The stands having the smallest distance vector being judged as most similar. The subject stand is then merged with the adjacent stand estimated to be most similar. Aggregation is an iterative process gradually processing individual 0.2 acre pixels and sub-MMU

size stands to build larger and larger polygons. As a result, the aggregation process is used to filter the original individual pixels during the initial stages of aggregation, as well as to aggregate larger, but still sub-MMU size stands into valid size polygons. When the aggregation process has been completed, all stands meet the MMU size limits.

4.2 Minimum Area Mapping Limits

The preservation of distinctly different map types helps to maintain the accuracy of the mapping effort since fewer stands are generated that represent a mixture of significantly different types, solely for the purpose of satisfying a minimum size mapping unit. The minimum size mapping unit obviously affects the accuracy of any map and the mapper's ability to represent the land cover types present on the ground. The larger the minimum size mapping unit, the greater the probability that a polygon of a size equal to or just above the MMU size limit represents a diverse grouping of somewhat heterogeneous pixel classes that could have been represented by smaller, more homogeneous groups of different pixel classes if the minimum size mapping unit were smaller. The larger the size of a mapped polygon, the greater the chances that it represents more homogenous landscape features that were not merged together solely to meet the MMU size limit.

The RNSP project called for a minimum mapping unit (MMU) of 0.5 hectares or approximately 1.24 acres for the entire project area. For this project, special features could be mapped to a lower size limit, if GRS believed lowering the limit would preserve these features. The 0.5 hectare MMU equates to an MMU of 6.15 28.5-meter pixels in the pixel data set. Rather than round up to 7 pixels resulting in a minimum mapping area of over 1.4 acres, GRS used 6 pixels for the MMU size limit for the polygon data set. Review of initial results indicated that some small wet herbaceous and dune types areas that were smaller than 6 pixels in size were being lost as they were merged into adjacent vegetation/land cover types when they failed to meet the MMU of 6 pixels. In addition, some small lakes and barren areas were other features that were hard to maintain at this MMU. For these reasons, GRS dropped the MMU slightly from 6 pixels to 5 pixels, or approximately 0.4 hectares or 1.0 acres for these types. This enabled the continued segregation of some of the small but significantly different types and prevented the potential loss or degradation of information due to the inclusion of the small distinctly different types within another stand.

4.3 Pixel-Pixel Group-Polygon Aggregation

At the individual pixel level, aggregation is not based on frequency (modal) values. Instead, aggregation is based on a hierarchical order of significance as defined by the land cover type/vegetation classification rules (Stumpf, 1993). Pixel level aggregation results in groups of pixels that range from the individual pixel to large groups that already exceed the minimum area requirements and form valid type polygons. The sub-minimum size groups must be aggregated with other sub-minimum area groups, or with valid size groups to form a data set comprised entirely of valid size groups. When sub-minimum size groups of pixels are recognized and processed, the sub-minimum size mapping group is aggregated with the adjacent group estimated to be most similar to the subject area. The characteristics of each neighboring group are evaluated to develop an index of similarity. As previously mentioned, this evaluation was primarily based upon the estimated differences in species composition, in terms of the similar and different numbers of species present at

the compared pixel locations and the cover composition of the pixel locations. In addition, tree size, total cover by lifeform, and land cover type were additional attributes used to estimate the similarity adjacent pixels/areas.

Aggregation is based on the premise that if all the characteristics of adjoining groups are similar, except for one, such as the tree canopy cover, then the most similar adjoining group is the group with the most similar (least different) tree canopy cover values. Differences between the subject pixel group's characteristics and the adjacent pixel groups' characteristics are estimated numerically to represent a quantitative estimate of similarity. The differences of stand characteristics are estimated as root-mean-squared differences and absolute values and then summed to estimate a quantitative distance vector that represents the relative similarity of the stands being compared. The smaller the size of the distance vector the more similar the stands (a vector of size zero indicates no difference in stands being compared).

Aggregation choices that involve only one different characteristic are relatively easy to make as compared to choices involving multiple differences. Most often, multiple differences, such as species cover composition, lifeform cover components, tree size, and land cover/vegetation type, are observed and used to characterize similarity. Some of these types of differences (species cover versus tree size) are more significant than others. Levels of significance were estimated in an attempt to recognize differences between land cover/vegetation types and characteristics and reflect the land cover/vegetation classification rules. Since this was a mapping project based upon USNVC typing and naming conventions, species presence and cover composition received significantly higher importance than other factors used to estimate similarity.

During this project, the hierarchical rules tended to place the most emphasis on the similarity of vegetation and land cover components, in terms of the different species-specific cover contributions, as well as their presence or absence. Similarity of species cover for any given area relative to each adjacent area was determined by computing the root-mean-squared differences of the individual species cover values, as well as for the major tree, shrub, herbaceous, and non-vegetation cover components of each set of stands being compared. Similarity of species components (presence or absence) was determined by evaluating the individual species cover values for the major tree, shrub, herbaceous, and non-vegetation cover components and then assigning a value of 1 if the feature was present and 0 if it was absent. A quantitative measure of species component similarity was estimated by summing the absolute values of these species presence values for adjacent stands and comparing that to the total number of species at both sites. Canopy cover by species was by far the most significant factor in the aggregation process; the next most important fact was species presence. Other characteristics, such as the cover by lifeform and estimated tree QMD of the trees present were given much less weight in developing the estimate of stand similarity, except that they did play a role in distinguishing mature redwood stands from young growth or recently regenerated stands. Areas having similar levels of species composition of somewhat different total cover would be grouped together rather than grouping areas of different species composition having the same density of tree cover. Areas of similar species cover and composition but different tree size would not be grouped

together if the size differences were significant and indicated differences in mature stands, young growth stands, and recently regenerated stands.

Aggregation was performed as an iterative step-wise process, starting with very low minimum size limits and progressing from the individual pixel to the project MMU size limits for adjacent but significantly different types, to as much as 4 hectares (almost 10 acres) for adjacent stands that were very similar in their characteristics (aggregation of very similar areas to these larger minimum size limits resulted in types larger than the MMU size limit). The aggregation process performed in one step (from the initial pixel groups to the final limits) results in larger, more generalized types, than a step-wise aggregation process. The step-wise aggregation process involved smaller size increases and tended to merge smaller numbers of stands at each step, thereby maintaining stands of similar characteristics rather than merging many small stands at once into a few large generalized stands. In addition, more similar areas are merged first during the step-wise process and more dissimilar areas are merged last in order to form as many larger than MMU size stands of similar characteristics before merging any dissimilar pixels or areas into adjacent stands. This approach tends to lessen the impact of the dissimilar stand characteristics on the adjacent stand's attributes than would have occurred if the merge occurred sooner in the process.

4.4 Estimation of Polygon Characteristics

The final estimate of each aggregated stand's vegetation/land cover characteristics is based on the summarization of all the pixel type attributes that represent the different DCMM pixel classes found within each of the final stand boundaries. The estimation of attributes is not a frequency of occurrence or highest probability modeling exercise where the stands' characteristics are based upon the most frequently occurring pixel class. The pixels of all sub-minimum size mapping units that were merged into a final stand are included in the stand summary data regardless of the vegetation/land cover features they represent. Therefore, inclusions of sub-minimum size mapping units are contained in the stand pixel summaries. Thus some stands may represent what might be considered a complex of land cover/vegetation types that individually were too small to maintain as separate stands. Stand characteristics were calculated by the GRS's program covmatrixsum. Each stand listing of merged image classification pixel attributes yielded an estimated distribution of canopy cover by species and size class. An example pixel class distribution for stand 645592 is shown in Table 7. Each polygon's attributes represent the weighted average of the individual pixel characteristics that have been aggregated to form each polygon. This is why nearly every polygon has a unique set of attribute values. While categorical values may often appear to be the same, the actual characteristics of cover by species and diameter at breast height (dbh) class, QMD, and fine and coarse woody debris counts are typically different. An example of an individual polygon's vegetation/land cover characteristics (Stand Percent Cover Summary) based on stand 645592 is shown in Table 8.

Table 7. Pixel class frequency distribution for stand 645592.

Stand#	Gridval	Frequency
645592	6049	1
645592	8010	1
645592	8011	1
645592	9061	1
645592	9063	1
645592	16005	1
645592	16006	1
645592	16012	1
645592	16015	1
645592	33010	1
645592	41009	1
645592	41032	1
645592	41073	1
645592	51521	1
645592	51537	1
645592	51548	1
645592	51550	1

Each polygon's USNVC association characteristics were assigned by evaluating the distribution of cover by species and tree size, using the RNSP land cover/vegetation classification rules and definitions represented in the RNSP vegetation/land cover key. This assignment of Generalized Association and Alliance values and other categorical values such as size class or cover class were performed as a post classification/aggregation process using SQL updates statements applied to the database table. Such assignments do not require additional image classification or aggregation. As a result, type name assignments and class limits may be altered post classification to develop different or additional categorical values without any additional classification or interpretation of the imagery. Many different maps can be developed simply by creating new legend definitions based upon the different polygon attributes stored in the DCMM map data set.

Table 8. Stand percent cover summary for all layers for stand 645592 (number of pixels = 17).

Species	Dbh Size Class:						Tree Cover	Non-Tree Cover	Total Cover
	<=4.9"	> 4.9" <=10.9"	>10.9" <=23.9"	>23.9" <=59.9"	>35.9"	>59.9"			
Oregon White Oak	0.1	7.0	20.3	0.4	0.0	0.0	27.9	–	27.9
Canyon Live Oak	0.0	0.3	0.7	0.0	0.0	0.0	1.0	–	1.0
Doug-fir	0.1	0.7	2.7	0.0	0.0	0.0	3.4	–	3.4
Doug-fir dead	0.0	0.1	0.3	0.0	0.0	0.0	0.4	–	0.4
Big-Leaf Maple	0.0	0.0	0.8	0.0	0.0	0.0	0.8	–	0.8
CA Bay	0.5	0.0	0.0	0.0	0.0	0.0	0.5	–	0.5
Poison-Oak	–	–	–	–	–	–	–	2.7	2.7
Rubus Ursinus	–	–	–	–	–	–	–	2.2	2.2
Rubus Armeniac	–	–	–	–	–	–	–	0.7	0.7
Corylus Cornuta	–	–	–	–	–	–	–	0.6	0.6
Rose Species	–	–	–	–	–	–	–	0.5	0.5
Arrhen Elatius	–	–	–	–	–	–	–	16.6	16.6
Cynosu Echinat	–	–	–	–	–	–	–	10	10
Dactyl Glomera	–	–	–	–	–	–	–	7.0	7.0
Rumex Acetose	–	–	–	–	–	–	–	4.3	4.3
Carex Obnupta	–	–	–	–	–	–	–	3.5	3.5
Anthox Odoratu	–	–	–	–	–	–	–	2.6	2.6
Galium Aparine	–	–	–	–	–	–	–	2.5	2.5
Lathyr Brownii	–	–	–	–	–	–	–	2.3	2.3
Pterid Aquilin	–	–	–	–	–	–	–	2.0	2.0
Holcus Lanatus	–	–	–	–	–	–	–	1.9	1.9
Osmorh Chilens	–	–	–	–	–	–	–	1.8	1.8
Hypoch Radicat	–	–	–	–	–	–	–	1.8	1.8
Poa Pratensis	–	–	–	–	–	–	–	1.7	1.7
Fragar Vesca	–	–	–	–	–	–	–	1.7	1.7
Vulpia Bromoid	–	–	–	–	–	–	–	1.6	1.6
Dantho Califor	–	–	–	–	–	–	–	1.6	1.6
Bromus Vulgari	–	–	–	–	–	–	–	1.6	1.6
Planta Lanceol	–	–	–	–	–	–	–	1.5	1.5
Lathyr Nevaden	–	–	–	–	–	–	–	1.5	1.5
Aira Caryophyl	–	–	–	–	–	–	–	1.5	1.5
Torili Arvensi	–	–	–	–	–	–	–	1.4	1.4
Trifol Dubium	–	–	–	–	–	–	–	1.3	1.3
Vicia Species	–	–	–	–	–	–	–	1.2	1.2
Elymus Glaucus	–	–	–	–	–	–	–	1.2	1.2
Ranunc Occiden	–	–	–	–	–	–	–	1.1	1.1
Polyst Munitum	–	–	–	–	–	–	–	1.1	1.1

Table 8. Stand percent cover summary for all layers for stand 645592 (number of pixels = 17)
(continued).

Species	Dbh Size Class:						Tree Cover	Non- Tree Cover	Total Cover
	<=4.9"	> 4.9" <=10.9"	>10.9" <=23.9"	>23.9" <=59.9"	>35.9"	>59.9"			
Achill Millefo	–	–	–	–	–	–	–	1.1	1.1
Melica Subulat	–	–	–	–	–	–	–	1.0	1.0
Bromus Hordeac	–	–	–	–	–	–	–	1.0	1.0
Sanicu Crassic	–	–	–	–	–	–	–	0.9	0.9
Marah Oreganus	–	–	–	–	–	–	–	0.9	0.9
Bromus Sterili	–	–	–	–	–	–	–	0.9	0.9
Delphinium Sp	–	–	–	–	–	–	–	0.8	0.8
Ranunculus Sp	–	–	–	–	–	–	–	0.7	0.7
Whippl Modesta	–	–	–	–	–	–	–	0.6	0.6
Clayto Perfoli	–	–	–	–	–	–	–	0.6	0.6
Poa Sp	–	–	–	–	–	–	–	0.5	0.5
Agoseris Sp	–	–	–	–	–	–	–	0.5	0.5
Bare Soil	–	–	–	–	–	–	–	9.5	9.5
Litter	–	–	–	–	–	–	–	81.7	81.7
Coarse Wdydown	–	–	–	–	–	–	–	1.3	1.3
Totals	0.7	8.1	24.8	0.4	0.0	0.0	34.0	185.0	219.0

4.5 Discrete Classification Pixel Aggregation Results

The extent of the aggregated DCMM polygon map was based upon the RNSP park boundaries. As a result, the aggregated DCMM land cover map represented basically the same area as the pixel classification map (ArcGIS grid rnsf4631jm) with total area of 57,490.8 hectares or 142,062.3 acres. The 339,327 unique pixel class stands were aggregated into 7,890 stands. The average stand size was 7.29 hectares or 18.0 acres. The smallest stand size was 0.406 hectares or 1.004 acres (5 pixels) and the largest size non-Water type stand was 1,124.32 hectares or 2,778.24 acres (13,842 pixels). Of the 7,890 stands, 6,695 were forestland type stands that averaged 19.3 acres in size, 191 were shrubland type stands that averaged 2.8 acres, and 679 were herbaceous type stands that averaged 7.8 acres.

The results of the pixel aggregation process, as represented in the polygon data set (the ArcGIS coverage rnsfLCMap), are shown in Figure 10 and Table 9. Figure 9 represents a portion of the aggregated polygon data set for the same area in the Bald Hills and Redwood Creek vicinities shown in Figure 8. Figure 11 shows the pixel classification map and aggregated polygon boundaries for the same area. Table 9 represents the distribution of the park's area, in terms of acres and hectares that were mapped into the different Generalized Alliance and Association USNVC type classes. Over 95% of the parklands were mapped as one of the vegetation types in the polygon data set, whereas the remaining 5% of the park was mapped as one of the non-vegetation types. The predominant vegetation lifeform mapped in the polygon data set was forestlands, as 90.9% or 129,193 acres of the parklands were aggregated into one of the forestland types. 0.4%, or 532 acres of the parklands were aggregated into Shrub type classes, 3.7% or 5,307 acres were aggregated as Herbaceous type classes, 0.6% or 866 acres were aggregated into Barren type classes, 4.3% or 6,138 acres were aggregated as a Water type class, and less than 1 acre remained as an Unknown type following aggregation efforts.

Table 9. Redwood National and State Parks land cover map data set - area summary by generalized alliance and association.

Generalized Alliance	Stands	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Stands	Acres	Hectares	% Total	Cumulative %
<i>Sequoia sempervirens</i> Mature Forest	1,146	42,687.8	17,275.2	30.0%	30.0%	Ss:tree/Pmu:herb	222	15,710.7	6,357.9	11.1%	11.1%
						Ss:tree/Vo:shrub	696	22,584.8	9,139.8	15.9%	27.0%
						Ss-Ama-Uc:tree	227	4,388.7	1,776.0	3.1%	30.0%
						Ss-Ame:tree	1	3.6	1.5	0.0%	30.0%
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	3,121	56,180.7	22,735.6	39.5%	69.6%	Ss-Ld:tree	1,510	35,603.0	14,408.1	25.1%	55.1%
						Ss-Ar:tree	193	2,265.9	917.0	1.6%	56.7%
						Ss-Pm:tree	478	6,546.4	2,649.3	4.6%	61.3%
						Ss-OtC:tree	77	492.4	199.3	0.3%	61.7%
						Pm-Ss:tree	368	5,739.6	2,322.7	4.0%	65.7%
						Ar-Ss:tree	186	2,309.3	934.5	1.6%	67.3%
						Ld-Ss:tree	215	2,327.7	942.0	1.6%	69.0%
						Ld-Ss-Oth:tree	92	891.2	360.7	0.6%	69.6%
						OtC-Ss:tree	2	5.2	2.1	0.0%	69.6%
<i>Picea sitchensis</i> -(Other) YG Mixed Forest	267	3,042.0	1,231.0	2.1%	71.7%	Ps:tree/Gs:shrub	118	557.4	225.6	0.4%	70.0%
						OtC-Ps:tree	43	386.6	156.4	0.3%	70.3%
						Ar-Ps:tree	106	2,098.0	849.0	1.5%	71.7%
<i>Picea sitchensis</i> Saturated Forest	6	30.6	12.4	0.0%	71.8%	Ps:tree/La:herb	6	30.6	12.4	0.0%	71.8%
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	49	327.3	132.5	0.2%	72.0%	Pm:tree	16	50.0	20.2	0.0%	71.8%
						Pm-Oth:tree	9	65.8	26.6	0.0%	71.8%
						Pm-Ar:tree	1	13.5	5.5	0.0%	71.8%
						OtC-Pm:tree	20	177.2	71.7	0.1%	72.0%
						Ar-Pm:tree	3	20.8	8.4	0.0%	72.0%
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG Mixed Forest	194	2,824.2	1,142.9	2.0%	74.0%	Pm-Ld-Ame:tree	99	1,759.6	712.1	1.2%	73.2%
						Pm-Ld-Oth:tree	95	1,064.6	430.8	0.7%	74.0%
<i>Pinus attenuata</i> Forest	16	279.0	112.9	0.2%	74.2%	Pa:tree/Lde:shrub	15	275.0	111.3	0.2%	74.2%
						Psp-Pa:tree	1	4.0	1.6	0.0%	74.2%
<i>Pinus jeffreyi</i> Forest	16	150.9	61.0	0.1%	74.3%	Pj:tree/Fi:herb	15	150.6	60.9	0.1%	74.3%
						Psp-Pj:tree	1	0.3	0.1	0.0%	74.4%
<i>Pinus monticola</i> Forest	21	238.6	96.5	0.2%	74.5%	Pmo-Pc:tree/Lde-Qv:shrub	21	238.6	96.5	0.2%	74.5%
<i>Pinus radiata</i> × <i>attenuata</i> Forest	13	123.6	88.6	0.2%	74.6%	Xra-Ss-Ld:tree	6	123.6	50.0	0.1%	74.6%
						Psp-Ld:tree	5	82.5	33.4	0.1%	74.6%
						Psp-Pm:tree	2	12.9	5.2	0.0%	74.6%
Totals Conifer Forest	4,849	105,980.0	42,888.7	74.6%	74.6%	Totals Conifer Forest	4,849	105,980.0	42,888.7	74.6%	74.6%
Montane Conifer-Hardwood Mixed Forest	219	1,980.1	801.3	1.4%	76.0%	ItC-OtB/XX:tree	219	1,980.1	801.3	1.4%	76.0%
Montane Hardwood Mixed Forest	127	714.2	289.0	0.5%	76.5%	OtB-Mix:tree	127	714.2	289.0	0.5%	76.5%
<i>Acer macrophyllum</i> Forest	34	53.7	21.7	0.0%	76.5%	Ama:tree/Ht:herb	24	36.9	14.9	0.0%	76.5%
						OtB-Ama:tree	10	16.8	6.8	0.0%	76.5%
<i>Alnus rubra</i> -(Other) Forest	783	11,667.4	4,721.6	8.2%	84.7%	Ar:tree/Co:herb	48	390.7	158.1	0.3%	76.8%
						Ar:tree/Oth:herb	100	1,580.9	639.8	1.1%	77.9%
						Ar-Oth:tree	27	139.0	56.3	0.1%	78.0%
						OtB-Ar:tree	608	9,556.7	3,867.5	6.7%	84.7%
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	587	7,900.1	3,197.1	5.6%	90.3%	Ld-Oth:tree	72	497.0	201.1	0.3%	85.1%
						OtB-Ld:tree	515	7,403.2	2,996.0	5.2%	90.3%

Table 9. Redwood National and State Parks land cover map data set - area summary by generalized alliance and association (continued).

Generalized Alliance	Stands	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Stands	Acres	Hectares	% Total	Cumulative %
<i>Quercus garryana</i> Forest	95	895.5	362.4	0.6%	90.9%	Qg:tree/Fc:herb	85	840.9	340.3	0.6%	90.9%
						OtB-QG:tree	10	54.6	22.1	0.0%	90.9%
<i>Umbellularia californica</i> Forest	1	1.8	0.7	0.0%	90.9%	OtB-Uc:tree	1	1.8	0.7	0.0%	90.9%
Totals Hardwood Forest	1,627	21,232.7	8,592.6	14.9%	90.9%	Totals Hardwood Forest	1,627	21,232.7	8,592.6	14.9%	90.9%
<i>Baccharis pilularis</i> Shrubland	24	76.6	31.0	0.1%	91.0%	Bp:shrub/Pmu:herb	19	44.9	18.2	0.0%	91.0%
						OtS-Bp:shrub	5	31.7	12.8	0.0%	91.0%
<i>Lithocarpus densiflorus</i> Shrubland	70	179.4	72.6	0.1%	91.1%	Lde:shrub	64	165.2	66.9	0.1%	91.1%
						OtS-Lde:shrub	6	14.2	5.7	0.0%	91.1%
<i>Quercus vaccinifolia</i> Shrubland	24	69.6	28.2	0.0%	91.2%	Qv:shrub	21	63.0	25.5	0.0%	91.2%
						OtS-Qv:shrub	3	6.7	2.7	0.0%	91.2%
<i>Rubus</i> Shrubland	57	157.9	63.9	0.1%	91.3%	Ra:shrub	18	51.1	20.7	0.0%	91.2%
						Rp:shrub	13	39.4	16.0	0.0%	91.2%
						Rs:shrub	14	31.9	12.9	0.0%	91.3%
						Ru-(Mix):shrub	11	33.8	13.7	0.0%	91.3%
						OtS-Ra:shrub	1	1.8	0.7	0.0%	91.3%
<i>Salix</i> Shrubland	9	26.9	10.9	0.0%	91.3%	Sh:shrub	2	4.5	1.8	0.0%	91.3%
						Sal-Sal-Oth:shrub	2	4.9	2.0	0.0%	91.3%
						OtS-Sal:shrub	5	17.5	7.1	0.0%	91.3%
Other Mixed Shrubland	7	21.7	8.8	0.0%	91.3%	OtS-Cs:shrub	1	3.8	1.5	0.0%	91.3%
						OtS-Rpu:shrub	6	17.9	7.2	0.0%	91.3%
Totals Shrublands	191	532.1	215.3	0.4%	91.3%	Totals Shrublands	191	532.1	215.3	0.4%	91.3%
<i>Ammophila arenaria</i> Grassland	7	216.1	87.4	0.2%	91.5%	Am:herb	7	216.1	87.4	0.2%	91.5%
<i>Leymus mollis</i> Grassland	3	17.2	7.0	0.0%	91.5%	Lm:herb	3	17.2	7.0	0.0%	91.5%
Other Dune Herbaceous	37	462.6	187.2	0.3%	91.8%	ODC:herb	37	462.6	187.2	0.3%	91.8%
<i>Agrostis gigantea</i> - <i>Agrostis stolonifera</i> Grassland	5	36.6	14.8	0.0%	91.8%	Ag-As:herb	5	36.6	14.8	0.0%	91.8%
<i>Arrhenatherum elatius</i> - <i>Cynosurus echinatus</i> Grassland	99	1,969.6	797.1	1.4%	93.2%	Ae-Ce:herb	99	1,969.6	797.1	1.4%	93.2%
<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland	110	383.7	155.3	0.3%	93.5%	Co-DeC:herb	110	383.7	155.3	0.3%	93.5%
<i>Festuca idahoensis</i> Grassland	7	21.8	8.8	0.0%	93.5%	Cp/Fi:herb	7	21.8	8.8	0.0%	93.5%
<i>Holcus lanatus</i> - <i>Anthoxanthum odoratum</i> Grassland	56	224.8	91.0	0.2%	93.7%	HI-HI:herb	17	65.1	26.3	0.0%	93.5%
						HI-Oth:herb	39	159.7	64.6	0.1%	93.7%
<i>Heterotheca oregona</i> Herbaceous	9	57.6	23.3	0.0%	93.7%	Ho-So:herb	9	57.6	23.3	0.0%	93.7%
Other Riverine Herbaceous	32	146.2	59.2	0.1%	93.8%	Ma-Oth:herb	32	146.2	59.2	0.1%	93.8%
<i>Carex obnupta</i> Herbaceous	27	87.1	35.3	0.1%	93.9%	Co:herb	27	87.1	35.3	0.1%	93.9%
<i>Scirpus microcarpus</i> Herbaceous	1	5.5	2.2	0.0%	93.9%	Sm:herb	1	5.5	2.2	0.0%	93.9%
<i>Sparganium (angustifolium)</i> Herbaceous	1	1.2	0.5	0.0%	93.9%	Sa:herb	1	1.2	0.5	0.0%	93.9%
<i>Typha latifolia</i> Herbaceous	9	23.5	9.5	0.0%	93.9%	TI:herb	9	23.5	9.5	0.0%	93.9%
Other Aquatic Herbaceous	13	33.4	13.5	0.0%	93.9%	OtA-Oth:herb	13	33.4	13.5	0.0%	93.9%
Other Grassland	251	1,557.8	630.4	1.1%	95.0%	OGC:herb	251	1,557.8	630.4	1.1%	95.0%
Other Herbaceous	12	62.0	25.1	0.0%	95.0%	OHC:herb	12	62.0	25.1	0.0%	95.0%

Table 9. Redwood National and State Parks land cover map data set - area summary by generalized alliance and association (continued).

Generalized Alliance	Stands	Acres	Hectares	% Total	Cumulative %	Generalized Alliance Component	Stands	Acres	Hectares	% Total	Cumulative %
Totals Herbaceous	679	5,306.5	2,147.5	3.7%	95.0%	Totals Herbaceous	679	5,306.5	2,147.5	3.7%	95.0%
Svg:other	7	26.1	10.5	0.0%	95.1%	SvgS:other	2	14.2	5.8	0.0%	95.1%
						SvgW:other	5	11.8	4.8	0.0%	95.1%
Barren:other	294	866.2	350.5	0.6%	95.7%	Bar:other	93	215.2	87.1	0.2%	95.2%
						BarH:other	46	269.9	109.2	0.2%	95.4%
						BarS:other	79	253.5	102.6	0.2%	95.6%
						BarW:other	76	127.6	51.6	0.1%	95.7%
Water:other	21	6,138.0	2,484.0	4.3%	100.00%	H2O:other	21	6,138.0	2,484.0	4.3%	100.00%
Unknown:other	3	0.6	0.2	0.0%	100.00%	Unknown:other	3	0.6	0.2	0.0%	100.00%
Grand Total	7,890	142,062.3	57,490.8	100.0%	100.0%	Grand Total	7,890	142,062.3	57,490.8	100.0%	100.0%

The 129,193 forest land acres were mapped into 11 conifer alliances representing 32 conifer associations, 6 hardwood alliances representing 12 hardwood associations, and one mixed conifer hardwood alliance representing one mixed conifer hardwood association. The majority of the forest land acres were coniferous alliances, as 105,980 acres or 82.0% of the forestland type acres were mapped as one of the conifer alliances. 21,233 acres or 16.4% of the forestland acres were mapped as one of the hardwood alliances. 1,980 acres or 1.4% of the forestland acres were mapped as the mixed conifer hardwood alliance. The two most prominent tree alliances classified were the *Sequoia sempervirens*-(Other) Young Growth Forest (56,181 acres or 39.5% of the parklands) and the *Sequoia sempervirens* Mature Forest (42,688 acres or 30.0% of the park lands). The two major hardwood alliances classified were the *Alnus rubra*-(Other) Forest (11,667 acres or 8.2% of the parklands) and the *Lithocarpus densiflorus*-(Other) Young Growth Mixed Forest (7,900 acres or 5.6% of the park lands).

Shrubland typed areas were mapped into 6 shrubland alliances representing 16 shrubland associations. These 6 alliances accounted for only 532 acres, or 0.4% of the parklands. Of this area, the *Lithocarpus densiflorus* Shrubland alliance (179 acres or 33.6% of the shrubland area) and *Rubus* Shrubland alliance (154 acres or 29.7% of the shrubland area) accounted for 63% of the shrubland acres.

Herbaceous typed areas were mapped into 17 herbaceous alliances representing 18 herbaceous associations. These 17 alliances accounted for 5,307 acres or 3.7% of the total area. Of this area, 1,970 acres or 37.1% of the herbaceous type area was classified as *Arrhenatherum elatius*-*Cynosurus echinatus* Grassland. The next most prominent herbaceous type was the Other Grassland type which accounted for 1,558 acres or 29.4 of the herbaceous type area. Dune herbaceous types accounted for 696 acres or 13.1% of the herbaceous type area. Riverine herbaceous types accounted for 204 acres or 3.8% of the herbaceous type area. Aquatic herbaceous types accounted for 151 acres or 2.8% of the herbaceous type area.

Areas mapped as a non-vegetated type accounted for 1,758 acres or 4.9% of the park. Of this area, the major types mapped were primarily the Barren type mapped on 866 acres or 0.6% of the parklands and the Water type mapped on 6,138 acres or 4.3% of the parklands. Note that 5,367 of these acres were accounted for by the polygon representing the Pacific Ocean off the shoreline of the parklands.

Chapter 5 - Pixel Classification and Stand Map Differences

The differences between the pixel classification map data set (rnsp4631jm) and the aggregated polygon or stand map data set (rnspLCMap) are shown in Tables 10 and 11. Table 10 represents area differences between the pixel classification map and the polygon stand map with respect to the USNVC Alliances. Table 11 represents the area differences between the pixel classification map and the polygon stand map with respect to the Generalized USNVC Associations.

The aggregation of pixels into polygons which met the minimum mapping unit (MMU) size limit of 0.5 hectares or approximately 1.2 acres resulted in some shifts in area between the different alliances and associations that were classified and mapped during this project. In general, some of the more frequently occurring alliances and associations typically got larger, while less frequently occurring alliances and associations got smaller. What might be considered purer single-species dominated alliances and associations typically got smaller while alliances and associations representing mixed species typically got larger. Such trends based upon type frequency and mixes often occur due to the law of averages, as individual pixels and small groups of similar pixels are aggregated together to form stands that meet the MMU limits (Stumpf, 1993).

5.1 Changes in Mapped Alliances

Following aggregation efforts, the area totals represented by different alliances mapped as pixels and polygons experienced some shifts in area (see table 10). The total area of forestland alliances increased by 2,396 acres or 1.7% of the parkland area. This increase was due to an increase in hardwood alliances of 4,911 acres or 3.5% of the total area, while conifer and mixed conifer-hardwood alliances actually declined in area by 995 acres or -0.7% of the total area and 1,520 acres or -1.1% of the total area respectively. Alliances that showed major increases were the *Alnus rubra*-(Other) Forest and *Lithocarpus densiflorus*-(Other) YG Mixed Forest alliances with increases of 4,596 acres or 3.2% of the total area and 1,122 acres or 0.8% of the total area respectively. In addition, while total conifer forestland area declined, the area of some conifer forestland alliances increased. The area of the *Sequoia sempervirens*-(Other) YG Mixed Forest alliance increased by 6,078 acres or 4.3% of the total area and the area of *Sequoia sempervirens* Mature Forest increased by 420 acres or 0.3% of the total area. These increases in alliance area were more than offset by decreases in the area of the *Pseudotsuga menziesii*-*Lithocarpus densiflorus* YG Mixed Forest, the *Pseudotsuga menziesii*-(Other) YG Mixed Forest, and the *Picea sitchensis*-(Other) Forest alliances with declines of 5,203 acres or -3.7% of the total area, 1,046 acres or -0.7% of the total area, and 808 acres or -0.6% of the total area respectively. These changes tend to indicate that the young growth *Pseudotsuga menziesii* and *Picea sitchensis* alliances were aggregated with pixels dominated by either *Sequoia sempervirens*, *Alnus rubra*, or *Lithocarpus densiflorus* as acres of aggregated stands shifted away from the less frequently occurring *Pseudotsuga menziesii* and *Picea sitchensis* alliances and more towards those alliances characterized by the presence of significant amounts of *Sequoia sempervirens*, *Alnus rubra*, or *Lithocarpus densiflorus*. All other tree alliances showed minor declines in area with the exception of the *Pinus radiata* X *attenuata* Mixed Forest and *Pinus* species

Table 10. Redwood National and State Parks pixel/polygon land cover differences by generalized alliance.

Generalized Alliance	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Difference	Cumulative %
<i>Sequoia sempervirens</i> Mature Forest	42,268.4	17,105.5	29.8%	42,687.8	17,275.2	30.0%	+419.5	+169.8	+0.3%	+0.3%
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	50,102.7	20,275.9	35.3%	56,180.7	22,735.6	39.5%	+6,078.0	+2,459.7	+4.3%	+4.6%
<i>Picea sitchensis</i> -(Other) YG Mixed Forest	3,850.2	1,558.1	2.7%	3,042.0	1,231.0	2.1%	-808.3	-327.1	-0.6%	+4.0%
<i>Picea sitchensis</i> Saturated Forest	199.1	80.6	0.1%	30.6	12.4	0.0%	-168.5	-68.2	-0.1%	+3.9%
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	1,373.5	555.8	1.0%	327.3	132.5	0.2%	-1,046.2	-423.4	-0.7%	+3.1%
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG Mixed Forest	8,027.6	3,248.7	5.7%	2,824.2	1,142.9	2.0%	-5,203.4	-2,105.8	-3.7%	-0.5%
<i>Pinus attenuata</i> Forest	441.6	178.7	0.3%	279.0	112.9	0.2%	-162.6	-65.8	-0.1%	-0.6%
<i>Pinus jeffreyi</i> Forest	239.6	97.0	0.2%	150.9	61.0	0.1%	-88.8	-35.9	-0.1%	-0.7%
<i>Pinus monticola</i> Forest	380.3	153.9	0.3%	238.6	96.5	0.2%	-141.8	-57.4	-0.1%	-0.8%
<i>Pinus radiata</i> × <i>attenuata</i> Forest	66.2	26.8	0.0%	123.6	50.0	0.1%	+57.4	+23.2	0.0%	-0.7%
<i>Pinus</i> species Mixed Forest	25.5	10.3	0.0%	95.3	38.6	0.1%	+69.8	+28.3	0.0%	-0.7%
Totals Conifer Forest	106,974.8	43,291.3	75.3%	105,980.0	42,888.7	74.6%	-994.8	-402.6	-0.7%	-0.7%
Montane Conifer-Hardwood Mixed Forest	3,500.0	1,416.4	2.5%	1,980.1	801.3	1.4%	-1,519.9	-615.1	-1.1%	-1.8%
Montane Hardwood Mixed Forest	977.1	395.4	0.7%	714.2	289.0	0.5%	-262.8	-106.4	-0.2%	-2.0%
<i>Acer macrophyllum</i> Forest	415.5	168.1	0.3%	53.7	21.7	0.0%	-361.8	-146.4	-0.3%	-2.2%
<i>Alnus rubra</i> -(Other) Forest	7,070.9	2,861.5	5.0%	11,667.4	4,721.6	8.2%	+4,596.5	+1,860.1	+3.2%	+1.0%
<i>Chrysolepis chrysophylla</i> Forest	16.1	6.5	0.0%	-	-	0.0%	-16.1	-6.5	-0.0%	+1.0%
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	6,778.6	2,743.2	4.8%	7,900.1	3,197.1	5.6%	+1,121.5	+453.9	+0.8%	+1.8%
<i>Quercus garryana</i> Forest	951.8	385.2	0.7%	895.5	362.4	0.6%	-56.3	-22.8	-0.0%	+1.8%
<i>Umbellularia californica</i> Forest	112.2	45.4	0.1%	1.8	0.7	0.0%	-110.4	-44.7	-0.1%	+1.7%
Totals Hardwood Forest	16,322.0	6,605.3	11.5%	21,232.7	8,592.6	14.9%	+4,910.7	+1,987.3	+3.5%	+1.7%
<i>Baccharis pilularis</i> Shrubland	230.4	93.2	0.2%	76.6	31.0	0.1%	-153.9	-62.3	-0.1%	+1.7%
<i>Garrya elliptica</i> Shrubland	23.1	9.3	0.0%	-	-	0.0%	-23.1	-9.3	-0.0%	+1.7%
<i>Lithocarpus densiflorus</i> Shrubland	355.9	144.0	0.3%	179.4	72.6	0.1%	-176.4	-71.4	-0.1%	+1.5%

Table 10. Redwood National and State Parks pixel/polygon land cover differences by generalized alliance (continued).

Generalized Alliance	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Difference	Cumulative %
<i>Quercus vacciniifolia</i> Shrubland	119.4	48.3	0.1%	69.6	28.2	0.0%	-49.8	-20.1	-0.0%	+1.5%
<i>Rubus</i> Shrubland	411.5	166.5	0.3%	157.9	63.9	0.1%	-253.5	-102.6	-0.2%	+1.3%
<i>Salix</i> Shrubland	72.7	29.4	0.1%	26.9	10.9	0.0%	-45.7	-18.5	-0.0%	+1.3%
Other Mixed Shrubland	108.8	44.0	0.1%	21.7	8.8	0.0%	-87.1	-35.3	-0.1%	+1.2%
Totals Shrubland	1,321.7	534.9	0.9%	532.1	215.3	0.4%	-789.6	-319.5	-0.6%	+1.2%
<i>Ammophila arenaria</i> Grassland	120.2	48.7	0.1%	216.1	87.4	0.2%	+95.9	+38.8	+0.1%	+1.3%
<i>Leymus mollis</i> Grassland	30.3	12.3	0.0%	17.2	7.0	0.0%	-13.1	-5.3	-0.0%	+1.3%
Other Dune Herbaceous	295.2	119.5	0.2%	462.6	187.2	0.3%	+167.4	+67.7	+0.1%	+1.4%
<i>Agrostis gigantea</i> - <i>Agrostis stolonifera</i> Grassland	192.9	78.1	0.1%	36.6	14.8	0.0%	-156.3	-63.3	-0.1%	+1.3%
<i>Arrhenatherum elatius</i> - <i>Cynosurus echinatus</i> Grassland	1,749.0	707.8	1.2%	1,969.6	797.1	1.4%	+220.6	+89.3	+0.2%	+1.4%
<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland	470.5	190.4	0.3%	383.7	155.3	0.3%	-86.8	-35.1	-0.1%	+1.4%
<i>Festuca idahoensis</i> Grassland	50.0	20.2	0.0%	21.8	8.8	0.0%	-28.2	-11.4	-0.0%	+1.4%
<i>Holcus lanatus</i> - <i>Anthoxanthum odoratum</i> Grassland	729.2	295.1	0.5%	224.8	91.0	0.2%	-504.4	-204.1	-0.4%	+1.0%
<i>Heterotheca oregona</i> Herbaceous	145.5	58.9	0.1%	57.6	23.3	0.0%	-87.9	-35.6	-0.1%	+0.9%
<i>Hirschfeldia incana</i> Herbaceous	1.4	0.6	0.0%	-	-	0.0%	-1.4	-0.6	-0.0%	+0.9%
Other Riverine Herbaceous	65.4	26.5	0.0%	146.2	59.2	0.1%	+80.7	+32.7	+0.1%	+1.0%
<i>Carex obnupta</i> Herbaceous	43.4	17.5	0.0%	87.1	35.3	0.1%	+43.8	+17.7	+0.0%	+1.0%
<i>Phalaris arundinacea</i> Herbaceous	44.8	18.1	0.0%	-	-	0.0%	-44.8	-18.1	-0.0%	+1.0%
<i>Scirpus microcarpus</i> Herbaceous	26.7	10.8	0.0%	5.5	2.2	0.0%	-21.2	-8.6	-0.0%	+1.0%
<i>Sparganium (angustifolium)</i> Herbaceous	13.4	5.4	0.0%	1.2	0.5	0.0%	-12.3	-5.0	-0.0%	+1.0%
<i>Typha latifolia</i> Herbaceous	28.1	11.4	0.0%	23.5	9.5	0.0%	-4.6	-1.9	-0.0%	+1.0%
Other Aquatic Herbaceous	24.5	9.9	0.0%	33.4	13.5	0.0%	+8.9	+3.6	+0.0%	+1.0%
Other Grassland	1,181.4	478.1	0.8%	1,557.8	630.4	1.1%	+376.4	+152.3	+0.3%	+1.2%
Other Herbaceous	82.1	33.2	0.1%	62.0	25.1	0.0%	-20.1	-8.1	-0.0%	+1.2%

Table 10. Redwood National and State Parks pixel/polygon land cover differences by generalized alliance (continued).

Generalized Alliance	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Difference	Cumulative %
Totals Herbaceous	5,294.0	2,142.4	3.7%	5,306.5	2,147.5	3.7%	+12.6	+10.5	+0.0%	+1.2%
Svg:other	-	-	0.0%	26.1	10.5	0.0%	+26.1	+10.5	+0.0%	+1.2%
Barren:other	2,053.1	830.9	1.4%	866.2	350.5	0.6%	-1,186.9	-480.3	-0.8%	+0.4%
Water:other	6,035.0	2,442.3	4.2%	6,138.0	2,484.0	4.3%	+103.0	+41.7	+0.0%	+0.5%
Unknown:other	561.8	227.3	0.4%	0.6	0.2	0.0%	-561.2	-227.1	-0.4%	+0.1%
Grand Total	142,062.3	57,490.8	100.0%	142,062.3	57,490.8	100.0%	0.0	0.0	0.0%	0.0%

Table 11. Redwood National and State Parks pixel/polygon land cover differences by association.

Association	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Differ.	Cumul. %
Ss:tree/Pmu:herb	20,917.3	8,465.0	14.7%	15,710.7	6,357.9	11.1%	-5206.6	-2,107.0	-3.7%	+0.3%
Ss:tree/Vo:shrub	16,761.4	6,783.1	11.8%	22,584.8	9,139.8	15.9%	+5,823.4	+2,356.7	+4.1%	+4.6%
Ss-Ama-Uc:tree	3,611.0	1,461.3	2.5%	4,388.7	1,776.0	3.1%	+777.7	+314.7	+0.5%	+4.0%
Ss-Ame:tree	978.7	396.1	0.7%	3.6	1.5	0.0%	-951.1	-394.6	-0.7%	+3.9%
Ss-Ld:tree	13,144.8	5,319.5	9.3%	35,603.0	14,408.1	25.1%	+22,458.3	9,088.6	+15.8%	+16.1%
Ss-Ar:tree	3,499.0	1,416.0	2.5%	2,265.9	917.0	2.6%	-1,233.1	-499.0	-0.9%	+15.2%
Ss-Pm:tree	8,680.8	3,513.0	6.1%	6,546.4	2,649.3	4.6%	-2,134.3	-863.7	-1.5%	+13.7%
Ss-OtC:tree	3,337.4	1,350.6	6.1%	492.4	199.3	0.3%	-2,845.0	-1,151.3	-2.0%	+11.7%
Pm-Ss:tree	9,684.1	3,919.0	6.8%	5,739.6	2,322.7	4.0%	-3,944.6	-1,596.3	-2.8%	+9.0%
Ar-Ss:tree	5,522.8	2,235.0	3.9%	2,309.3	934.5	1.6%	-3,213.5	-1,300.4	-2.3%	+6.7%
Ld-Ss:tree	2,022.8	818.6	1.4%	2,327.7	942.0	1.6%	304.9	123.4	+0.2%	+6.9%
Ld-Ss-Oth:tree	3,113.0	1,259.8	2.2%	891.2	360.7	0.6%	-2,221.8	-899.1	-1.6%	+5.3%
OtC-Ss:tree	1,098.1	444.4	0.8%	5.2	2.1	0.0%	-1,092.9	-442.3	-0.8%	+4.6%
Ps:tree/Gs:shrub	1,476.0	597.3	1.0%	557.4	225.6	0.4%	-918.6	-371.7	-0.6%	+3.9%
Ps-Ar:tree	1,048.1	424.2	0.7%	-	-	0.0%	-1,048.1	-424.2	-0.7%	+3.2%
Ar-Ps:tree	831.7	336.6	0.6%	386.6	156.4	0.3%	-445.2	-180.2	-0.3%	+2.9%
OtC-Ps:tree	494.4	200.1	0.3%	2,098.0	849.0	1.5%	1,603.6	649.0	+1.1%	+4.0%
Ps:tree/La:herb	199.1	80.6	0.1%	30.6	12.4	0.0%	-168.5	-68.2	-0.1%	+3.9%
Pm:tree	97.1	39.3	1.0%	50.0	20.2	0.0%	-47.2	-19.1	0.0%	+3.9%
Pm-Oth:tree	822.3	332.8	0.6%	65.8	26.6	0.0%	-756.5	-306.1	-0.5%	+3.3%
Pm-Ar:tree	217.8	88.1	0.2%	13.5	5.5	0.0%	-204.2	-82.6	-0.1%	+3.2%
Ar-Pm:tree	9.6	3.9	0.0%	177.2	71.7	0.1%	167.5	67.8	+0.1%	+3.3%
OtC-Pm:tree	226.6	91.7	0.2%	20.8	8.4	0.0%	-205.8	-83.3	-0.1%	+3.1%
Pm-Ld-Ame:tree	303.1	122.7	0.2%	1,759.6	712.1	1.2%	+1,456.5	+589.4	+1.0%	+4.2%
Pm-Ld-Oth:tree	7,724.6	3,126.0	5.4%	1,064.6	430.8	0.7%	-6,659.9	-2,695.2	-4.7%	-0.5%
Pa:tree/Lde:shrub	437.3	177.0	0.3%	275.0	111.3	0.2%	-162.4	-65.7	-0.1%	-0.6%
Psp-Pa:tree	4.2	1.7	0.0%	4.0	1.6	0.0%	-0.2	-0.1	0.0%	-0.6%
Pj:tree/Fi:herb	239.6	97.0	0.2%	150.6	60.9	0.1%	-89.1	-36.1	-0.1%	-0.7%
Psp-Pj:tree	-	-	0.0%	0.3	0.1	0.0%	0.3	0.1	0.0%	-0.7%
Pmo-Pc:tree/Lde-Qv:shrub	356.7	144.3	0.3%	238.6	96.5	0.2%	-118.1	-47.8	-0.1%	-0.8%
Psp-Pmo:tree	23.7	9.6	0.0%	-	-	0.0%	-23.7	-9.6	0.0%	-0.8%
Xra-Ss-Ld:tree	66.2	26.8	0.0%	123.6	50.0	0.1%	+57.4	+23.2	0.0%	-0.7%
Psp-Ld:tree	25.5	10.3	0.0%	82.5	33.4	0.1%	+57.0	+23.1	0.0%	-0.7%
Psp-Pm:tree	-	-	0.0%	12.9	5.2	0.0%	+12.9	+5.2	0.0%	-0.7%
Totals Conifer Forest	106,974.8	43,291.3	75.3%	105,980.0	42,888.7	74.6%	-994.8	-402.6	-0.7%	-0.7%
OtC-OtB/XX :tree	3,500.0	1,416.4	2.5%	1,980.1	801.3	1.4%	-1,519.9	-615.1	-1.1%	--1.8%
OtB-Mix:tree	977.1	395.4	0.7%	714.2	289.0	0.5%	-262.8	-106.4	-0.2%	-2.0%
Ama:tree/Ht:herb	415.5	168.1	0.3%	36.9	14.9	0.0%	-378.6	-153.2	-0.3%	-2.2%
OtB-Ama:tree	-	-	0.0%	16.8	6.8	0.0%	16.8	6.8	0.0%	-2.2%

Table 11. Redwood National and State Parks pixel/polygon land cover differences by association (continued).

Association	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Differ.	Cumul. %
Ar:tree/Co:herb	137.7	55.7	0.1%	390.7	158.1	0.3%	253.0	102.4	+0.2%	-2.0%
Ar:tree/Oth:herb	2,642.0	1,069.2	1.9%	1,580.9	639.8	1.1%	-1,061.0	-429.4	-0.7%	-2.8%
Ar-Oth:tree	1,224.5	495.6	0.9%	139.0	56.3	0.1%	-1,085.5	-439.3	-0.8%	-3.5%
OtB-Ar:tree	3,966.7	1,241.0	2.2%	9,556.7	3,867.5	6.7%	6,490.0	2,626.4	+4.6%	+1.0%
Cc:tree/Xt:herb	16.1	6.5	0.0%	-	-	0.0%	-16.1	-6.5	0.0%	+1.0%
Ld-Oth:tree	4,841.8	1,959.4	3.4%	497.0	201.1	0.3%	-4,344.8	-1,758.3	-3.1%	-2.0%
OtB-Ld:tree	1,936.9	783.8	1.4%	7,403.2	2,996.0	5.2%	5,466.3	2,212.2	+3.8%	+1.8%
Qg:tree/Fc:herb	947.6	383.5	0.7%	840.9	340.3	0.6%	-106.7	-43.2	-0.1%	+1.7%
OtB-Qg:tree	4.2	1.7	0.0%	54.6	22.1	0.0%	50.4	20.4	0.0%	+1.8%
Uc:tree/Co:herb	112.0	45.3	0.1%	1.8	0.7	0.0%	-110.2	-44.6	-0.1%	+1.7%
OtB-Uc:tree	0.2	0.1	0.0%	-	-	0.0%	-0.2	-0.1	0.0%	+1.7%
Totals Hardwood Forest	16,322.0	6,605.3	11.5%	21,232.7	8,592.6	14.9%	+4,910.7	+1,987.3	+3.5%	+1.7%
Bp:shrub	186.7	75.5	0.1%	44.9	18.2	0.0%	-141.8	-57.4	-0.1%	+1.6%
OtS-Bp:shrub	43.8	17.7	0.0%	31.7	12.8	0.0%	-12.1	-4.9	0.0%	+1.6%
Ge:shrub	23.1	9.3	0.0%	-	-	0.0%	-23.1	-9.3	0.0%	+1.6%
Lde:shrub	355.9	144.0	0.3%	165.2	66.9	0.1%	-190.6	-77.1	-0.1%	+1.4%
OtS-Lde:shrub	-	-	0.0%	14.2	5.7	0.0%	+14.2	+5.7	0.0%	+1.4%
Qv:shrub	119.4	48.3	0.1%	63.0	25.5	0.0%	-56.4	-22.8	0.0%	+1.4%
OtS-Qv:shrub	-	-	0.0%	6.7	2.7	0.0%	+6.7	+2.7	0.0%	+1.4%
Ra:shrub	140.5	56.9	0.1%	51.1	20.7	0.0%	-89.4	-36.2	-0.1%	+1.3%
Rp:shrub	84.1	34.0	0.1%	39.4	16.0	0.0%	-44.7	-18.1	0.0%	+1.3%
Rs:shrub	186.9	75.6	0.1%	31.9	12.9	0.0%	-154.9	-62.7	-0.1%	+1.2%
Ru-(Mix):shrub	-	-	0.0%	33.8	1378	0.0%	+33.8	+13.7	0.0%	+1.2%
OtS-Ra:shrub	-	-	0.0%	1.8	0.7	0.0%	+1.8	+0.7	0.0%	+1.2%
Sh:shrub	48.2	19.5	0.0%	4.5	1.8	0.0%	-43.7	-17.7	0.0%	+1.2%
Sal-Sal-Oth:shrub	16.7	6.7	0.0%	4.9	2.0	0.0%	-11.7	-4.8	0.0%	+1.2%
OtS-Sal:shrub	7.8	3.2	0.0%	17.5	7.1	0.0%	+9.7	+3.9	0.0%	+1.2%
OtS-Cs:shrub	3.0	1.2	0.0%	3.8	1.5	0.0%	+0.8	+0.3	0.0%	+1.2%
OtS-Ct:shrub	15.5	6.3	0.0%	-	-	0.0%	-15.5	-6.5	0.0%	+1.2%
OtS-Rpu:shrub	83.3	33.7	0.1%	17.9	7.2	0.0%	-65.4	-26.5	0.0%	+1.1%
OtS-Sh:shrub	7.0	2.8	0.0%	-	-	0.0%	-7.0	-2.8	0.0%	+1.1%
Totals Shrublands	1,321.7	534.9	0.9%	532.1	215.3	0.4%	-789.6	-319.5	-0.6%	+1.1%
Am:herb	120.2	48.7	0.1%	216.1	87.4	0.2%	+95.9	+38.8	+0.1%	+1.2%
Lm:herb	30.3	12.3	0.0%	17.2	7.0	0.0%	-13.1	-5.3	0.0%	+1.2%
ODC:herb	295.2	119.5	0.2%	462.6	187.2	0.3%	+167.4	+67.7	+0.1%	+1.3%
Ag-As:herb	192.9	78.1	0.1%	36.6	14.8	0.0%	-156.3	-63.3	-0.1%	+1.2%
Ae-Ce:herb	1,749.0	707.8	1.2%	1,969.6	797.1	1.4%	+220.6	+89.3	+0.2%	+1.4%
Co-DeC:herb	470.5	190.4	0.3%	383.7	155.3	0.3%	-86.3	-35.1	-0.1%	+1.3%
Cp/Fi:herb	50.0	20.2	0.0%	21.8	8.8	0.0%	-28.2	-11.4	0.0%	+1.3%

Table 11. Redwood National and State Parks pixel/polygon land cover differences by association (continued).

Association	Pixel Classification Map			Polygon Map			Map Area Differences			
	Acres	Hectares	% Area	Acres	Hectares	% Area	Acres	Hectares	% Differ.	Cumul. %
HI-HI:herb	339.6	137.4	0.2%	65.1	26.3	0.0%	-274.5	-111.1	-0.2%	+1.1%
HI-Oth:herb	389.6	157.7	0.3%	159.7	64.6	0.1%	-229.8	-93.0	-0.2%	+0.9%
Ho-So:herb	145.5	58.9	0.1%	57.6	23.3	0.0%	-87.9	-35.6	-0.1%	+0.9%
HI-Cb:herb	1.4	0.6	0.0%	-	-	0.0%	-1.4	-0.6	0.0%	+0.9%
Ma-Oth:herb	65.4	26.5	0.0%	146.2	59.2	0.1%	+80.7	+32.7	+0.1%	+0.9%
Co:herb	43.4	17.5	0.0%	87.1	35.3	0.1%	+43.8	+17.7	0.0%	+0.9%
Pa:herb	44.8	18.1	0.0%	-	-	0.0%	-44.8	-18.1	0.0%	+0.9%
Sm:herb	26.7	10.8	0.0%	5.5	2.2	0.0%	-21.2	-8.6	0.0%	+0.9%
Sa:herb	13.4	5.4	0.0%	1.2	0.5	0.0%	-12.3	-5.0	0.0%	+0.9%
TI:herb	28.1	11.4	0.0%	23.5	9.5	0.0%	-4.6	-1.9	0.0%	+0.9%
OtA-Oth:herb	24.5	9.9	0.0%	33.4	13.5	0.0%	+8.9	+3.6	0.0%	+0.9%
OGC:herb	1,181.4	478.1	0.8%	1,557.8	630.4	1.1%	+376.4	+152.3	+0.3%	+1.2%
OHC:herb	82.1	33.2	0.1%	62.0	25.1	0.0%	-20.1	-8.1	0.0%	+1.1%
Totals Herbaceous	5,294.0	2,142.4	3.7%	5,306.5	2,147.5	3.7%	+12.6	+5.1	0.0%	+1.1%
SvgS:other	-	-	0.0%	14.2	5.8	0.0%	+14.2	+5.8	0.0%	+1.1%
SvgW:other	-	-	0.0%	11.8	4.8	0.0%	+11.8	+4.8	0.0%	+1.2%
Bar:other	606.1	245.3	0.4%	215.2	87.1	0.0%	-390.9	-158.2	-0.3%	+0.9%
BarH:other	672.4	272.1	0.5%	269.9	109.2	0.0%	-402.5	-162.9	-0.3%	+0.6%
BarS:other	293.4	118.8	0.2%	253.5	102.6	1.1%	-40.0	-16.2	0.0%	+0.6%
BarW:other	481.1	194.7	0.3%	127.6	51.6	0.0%	-353.5	-143.1	-0.2%	+0.3%
Totals Barren	2,053.1	830.9	1.4%	866.2	350.5	0.6%	-1,186.9	-480.3	-0.8%	+0.3%
H2O:other	6,035.0	2,442.3	4.2%	6,138.0	2,484.0	4.3%	+103.4	+41.7	+0.1%	+0.4%
Unknown:other	561.8	227.3	0.4%	0.6	0.2	0.0%	-561.2	-227.1	0.0%	0.0%
Grand Total	142,062.3	57,490.8	100.0%	142,062.3	57,490.8	100.0%	0.0	0.0	0.0%	0.0%

Mixed Forest alliances which each actually showed minor increases of 57 and 70 acres respectively due to the presence of the pine indicator species. While the *Alnus rubra* and *Lithocarpus densiflorus* dominated alliances increased, the area of *Quercus garryana* Forest alliance declined by only 56 acres. However, most of the other less common predominantly pure single-species hardwood alliances were significantly impacted by the aggregation process. The few acres of the *Chrysolepis chrysophylla* Forest alliance were completely removed from the aggregated map data set, while the area of the *Acer macrophyllum* Forest and *Umbellularia californica* Forest alliances were reduced by 90 to 99% of their pixel classification map areas. The dramatic decline of these types tends to indicate that they were not present in the pixel classification maps as stands of at least 0.5 hectares or 1.2 acres and they were absorbed into adjacent tree type stands as the MMU limits were met.

The area of shrubland alliances declined following aggregation by 790 acres which was a decline of -60% of the original shrubland area, but only -0.6% of the total area. Most of this decline was accounted for by decreases in the area of the *Baccharis pilularis* Shrubland, *Lithocarpus densiflorus* Shrubland, and the *Rubus* Shrubland. The area of these alliances decreased 154 acres, 176 acres, and 254 acres respectively. The area of the *Garrya elliptica* Shrubland alliance completely disappeared during the aggregation process. These changes indicate that many shrubland type pixels did not occur in groups large enough to meet the MMU limits and form stands during the aggregation process and they were likely absorbed into adjacent tree type alliance stands.

The overall balance of area of the herbaceous alliances changed by only 13 acres, a relatively insignificant amount. Dune alliances increased by about 250 acres, Riverine alliances declined slightly by 9 acres, aquatic alliances declined by about 30 acres, and the major grassland alliances declined by approximately 200 acres. The alliances that increased the most were the *Arrhenatherum elatius-Cynosurus echinatus* Grassland, Other Grassland, Other Dune Herbaceous, and the *Ammophila arenaria* Grassland alliances which increased in area by 221 acres, 376 acres, 167 acres, and 96 acres respectively. The *Arrhenatherum elatius-Cynosurus echinatus* Grassland alliance represents the most common herbaceous alliance which likely absorbed some of the less common but too-small-to-keep groups of other herbaceous alliance pixels. Both of these “Other” alliances represent mixtures that were created during the aggregation process and likely increased during the aggregation process. The *Ammophila arenaria* Grassland alliance likely increased in area as isolated pixels or small groups of barren sand pixels were aggregated with the *Ammophila arenaria* Grassland alliance type pixels to form larger stands of this alliance. The alliance that demonstrated the largest decrease was the *Holcus lanatus-Anthoxanthum odoratum* Grassland alliance which declined 504 acres or about two-thirds of its original area. Such declines were likely due to the pixels classified as this alliance being scattered amongst the other pixel alliances, such that large areas did not exist, and mixed “Other” alliances were likely formed as the pixels were aggregated.

A small area of Sparse Vegetation alliance totaling 26 acres was formed during the aggregation process; this alliance did not exist at the pixel level. These associations were most likely formed in areas that were classified as barren pixels that were interspersed with a smattering of low cover herbaceous, shrub, or tree type pixels. The resulting stand had at least 15% vegetative cover but did not meet the thresholds of any particular vegetated association. As a result it was assigned this Sparse

Vegetation designation to differentiate it from a truly barren area. Examples of such areas might be sparsely vegetated slides, road right-of-ways, and rock out crops.

Of the other major alliances, the Barren type alliance decreased from 2,053 acres to 866 acres, a decline of nearly 60%. This decline indicates that many of the pixels classified as a Barren alliance did not occur in sufficiently large groups that met the MMU limits. Many of the barren pixels were on portions of the beaches, gravel/sand bars, roads, and old landings which more often than not did not occur in areas larger than 0.5 hectares or 1.2 acres. As they were merged with adjacent vegetated pixels, the vegetation characteristics of the adjacent pixels overwhelmed the barren pixel characteristics, resulting in a group of pixels whose averaged characteristics now met one of the vegetated alliance definitions.

The total area of the Water type increases very slightly by 103 acres or 0.1% of the total area; this is likely due to the aggregation of some small less than MMU size areas of wet herbaceous or barren types along the edges of prominent water bodies and river channels that are aggregated into those water type areas rather than into other adjacent types that may be either forestland, shrubland, or a dry or mesic herbaceous type areas. As these non-water type pixels are aggregated into the larger bodies of water they most often do not contribute enough non-water cover composition to the resulting polygon's cover attributes to change the polygon's Water type designation to a different type.

There were 561 acres of "Unknown" alliance in the pixel classification map. Only one "Unknown" stand amounting to 3 contiguous pixels (0.6 acres) was present in the aggregated stand map data set, indicating the extremely isolated nature of these "Unknown" pixels that lead to nearly all of them being absorbed into adjacent stands with an USNVC alliance and association designation.

5.2 Changes in Mapped Associations

Following the aggregation efforts, the area totals represented by different associations mapped as pixels and polygons also experienced some shifts in area (see Table 11). While alliance level area totals showed an overall increase of forestland alliance total area due primarily to an increase of the area of the hardwood alliances accompanied by decreases of total area for nearly all other major types of alliances, with the exception of the herbaceous alliances and water land cover class, which basically maintained their total pixel area. When viewing changes at the association level, there are some major changes in area, which while not significantly impacting the alliance area totals did result in some significant changes in association totals. Most of these changes are due to shifts of species composition as pixels were aggregated into stands and stand composition was calculated as the weighted average of each stand's pixel components. Large homogeneous areas tended to retain the same association at both the pixel and stand level, whereas areas of mixed pixel composition tended to gravitate towards those key associations identified by the order of the most predominant species listed in the key.

Many acres of *Sequoia sempervirens* Mature Forest shifted associations. The Ss:tree/Pmu:herb association decreased by about 5,200 acres while the Ss:tree/Vo:shrub association increased by over 5,800 acres. The drier Ss-Ame:tree association basically disappeared from the map as it decreased by

975 acres while the Ss-Ama-Uc:tree association increased by 778 acres. Most of the Ss-Ame:tree area was absorbed into the drier Ss:tree/Vo:shrub association while much of the increase in the Ss-Ama-Uc:tree association area came from the Ss:tree/Pmu:herb association. The remaining shift was from the Ss:tree/Pmu:herb association to the Ss:tree/Vo:shrub association indicating that as many stands were formed from this mixture of pixels that the average cover of shrub components indicating the Vo:shrub understory tended to be greater than the average cover of the herbaceous components that indicated the Pmu:herb understory.

There was a significant shift in area that occurred in the *Sequoia sempervirens*-(Other) YG Mixed Forest associations. Overall, this alliance increased by over 6,000 acres, but the overwhelming component of this shift was an increase in the Ss-Ld:tree (22,458 acres) and Ld-Ss:tree (305 acres) associations. In the pixel map data set these associations accounted for 10.7% of the total parkland area whereas they accounted for 26.7% of the total parkland area in the stand map data set. All other *Sequoia sempervirens*-(Other) YG Mixed Forest associations showed declines in stand area relative to pixel area from a low of 1,093 acres to a high of 3,945 acres. This dramatic shift in the area of the *Sequoia sempervirens*-(Other) YG Mixed Forest associations is likely due to the very common occurrence of *Lithocarpus densiflorus* as a component of most of these associations. It is certainly a significant component of the original 18,261 acres of pixels named as either Ss-Ld:tree, Ld-Ss:tree, or Ld-Ss-Oth:tree associations. The aggregation of the pixels into stands appears to have resulted in many stands having an estimated average *Lithocarpus densiflorus* cover of at least 25% at the stand level thereby meeting the key threshold for the Ss-Ld:tree or Ld-Ss:tree associations and assigning this association before any other species components are evaluated.

Many of the other *Picea sitchensis* dominated conifer associations in the *Picea sitchensis* Forest alliances declined in total area from a low of 168 acres to a high of 1,048 acres, while the mixed OtC-Ps:tree association in which *Picea sitchensis* was the most commonly occurring species, but did not comprise the majority of the tree cover, increased by 1,604 acres. A similar trend was seen in the *Pseudotsuga menziesii* Forest associations as these associations declined in total area from a low of 47 acres to a high of 756 acres in the stand map data set, while the Ar-Pm:tree association representing a mixed species association increased in area by 168 acres. The three specific pine dominated associations representing *Pinus jeffreyi*, *Pinus monticola*, and *Pinus attenuata* showed a similar trend as they lost area in the stand map, while the mixed pine associations, Psp-Ld:tree and Psp-Pm:tree, and the Xra-Ss-Ld:tree slightly increased in area.

There was a major loss in area from Pm-Ld-Oth:tree association as it declined by 6,600 acres while the Pm-Ld-Ame:tree association increased by 1,456 acres. Overall this alliance declined 5,203 acres as many of the Pm-Ld-Oth:tree association pixels were absorbed into neighboring groups of pixels of the Pm-Ld-Ame:tree association or into nearby stands with at least 25% cover of *Sequoia sempervirens* that combined to form a Ss-Ld:tree association.

The hardwood associations showed a general trend of single-species majority dominated associations declining while the mixed species associations increased in area. Thousands of acres shifted from the single-species majority *Alnus rubra* and *Lithocarpus densiflorus* associations to mixed species associations in which these species still provided the most cover, but not the majority. In most of

these cases the changes in area occurred because the average cover of the previous species of majority cover at the pixel level failed to satisfy the majority requirement at the stand level. As a result, area tended to shift from single-species majority associations to mixed species associations within each species alliance. As previously mentioned in the discussion of pixel and alliance area changes, one of the single-species associations, Cc:tree/Xt:herb, disappeared from the stand map and the area of the *Acer macrophyllum* and *Umbellularia californica* associations nearly disappeared from the stand map.

The shrubland associations showed changes similar to the trend shown by the hardwood associations. Several of the single-species majority dominated associations declined in area while the mixed species associations increased in area. This happened for the associations of all the shrubland alliances except for the *Baccharis pilularis*, *Garrya elliptica*, and other mixed Shrubland alliances. Many of these shrubland association pixels comprised such a small area that they lost most if not all of their area during the aggregation process. Only 532 acres of the original 1322 acres of shrubland pixels survived the aggregation process, indicating that many of these shrubland pixels occurred in groups of pixels smaller than the MMU size limit.

As previously mentioned, the overall balance of area of the herbaceous associations changed by only 13 acres, a relatively insignificant amount. As many of these alliances are also associations the changes shown at the association level are basically the same as those shown at the alliance level. The associations that increased the most were the Ae-Ce:herb, OtG:herb, ODC:herb, and the Ama:herb associations which increased in area by 221 acres, 376 acres, 167 acres, and 96 acres respectively. The Ae-Ce:herb association represents the most common herbaceous association which likely absorbed some of the less common but too-small-to-keep groups of other herbaceous association pixels. Both of these “Other” associations represent mixtures that were created during the aggregation process and likely increased during the aggregation process. The Ama:herb and ODC:herb associations likely increased in area as isolated pixels or small groups of barren sand pixels were aggregated with the Ama:herb association type pixels to form larger stands of this association. The associations that demonstrated the largest decrease were the Hl-Hl:herb and Hl-Oth:herb associations which declined 274 and 230 acres respectively. Such declines were likely due to the pixels classified as these associations being scattered amongst the other pixel associations, such that large contiguous areas did not exist, and mixed “Other” alliances were likely formed as the pixels of other herbaceous associations were aggregated together to form a herbaceous area.

Of the other major associations, the area of Barren type associations decreased from 2,053 acres to 866 acres, a decline of nearly 60%. This decline indicates that many of the pixels classified as one of the Barren associations did not occur in sufficiently large contiguous groups that met the MMU limits. Many of the barren association pixels were on portions of the beaches, gravel/sand bars, roads, and old landings which more often than not did not occur in areas larger than 0.5 hectares or 1.2 acres. As they were merged with adjacent vegetated pixels, the vegetation characteristics of the adjacent pixels overwhelmed the barren pixel characteristics, resulting in a group of pixels whose averaged characteristics now met one of the vegetated association definitions.

A small area of SVg associations totaling 26 acres was formed during the aggregation process that did not exist at the pixel level. These associations were likely formed in areas likely classified as barren interspersed with a smattering of low cover herbaceous, shrub, or tree type pixels. The resulting stand had at least 15% vegetative cover but did not meet the thresholds of any particular vegetated association. As a result it was assigned this Sparse Vegetation designation to differentiate it from a truly barren area. Examples of such areas might be sparsely vegetated slides, road right-of-ways, and rock out crops.

The total area of the Water type increases very slightly by 103 acres or 0.1% of the total area; this is likely due to the aggregation of some small less than MMU size areas of wet herbaceous or barren types along the edges of prominent water bodies and river channels that are aggregated into those water type areas rather than into other adjacent types that may be either forestland, shrubland, or a dry or mesic herbaceous type areas. As these non-water type pixels are aggregated into the larger bodies of water they most often do not contribute enough non-water cover composition to the resulting polygon's cover attributes to change the polygon's Water type designation to a different type.

Lastly, and as previously mentioned, there were 561 acres of the "Unknown" association in the pixel classification map. Only one "Unknown" stand amounting to 3 contiguous pixels (0.6 acres) was present in the aggregated stand map data set, indicating the extremely isolated nature of these "Unknown" pixels that lead to nearly all of them being absorbed into adjacent stands with an USNVC alliance and association designation.

Chapter 6 - Thematic Accuracy Assessment

6.1 Introduction

This report provides the results of a thematic accuracy assessment (AA) of the imagery based vegetation map for RNSP (study area) conducted by Kier Associates in 2013 and 2014 (Order # P10PD76458).

The thematic accuracy of a remotely sensed map is the probability, for any location depicted by the map, that the thematic map class that is depicted by the product for that location will match the class in the same theme as observed at the location on the earth's surface. NVMI protocols (Lea and Curtis 2010) require that this probability (accuracy) be assessed for individual classes within the theme (*i.e.*, individual vegetation map classes).

For individual classes, there are two aspects of accuracy that are of interest to a map user. User's accuracy is the probability that the class, wherever depicted by the map, has been mapped accurately (as observed on the ground) and is equivalent to 100% minus the estimated rate of errors of commission, for observations that were placed and made within that map class. Producer's accuracy for a class is the probability that the class, wherever it may be encountered on the ground, will have been depicted correctly by the map and is equivalent to 100% minus the estimated rate of errors of omission, for all observations that were identified as the class on the ground.

To assess individual classes, a random sample of locations within the class (the sample data) is selected. A field observer who is not informed of ("blind to") the sample data values then visits the locations on the ground and establishes their thematic identity from that perspective (the reference data). The reference data value is assumed to be the accurate value, and accuracy is estimated as the percentage of all observations that have sample and reference data values matching.

Individual class accuracy rates are of interest to a map user because resource management activities often are directed toward individual map classes or smaller sets of classes of interest, rather than toward the entire map (Lea and Curtis 2010). User's and producer's accuracy rates lend insight into which classes are confused with which other classes into the rate of over-mapping or under-mapping for individual classes. In order to allow relatively robust per-class estimation, the AA observations are stratified by map class to ensure a reasonably large sample size for each class.

Overall accuracy is the probability that any individual site depicted by the map will have been mapped accurately (*i.e.*, the probability that the class depicted by the map and the class observed on the ground will match). Such an estimate pertains to the entire map, regardless of the identity of the classes involved in the errors, and is a simplified metric that lends insight into the overall quality and reliability of the map. When AA observations are stratified by map class, the individual class samples typically are pooled to yield an overall map accuracy estimate.

Since the sampling design to obtain individual class user's accuracies constitutes simple random sampling within each class, the user's accuracy for a class is estimated simply as the number of observations for which the ground observation is a match with the map class. Calculation of

producer's accuracies is more complex, since the occurrence of any class as it occurs on the ground cannot be predicted *a priori*. Therefore, individual observations must be weighted by the size of the map class (sampling stratum) in which they were observed, since the different strata have different sizes and, therefore, observations between strata will have different probabilities of inclusion (Czaplewski 1992, 2003; Congalton and Green 2009; Lea and Curtis 2010).

Similarly, individual observations that are pooled in order to estimate overall accuracy have unequal probabilities of inclusion because they are sampled from map class strata of different sizes. The subsample from each individual map class must be weighted by its map class size when it is pooled with the other subsamples. The calculations of Lea and Curtis (2010) for simple random sampling (for user's accuracies) and for stratified random sampling (for producer's accuracies and overall accuracy) were applied. The results were displayed as (1) a sample contingency table, which is a matrix that depicts the total raw counts of AA observations having sample data (map class) values and reference data (field call) values and as (2) a population (or proportional) contingency table, which is a matrix of the same sample/reference value data adjusted to their estimated representative proportion of the entire map (Lea and Curtis 2010).

The proportions for individual classes in a population contingency table that may represent confusion between classes may be aggregated together to estimate map class accuracies, for at thematically coarser, but more accurate, renditions of the map. For RNSP, estimations of class accuracy at the alliance level were aggregated to obtain accuracies at coarser levels of the USNVC (*e.g.*, group to class levels).

6.2 Methods

6.2.1 Sampling Design

A simple random sampling design was used to allocate reference plots within each generalized alliance level map class. The plots were buffered from access including trails, roads, and highways so that the points would be far enough from access to avoid any influence of the road or trail, but be close enough so that the points could be accessed within a reasonable amount of effort and safety.

The buffers used were:

- A minimum of 70, but no more than 370 meters from any highway
- A minimum of 25, but no more than 325 meters from other roads
- A minimum of 5, but no more than 305 meters from trails

All highway, road, and trail GIS layers used for buffering were provided by RNP. All GIS processes and analyses were completed using Windows XP based ESRI ArcMap, ArcTools, and ArcGIS Version 10.0 software.

Kier Associates worked closely with RNSP staff to determine the appropriate number of reference plots to be sampled within each map class. It was ultimately determined that one point per five hectares was appropriate for the project, but with a minimum of five points for smaller map classes

and a maximum of 30 points for larger map classes. The polygons for each map class were “dissolved” into single features prior to generating the random coordinates within them with ArcGIS.

The formula used to allocate the points was:

- if $A < 25$ ha, $N = 5$
- if $25 \text{ ha} \leq A \leq 150 \text{ ha}$, $N = 0.2$ per ha
- if $A > 150$ ha, $N = 30$

Where A = Total are of the map class and N = Number of random reference plots.

This formula resulted in 718 random points, with points not being assigned to the “water” map class. RNSP then requested that points be removed from the Barren, *Umbellularia californica* Forest, and *Arrhenatherum elatius*-*Cynosurus echinatus* Grassland map classes in addition to points in the *Leymus mollis* Grassland map class near the mouth of the Klamath River. A second set of random points was then generated with these constraints resulting in 657 random points across 39 map classes. The plot number for each point was randomly assigned to the points, so that points within each map classes were not numbered sequentially.

Four other small map classes that posed access issues and lacked enough accessible area to make it feasible to move reference plots were also excluded from the sampling: *Acer macrophyllum* Forest, *Quercus vaccinifolia* Shrubland, Sparse Vegetation, and *Sparganium* Herbaceous. Seven additional map classes were combined with other classes. Ultimately, the following 30 map classes were used:

1. *Alnus rubra* Forest
2. *Ammophila arenaria* Grassland
3. *Baccharis pilularis* Shrubland
4. *Carex obnupta* Herbaceous
5. *Carex obnupta*-*Deschampsia cespitosa* Grassland
6. Dune Herbaceous (*Leymus mollis* Grassland + Other Dune Herbaceous)
7. *Festuca idahoensis* Grassland
8. *Lithocarpus densiflorus* Shrubland
9. *Lithocarpus densiflorus*-(Other) YG Mixed Forest
10. Montane Conifer-Hardwood Mixed Forest
11. Montane Hardwood Mixed Forest
12. Other Aquatic Herbaceous
13. Other Dry Mixed Shrubland
14. Other Herbaceous
15. Native/Non-native Perennial Grassland (*Holcus lanatus* mixed +Other Grassland + *Agrostis gigantea*-*Agrostis stolonifera* Grassland)
16. *Picea sitchensis*-(Other) Forest
17. *Pinus attenuata* Forest
18. *Pinus jeffreyi* Forest
19. *Pinus monticola* Forest

20. *Pinus radiata* X *attenuata* YG Mixed Forest
21. *Pinus* species Mixed Forest
22. *Pseudotsuga menziesii*-(Other) YG Mixed Forest
23. *Pseudotsuga menziesii*-*Lithocarpus densiflorus* YG Mixed Forest
24. *Quercus garryana* Forest
25. Riverine Herbaceous (*Heterotheca oregona* Herbaceous+ Other Riverine Herbaceous)
26. *Rubus* Shrubland
27. *Salix* Shrubland
28. *Sequoia sempervirens* Mature Forest
29. *Sequoia sempervirens*-(Other) YG Mixed Forest
30. *Typha latifolia* Herbaceous

It was the initial intent that the field personnel would be completely blind to the map classes and were not initially given a copy of the map. During the course of the project it became necessary for points to be moved by the field personnel and the map was provided for the purpose of moving inaccessible points within the same map class. The map was not studied or evaluated and was not viewed in areas where points were not relocated until the field work was completed.

Many of the original reference plots, although buffered from existing roads and trails were not accessible for a variety of reasons. Many of the roads were not useable because they were blocked by fallen trees, overgrown, or decommissioned. Steep terrain, impenetrable vegetation, and long distances from vehicle access for points along trails often impeded access to reference plots. In many of these cases, the plots were moved to improve access. There were three ways in which plots were moved. (1) In cases where the observer was in relatively close proximity to the point, but could not reach the point because of steep terrain or impenetrable vegetation, a new waypoint was taken "on the fly" at the point where the attempt was abandoned. In some cases, the new points were in different map classes. The field personnel were still blind to the map classes when points were moved this way. Waypoints were taken using the averaging feature in the Garmin GPSmap 62 receivers. (2) When the reference plots were on or very near the boundary between vegetation types, the point was moved into one of the vegetation types. In some cases this also resulted in reference plots changing map classes. Field personnel were still blind to the map classes. (3) For plots associated with unusable roads or where the observer could not get within close proximity to the point (generally about 500 feet), the points were moved to more accessible areas using the map GIS software. Plots were haphazardly placed in accessible areas, in no cases was the person moving the point aware of the vegetation in the area the point was placed. An effort was made to replace as many of the inaccessible plots and feasible, however not all of them were replaced. With the removing of additional map classes, combining of others, and access issues, 512 reference plots were ultimately sampled. Of these, 187 were moved from their original random locations. 85 of these were moved "on the fly" and field personnel were still blind to the map class. 102 of the plots were moved using the map by field personnel that were then aware of the map class when the plot was sampled.

The need to move such a large number of the plots was an unexpected during the initial planning and the development of buffer distances. Given the terrain and often dense vegetation of the study area, if

would have been more ideal to have smaller buffers from trails and only clearly drivable roads when possible. Although this would have decreased the sampling area size, it would have helped maintain the "blindness" of field personnel and the truly random sampling design that was initially created. Of the 512 plots sampled, 325 (63%) of them were not moved and, therefore truly random and also unbiased, since the field personnel were blind to the map class. In 85 additional reference plots that were moved "on the fly" in field, the personnel were still blind as to the map class and, therefore, unbiased. Thus, in 410 (80%) of the 512 plots field personnel were unaware of the map class when the reference plots were sampled. In the additional 102 plots (20%), field personnel were aware of the map classes when the plots were sampled. Any bias created in making the field call while knowing the map class would have likely leaned towards the map class and a higher reported map accuracy.

6.2.2 Field Methods

A shapefile of the reference plot coordinates was uploaded into DNR Garmin Version 5.4.1., then converted to a GPS Exchange File (GPX) and uploaded into Garmin GPSmap 62 receivers, which were used to navigate to the points on the ground. Many of the unpaved roads used for access required use of a four-wheel drive truck or an ATV. The field work occurred from mid-August 2013 to mid-September 2014.

At each point the vegetation was identified to the alliance level using the key provided by RNP. The observation area was 0.5 hectares. This was predominately circular plot 40 meters in radius. In relatively few cases, which were mainly in immediate coastal areas, the reference plot was an irregular shape or rectangle. If the plot was on or very near (closer than GPS accuracy) the boundary between two vegetation types, it was moved as described in Section 2.1 above. The data were recorded on field data forms.

6.2.3 Analysis

The reference data (field classes) were entered into an excel spreadsheet containing the list of plot numbers and their map classes. The final data was sorted by map class and field class in Excel. The number and type of each field class was tallied for each map class and entered into the sample contingency table. The population contingency tables were calculated using the methods of Lea and Curtis (2010).

6.3 Results and Discussion

The distribution of individual observation points is depicted in a sample contingency table (Table 12). The overall map accuracy at the thematic resolution of generalized alliance was 65.5% with the lower and upper 90% confidence intervals at 58.8% and 72.1%, respectively. Users' and producers' accuracy for the map classes range from 0-100% (Table 13). The *kappa* index for estimated accuracy (Foody 1992) is 44.1% (90% confidence interval: 40.4%-47.8%).

The largest map class, young redwood (*Sequoia sempervirens* YG Mixed Forest) has a users' accuracy of 80.6% and a producers' accuracy of 79.3%. A total of 46 plots mapped as other map classes were *Sequoia sempervirens* YG Mixed Forest, thus increasing the estimate of true area of young redwood forest in the study area.

The users' accuracy of the second largest map class, mature redwood (*Sequoia sempervirens* Mature Forest), was 65.6%. The producers' accuracy was 100%. No reference plots in other map classes were recorded as mature redwood. Six sample plots in areas mapped as mature redwood were Sitka spruce forest (*Picea sitchensis* Forest), four of the sample plots had been previously logged and were classified as young redwood, and one plot was in *Pseudotsuga menziesii*-*Lithocarpus densiflorus* YG Mixed Forest. Thus, the estimated true area of mature redwood decreased in the study area.

The most accurate map classes were: *Festuca idahoensis* Grassland, *Pinus jeffreyi* Forest, *Pinus radiata* X *attenuata* YG Mixed Forest, *Quercus garryana* Forest, and *Picea sitchensis* Forest.

Map classes with 0% or very low accuracy include: *Carex obnupta* Herbaceous, *Lithocarpus densiflorus* Shrubland, Montane Hardwood Mixed Forest, Other Dry Mixed Shrubland, *Pinus* species Mixed Forest, and Montane Conifer-Hardwood Mixed Forest.

Five classes were identified that were not mapped. Plots were not sampled in the Barren or *Quercus vacciniifolia* Shrubland map classes, however reference plots in other map classes were identified as these field classes. Three other vegetation types were included in the vegetation key, but not on the map, and are assumed to have been determined to not have areas over the minimum mapping unit of 0.5 hectares in the study area. Reference plots for other map classes were identified as *Chamaecyparis lawsoniana* Forest, *Tsuga heterophylla* Forest, and Other conifer mixed alliance in stands that were larger than 0.5 hectares.

Using the thematic accuracy assessment results and map class sizes, the true areas of each class, adjusted for mapping error, can be estimated for classes (Czaplewski 1992, 2003; Lea and Curtis 2010) and are depicted for RNSP in Table 14. This information is informative for management, since it enables more representative estimates of the true areas of vegetation classes, accounting for tendencies to over-map or under-map individual types.

Tables 15-19 depict estimated individual map class accuracies for aggregations of the generalized alliance map classes to coarser levels of the USNVC (Lea and Curtis 2010). These estimated accuracies are 86.2%, 95.4%, 96.0%, 96.0%, 96.9%, and 97.4% at the USNVC levels of group, macrogroup, division, formation, subclass, and class, respectively. This information is useful for uses of the map that may require higher accuracy but less thematic resolution.

Table 12. Sample contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - generalized alliance level.

	<i>Pinus attenuata</i> Forest	<i>Pinus radiata</i> × <i>attenuata</i> YG Mixed Forest	<i>Quercus garryana</i> Forest	<i>Pinus jeffreyi</i> Forest	<i>Pinus monticola</i> Forest	<i>Pinus</i> species Mixed Forest	<i>Alnus rubra</i> Forest	<i>Chamaecyparis lawsoniana</i> Forest	<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	Montane Conifer-Hardwood Mixed Forest	Montane Hardwood Mixed Forest	Other conifer mixed alliance	<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG	<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	<i>Sequoia sempervirens</i> Mature Forest	<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	<i>Picea sitchensis</i> -(Other) Forest	<i>Tsuga heterophylla</i> Forest	<i>Quercus vaccinifolia</i> Shrubland	<i>Festuca idahoensis</i> Grassland	Perennial Grassland	Other Herbaceous	<i>Lithocarpus densiflorus</i> Shrubland	Other Dry Mixed Shrubland	<i>Baccharis pilularis</i> Shrubland	<i>Rubus</i> Shrubland	Dune Herbaceous	<i>Ammophila arenaria</i> Grassland	Riverine Herbaceous	<i>Salix</i> Shrubland	<i>Carex obnupta</i> Herbaceous	<i>Carex obnupta-Deschampsia cespitosa</i> Grassland	<i>Typha latifolia</i> Herbaceous	Other Aquatic Herbaceous	Bare	TOTALS, SAMPLE DATA (<i>ni</i> +)				
<i>Pinus attenuata</i> Forest	11			6									3	1		1																						22		
<i>Pinus radiata</i> × <i>attenuata</i> YG Mixed Forest		9														1																						10		
<i>Quercus garryana</i> Forest			26						1	1	1																												29	
<i>Pinus jeffreyi</i> Forest				12										1																									13	
<i>Pinus monticola</i> Forest					10			6	1				2	3									1																23	
<i>Pinus</i> species Mixed Forest	5			5										1																									11	
<i>Alnus rubra</i> Forest							13									5	3	1									1												23	
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	1								5	1			11	1		9																							28	
Montane Conifer-Hardwood Mixed Forest	1							1	1	1			4	1		4	7																						20	
Montane Hardwood Mixed Forest			1				3		1					1			4							1	2	4						1							18	
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG Mixed Forest													10	7		4					1																		22	
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest												4		3		2	1						1																	11
<i>Sequoia sempervirens</i> Mature Forest													1		21	4	6																						32	
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest							2						2	1		25	1																						31	
<i>Picea sitchensis</i> -(Other) Forest																1	25									2	2													30
<i>Festuca idahoensis</i> Grassland																				6																			6	
Perennial Grassland			2				2			1			2			4	4					16			1	2	2	1	2				3		1					43
Other Herbaceous																	1					2				2													5	
<i>Lithocarpus densiflorus</i> Shrubland													3	1		4			1																				9	
Other Dry Mixed Shrubland																															1									3
<i>Baccharis pilularis</i> Shrubland																	1									1	1													3
<i>Rubus</i> Shrubland																										2	7													9
Dune Herbaceous																	1										1	10	13				2					6	33	
<i>Ammophila arenaria</i> Grassland																												5	8				2					2	17	
Riverine Herbaceous							1																		3	1		1		8	2							2	18	
<i>Salix</i> Shrubland																														1	1									2
<i>Carex obnupta</i> Herbaceous																					2							1	2						1				6	
<i>Carex obnupta-Deschampsia cespitosa</i> Grassland									2				2			7					3						1		3				4	3					25	
<i>Typha latifolia</i> Herbaceous							1																												4				5	
Other Aquatic Herbaceous																	2																		1				5	
TOTALS, REFERENCE DATA (<i>n</i> + <i>j</i>)	18	9	29	23	10	0	22	7	11	4	1	4	40	21	21	71	56	1	1	6	22	2	2	5	12	21	18	28	10	4	13	4	5	1	10			n = 512		

Table 13. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - generalized alliance level.

	<i>Pinus attenuata</i> Forest	<i>Pinus radiata</i> × <i>attenuata</i> YG Mixed Forest	<i>Quercus garryana</i> Forest	<i>Pinus jeffreyi</i> Forest	<i>Pinus monticola</i> Forest	<i>Pinus</i> species Mixed Forest	<i>Alnus rubra</i> Forest	<i>Chamaecyparis lawsoniana</i>	<i>Lithocarpus densiflorus</i> -(Other)	Montane Conifer-Hardwood Mixed For.	Montane Hdwd. M. F.	Other conifer mixed allian.	<i>P. menziesii</i> - <i>L. densiflorus</i> YGMF	<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	<i>Sequoia sempervirens</i> Mature Forest	<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	<i>Picea sitchensis</i> -(Other) Forest	<i>Tsuga heterophylla</i>	<i>Quercus vaccinifolia</i>	<i>Festuca idahoensis</i> Grassland	Other Grassland	Other Herbaceous	<i>Lithocarpus</i> Shrubl.	Other Mixed Shrubland	<i>Baccharis pilularis</i> Shrubland	<i>Rubus</i> Shrubland	Dune Herbaceous	<i>Ammophila arenaria</i> Grassland	Riverine Herbaceous	<i>Salix</i> Shrubland	<i>Carex obnupta</i> Herbaceous	<i>C. obnupta</i> - <i>D. cespitosa</i> Grassland	<i>Typha latifolia</i> Herbaceous	Other Aquatic Herbaceous	Bare	ESTIMATED USER'S ACCURACY (%)			
<i>Pinus attenuata</i> Forest	T			T									T	T		T																					50		
<i>Pinus radiata</i> × <i>attenuata</i> YG Mixed Forest		T														T																					90		
<i>Quercus garryana</i> Forest			0.6						T	T	T																											90	
<i>Pinus jeffreyi</i> Forest				T										T																								92	
<i>Pinus monticola</i> Forest					T			T	T				T	T									T															43	
<i>Pinus</i> species Mixed Forest	T			T										T																								0	
<i>Alnus rubra</i> -(Other) Forest							5.1									2.0	1.2	T									T											57	
<i>Chamaecyparis lawsoniana</i> Forest																																						N/A	
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	T								1.1	T			2.4	T		1.9																						18	
Montane Conifer-Hardwood Mixed Forest	T							T	T	T			T	T		T	0.5																					5	
Montane Hardwood Mixed Forest			T				T		T					T			T							T	T	T									T			0	
Other conifer mixed alliance																																						N/A	
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YGM Forest													1.2	0.8		0.5					T																	45	
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest												T		T			T	T					T															27	
<i>Sequoia sempervirens</i> Mature Forest													0.9		19.3	3.7	5.5																					66	
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest							2.7						2.7	1.4		34.0	1.4																					81	
<i>Picea sitchensis</i> -(Other) Forest																	T	2.1								T	T												83
<i>Tsuga heterophylla</i> Forest																																							N/A
<i>Quercus vaccinifolia</i> Shrubland																																							N/A
<i>Festuca idahoensis</i> Grassland																					T																	100	
Other Grassland			T				T			T			T			T	T				1.1			T	T	T	T	T	T	T						T		37	
Other Herbaceous																	T					T				T												40	
<i>Lithocarpus densiflorus</i> Shrubland													T	T		T																						0	
Other Mixed Shrubland																																						0	
<i>Baccharis pilularis</i> Shrubland																											T	T											33
<i>Rubus</i> Shrubland																											T	T											78
Dune Herbaceous																												T	T	T	T							T	30
<i>Ammophila arenaria</i> Grassland																													T	T	T							T	47
Riverine Herbaceous																					T								T	T								0	
<i>Salix</i> Shrubland									T				T								T						T			T	T							12	
<i>Carex obnupta</i> Herbaceous																																							20
<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland							T																		T	T												44	
<i>Typha latifolia</i> Herbaceous																																							50
Other Aquatic Herbaceous							T																																80
Bare																																							N/A
ESTIMATED PRODUCER'S ACCURACY (%)	27	100	77	48	100	0	63	0	87	20	0	0	15	3	100	79	19	0	0	100	86	100	0	0	4	10	44	18	0	76	100	82	17	17	0				

Estimate of overall accuracy at generalized alliance level: 65.5%. Note: Generalized alliances whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A). Cell values are %. T denotes a value <0.5%

Table 14. Mapped area and estimated area (from thematic accuracy assessment) of generalized alliances for Redwood National and State Parks vegetation map.

	MAPPED AREA (A _{ij}), ACRES	ESTIMATED TRUE AREA (A _{ij}), ACRES	MAPPED AREA (A _{ij}), HECTARES	ESTIMATED TRUE AREA (A _{ij}), HECTARES
<i>Pinus attenuata</i> Forest	372	676	150	274
<i>Pinus radiata</i> × <i>attenuata</i> YG Mixed Forest	124	111	50	45
<i>Quercus garryana</i> Forest	928	1078	375	436
<i>Pinus jeffreyi</i> Forest	168	325	68	132
<i>Pinus monticola</i> Forest	451	196	183	79
<i>Pinus</i> species Mixed Forest	151	0	61	0
<i>Alnus rubra</i> Forest	13284	11842	5376	4792
<i>Chamaecyparis lawsoniana</i> Forest	0	226	0	92
<i>Lithocarpus densiflorus</i> -(Other) YG Mixed Forest	8759	1804	3545	730
Montane Conifer-Hardwood Mixed Forest	2175	553	880	224
Montane Hardwood Mixed Forest	840	32	340	13
Other conifer mixed alliance	0	163	0	66
<i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> YG Mixed Forest	3845	11334	1556	4587
<i>Pseudotsuga menziesii</i> -(Other) YG Mixed Forest	448	3926	181	1589
<i>Sequoia sempervirens</i> Mature Forest	43034	28241	17416	11429
<i>Sequoia sempervirens</i> -(Other) YG Mixed Forest	61624	62750	24939	25395
<i>Picea sitchensis</i> -(Other) Forest	3648	16288	1476	6592
<i>Tsuga heterophylla</i> Forest	0	578	0	234
<i>Quercus vaccinifolia</i> Shrubland	0	23	0	9
<i>Festuca idahoensis</i> Grassland	28	28	11	11
Perennial Grassland	4292	1853	1737	750
Other Herbaceous	76	31	31	12
<i>Lithocarpus densiflorus</i> Shrubland	203	60	82	24
Other Dry Mixed Shrubland	22	185	9	75
<i>Baccharis pilularis</i> Shrubland	77	630	31	255
<i>Rubus</i> Shrubland	182	1437	74	581
Dune Herbaceous	497	343	201	139
<i>Ammophila arenaria</i> Grassland	216	578	87	234
Riverine Herbaceous	230	124	93	50
<i>Salix</i> Shrubland	30	87	12	35
<i>Carex obnupta</i> Herbaceous	95	435	38	176
<i>Carex obnupta</i> - <i>Deschampsia cespitosa</i> Grassland	413	65	167	26
<i>Typha latifolia</i> Herbaceous	26	121	10	49
Other Aquatic Herbaceous	36	7	15	3
Bare (** totals reflect areas mapped as vegetation only)	0	141	0	57

Table 15. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - U.S. National Vegetation Classification group level.

	G198 Californian Conifer Forest & Woodland	G344 Californian Montane Conifer Forest & Woodland	G235 Californian Coastal Redwood Forest	G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest	G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest	G206 Cascadian Oregon White Oak - Conifer Forest & Woodland	G662 California North Coastal & Mesic Scrub	G648 Southern Vancouverian Lowland Ruderal Grassland & Shrubland	G488 Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie	G282 Western North American Montane Sclerophyll Scrub	G498 North Pacific Maritime Coastal Scrub & Herb Beach & Dune	G647 North Pacific Maritime Coastal Ruderal Shrub & Grass Dune	G322 Vancouverian Wet Shrubland	G517 Vancouverian Freshwater Wet Meadow & Marsh	G531 Arid West Interior Freshwater Emergent Marsh	G544 Western North American Temperate Freshwater Aquatic Bed	Unvegetated, Bare	ESTIMATED USER'S ACCURACY (%)
G198 Californian Conifer Forest & Woodland	0.2	0.1	0.1															60
G344 Californian Montane Conifer Forest & Woodland	<0.1	0.3	0.2							<0.1								55
G235 Californian Coastal Redwood Forest	0.3		81.4	0.4	8.7	<0.1	0.1	0.1	0.6	<0.1			<0.1					89
G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest																		N/A
G751 North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest			0.1		2.1		0.2		0.2									83
G206 Cascadian Oregon White Oak - Conifer Forest & Woodland			0.1			0.6												90
G662 California North Coastal & Mesic Scrub					<0.1		<0.1		<0.1									33
G648 Southern Vancouverian Lowland Ruderal Grassland & Shrubland			0.6		0.3	0.1	0.1	1.1	0.2		0.1	0.1		0.2	0.1			37
G488 Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie					<0.1		<0.1		0.2				<0.1					75
G282 Western North American Montane Sclerophyll Scrub			0.1							<0.1								11
G498 North Pacific Maritime Coastal Scrub & Herb Beach & Dune					<0.1				<0.1		0.1	0.1		<0.1			0.1	30
G647 North Pacific Maritime Coastal Ruderal Shrub & Grass Dune											<0.1	0.1		<0.1			<0.1	47
G322 Vancouverian Wet Shrubland			0.0				<0.1		<0.1		<0.1		0.1				<0.1	61
G517 Vancouverian Freshwater Wet Meadow & Marsh								0.1	<0.1		<0.1	0.1		0.1				26
G531 Arid West Interior Freshwater Emergent Marsh			<0.1												<0.1			80
G544 Western North American Temperate Freshwater Aquatic Bed					<0.1									<0.1		<0.1		20
Unvegetated, Bare																		N/A
ESTIMATED PRODUCER'S ACCURACY (%)	38	81	99	0	19	77	4	86	14	27	44	18	75	26	17	100	0	

Estimate of overall accuracy at USNVC group level: 86.2%.

Note: Groups whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A).

Table 16. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - U.S. National Vegetation Classification macrogroup level.

	M009 California Forest & Woodland	M023 Southern Vancouverian Montane-Foothill Forest	M024 Vancouverian Lowland & Montane Forest	M886 Southern Vancouverian Dry Foothill Forest	M044 California Coastal Scrub	M493 Western North American Ruderal Grassland & Shrubland	M050 Southern Vancouverian Lowland Grassland & Shrubland	M094 Cool Interior Chaparral	M059 Pacific Coastal Beach & Dune Vegetation	M511 North Pacific Coastal Ruderal Grassland & Shrubland	M073 Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh	M888 Arid West Interior Freshwater Emergent Marsh	M109 Western North American Freshwater Aquatic	Unvegetated, Bare	ESTIMATED USER'S ACCURACY (%)
M009 California Forest & Woodland	0.2	0.1	0.1												60
M023 Southern Vancouverian Montane-Foothill Forest	<0.1	0.3	0.2					<0.1							55
M024 Vancouverian Lowland & Montane Forest	0.3		92.7	<0.1	0.2	0.1	0.7	<0.1			<0.1				98
M886 Southern Vancouverian Dry Foothill Forest			0.1	0.6											90
M044 California Coastal Scrub			<0.1		<0.1		<0.1								33
M493 Western North American Ruderal Grassland & Shrubland			0.9	0.1	0.1	1.1	0.2		0.1	0.1	0.2	0.1			37
M050 Southern Vancouverian Lowland Grassland & Shrubland			<0.1		<0.1		0.2				<0.1				75
M094 Cool Interior Chaparral			0.1					<0.1							11
M059 Pacific Coastal Beach & Dune Vegetation			<0.1				<0.1		0.1	0.1	<0.1			0.1	30
M511 North Pacific Coastal Ruderal Grassland & Shrubland									<0.1	0.1	<0.1			<0.1	47
M073 Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh			0.1		<0.1	0.1	<0.1		<0.1	0.1	0.2			<0.1	38
M888 Arid West Interior Freshwater Emergent Marsh			<0.1									<0.1			80
M109 Western North American Freshwater Aquatic Vegetation			<0.1								<0.1		<0.1		20
Unvegetated, Bare															N/A
ESTIMATED PRODUCER'S ACCURACY (%)	38	81	98	77	4	86	14	27	44	18	41	17	100	0	

Estimate of overall accuracy at USNVC macrogroup level: 95.4%

Note: Macrogroups whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A).

Table 17. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - U.S. National Vegetation Classification division level.

	1.B.1.Nc Californian Warm Temperate Forest	1.B.2.Nd Vancouverian Cool Temperate Forest	2.B.1.Na Californian Scrub 2	2.B.2.Na Western North American Grassland & Shrubland	.B.2.Nd Western North American Interior Sclerophyllous Chaparral	2.B.4.Nb Pacific North American Coast Scrub & Herb Vegetation	2.C.4.Nb Western North American Freshwater Shrubland, Wet Meadow & Marsh	5.B.2.Na North American Freshwater Aquatic Vegetation	Unvegetated, Bare	ESTIMATED USER'S ACCURACY (%)
1.B.1.Nc Californian Warm Temperate Forest	0.2	0.1								60
1.B.2.Nd Vancouverian Cool Temperate Forest	0.3	93.8	0.2	0.8	<0.1		<0.1			98
2.B.1.Na Californian Scrub		<0.1	<0.1	<0.1						33
2.B.2.Na Western North American Grassland & Shrubland		1.0	0.2	1.5		0.2	0.3			46
2.B.2.Nd Western North American Interior Sclerophyllous Chaparral		0.1			<0.1					11
2.B.4.Nb Pacific North American Coast Scrub & Herb Vegetation		<0.1		<0.1		0.3	<0.1		0.1	72
2.C.4.Nb Western North American Freshwater Shrubland, Wet Meadow & Marsh		0.1	<0.1	0.1		0.1	0.2		<0.1	39
5.B.2.Na North American Freshwater Aquatic Vegetation		<0.1					<0.1	<0.1		20
Unvegetated, Bare										N/A
ESTIMATED PRODUCER'S ACCURACY (%)	38	98	4	60	27	56	37	100	0	

Estimate of overall accuracy at USNVC division level: 96.0%.

Note: Divisions whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A).

Formation level overall accuracy is identical and involves the merging of 2.B.2.Na and 2.B.2.Nd. (User's accuracy of the merged unit is 45%; producer's accuracy is 59%).

Table 18. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - U.S. National Vegetation Classification subclass level.

	1.B Temperate & Boreal Forest & Woodland	2.B Temperate & Boreal Grassland & Shrubland	2.C Shrub & Herb Wetland	5.B Freshwater Aquatic Vegetation	Unvegetated, Bare	ESTIMATED USER'S ACCURACY (%)
1.B Temperate & Boreal Forest & Woodland	94.5	1.1	<0.1			99
2.B Temperate & Boreal Grassland & Shrubland	1.2	2.2	0.3		0.1	59
2.C Shrub & Herb Wetland	0.1	0.2	0.2		<0.1	39
5.B Freshwater Aquatic Vegetation	<0.1		<0.1	<0.1		20
Unvegetated, Bare						N/A
ESTIMATED PRODUCER'S ACCURACY (%)	99	64	37	100	0	

Estimate of overall accuracy at USNVC subclass level: 96.9%

Note: Subclasses whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A).

Table 19. Population contingency table for thematic accuracy assessment for Redwood National and State Parks vegetation map - U.S. National Vegetation Classification class level.

	1. Forest & Woodland	2. Grassland & Shrubland	5. Aquatic Vegetation	Unvegetated, Bare	ESTIMATED USER'S ACCURACY (%)
1.Forest & Woodland	94.5	1.1			99
2. Grassland & Shrubland	1.3	2.9		0.1	68
5. Aquatic Vegetation	<0.1	<0.1	<0.1		20
Unvegetated, Bare					N/A
ESTIMATED PRODUCER'S ACCURACY (%)	99	72	100	0	

Estimate of overall accuracy at USNVC class level: 97.4%

Note: Classes whose units neither were assessed nor were found in the reference data do not appear in this table (i.e., user's and producer's accuracies are N/A).

Chapter 7 - Project Products

- **Technical Project Report**
- **Landsat Satellite Imagery**
including raw and corrected imagery and image metadata
- **Field Training Sites Plot Data and Field Photos**
including field sheets, data files, and ground photographs for the DCMM.
- **GIS Map Data Sets in ESRI Geodatabase Format**
 - **rnsp4631jm - Final Pixel Classification Map Data Set (raster data)**
including spatial data, graphic, associated tables, and metadata.
 - **RNSPLCMap - Final Vegetation Map Data Set (vector data)**
including spatial data, graphic, associated tables, and metadata.
 - **trsites - Training Sites (point data)**
including spatial data, graphic, associated tables, and metadata.
 - **rnsp4631jmBuf - Final Pixel Classification Map Data Set (raster data) with 1-mile buffer area**
including spatial data, graphic, associated tables, and metadata.
 - **RNSPLCMapBuf - Final Vegetation Map Data Set (vector data) with 1-mile buffer area**
including spatial data, graphic, associated tables, and metadata.
- **NPS PLOTS Data**
including relevé data, and accuracy assessment field observation data in format of PLOTS 4.0 (USDI-NPS 2015).

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Appendix A. Redwood National and State Parks Vegetation and Land Cover Classification Key

Key to Main Vegetation & Landscape Categories - v7.4a – GRS 6/28/2013

1. Cover of tree species $\geq 10\%$. Tree canopy may overtop a denser layers of shrubs and herbaceous plants **Forests and Woodlands**
- 1'. Cover of tree species $< 10\%$ 2
2. Cover of shrub species $\geq 10\%$ 3
3. Cover of shrub species $>$ cover of herbaceous species or cover is herbaceous species $\leq 25\%$ or herbaceous species are shorter than shrubs..... **Shrublands**
- 3'. Cover of herb species $>$ cover of shrub species and cover of herb species $> 25\%$ and herbaceous species are taller than shrubs..... **Herbaceous vegetation**
- 2'. Vegetation not as above 4
4. Cover of herbaceous species $\geq 10\%$. When total vegetation cover is $\leq 10\%$, cover of herb species may be $< 10\%$ but should be $>$ the cover of shrub and tree species and $\geq 2\%$ cover **Herbaceous vegetation**
- 4'. Vegetation not as above 5
5. Cover of Water $\geq 33.3\%$ **Water**
- 5'. Landscape features not as above..... 6
6. Cover of all vegetation $\geq 15\%$ **Sparse Vegetation**
- 6'. Landscape features not as above **Barren**

Key to Forests and Woodlands

1. Combined cover of all conifer tree species is $\geq$ the combined cover of all broadleaved tree species 2
2. Combined cover of Pine trees is $>$ the combined cover of all other conifer species 3
 3. Cover of Jeffrey Pine (*Pinus jeffreyi*) $\geq 10\%$ and it is $>$ the cover of the other individual pine species. Combined cover of Idaho Fescue (*Festuca idahoensis*), California Fescue (*Festuca californica*), Blue Wildrye (*Elymus glaucus* ssp. *glaucus*), California Oatgrass (*Danthonia californica*), Prairie Junegrass (*Koeleria macrantha*), Lemmon's Needlegrass (*Achnatherum lemmonii*), *Aspidotis densa*, *Hastingsia serpentinicola*, *Sidalcea malviflora*, *Perideridia oregano*, *Horkelia sericata*, *Triteleia bridgesii*, *Sisyrinchium bellum* $\geq 10\%$. Little Bald Hills ***Pinus jeffreyi* alliance**
***Pinus jeffreyi/Festuca idahoensis* association(7)²**
 - 3'. Vegetation not as above 4
 4. Combined cover of Western White Pine (*Pinus monticola*) and Lodgepole Pine (*Pinus contorta* var. *murrayana*) $\geq 10\%$ and it is $>$ the combined cover of all other pine species. Huckleberry Oak (*Quercus vacciniifolia*), Dwarf Juniper (*Juniperus communis*), California coffeeberry (*Frangula californica*), Pinemat manzanita (*Arctostaphylos nevadensis*) are present in the shrub layer in addition to Dwarf Tanoak (*Lithocarpus densiflorus* v. *echinoides*) and Hairy Manzanita (*Arctostaphylos columbiana*) ***Pinus monticola* alliance**
Pinus monticola-Pinus contorta/Lithocarpus densiflorus
var. *echinoides*-*Quercus vacciniifolia* association(6)
 - 4'. Vegetation not as above 4A
 - 4A. Cover of Knobcone Pine (*Pinus attenuata*) is $\geq 10\%$ and it is $>$ the cover of other individual trees ***Pinus attenuata* alliance**
***Pinus attenuata/Lithocarpus densiflorus* var. *echinoides* association(5)**
 - 4A'. Vegetation not as above 4B
 - 4B. Cover of Monterey $\times$ Knobcone Pine cross (*Pinus radiata* $\times$ *attenuata*) $\geq 10\%$ and it is $>$ the cover of other individual tree species.....***Pinus radiata* $\times$ *attenuata* YG mixed alliance**
***Pinus radiata* $\times$ *attenuata* association(8)**
 - 4B'.Vegetation not as above ***Pinus species mixed alliance***
***Other Pinus* association(17)**

2'. Vegetation not as above	2A
2A. Cover of Monterey × Knobcone Pine cross (<i>Pinus radiata</i> × <i>attenuata</i>) ≥ 10%	
..... <i>Pinus radiata</i> × <i>attenuata</i> YG mixed alliance	
..... <i>Pinus radiata</i> × <i>attenuata</i> association(8)	
2A'. Vegetation not as above.....	5
5. Cover of Sitka Spruce (<i>Picea sitchensis</i>) ≥ 25% and it is > the combined cover of all other tree species	6
6. Combined cover of wetland indicators <i>Lysichiton americanus</i> , <i>Carex obnupta</i> , <i>Oenanthe sarmentosa</i> , <i>Chrysosplenium glechomifolium</i> ≥ 5%. Forested swamps.	
..... <i>Picea sitchensis</i> saturated forest alliance	
..... <i>Picea sitchensis</i>/<i>Lysichiton americanus</i> association(4)	
6'. Vegetation not as above	6A
6A. Combined cover of wetland indicators <i>Lysichiton americanus</i> , <i>Carex obnupta</i> , <i>Oenanthe sarmentosa</i> , and <i>Chrysosplenium glechomifolium</i> < 5%. Upland forests and forest on high river terraces	
..... <i>Picea sitchensis</i>-(other) alliance	
..... <i>Picea sitchensis</i>/<i>Gaultheria shallon</i> association(4)	
6A'. Vegetation not as above	6B
6B. Cover of red alder (<i>Alnus rubra</i>) > 5%. Riparian areas... <i>Picea sitchensis</i>-(other) alliance	
..... <i>Picea sitchensis</i>-<i>Alnus rubra</i> association(4)	
6B'. Vegetation not as above	
..... <i>Picea sitchensis</i>-(other) alliance	
..... <i>Picea sitchensis</i>-Other association(4)	
5'. Vegetation not as above	7
7. Cover of coastal redwood (<i>Sequoia sempervirens</i>) is ≥ 25%	8
8. Coastal Redwood (<i>Sequoia sempervirens</i>) trees resprout from stumps after logging and cover of trees ≥ 36" dbh is < 25%. Stands exhibit many young growth .characteristics	8A
8A. Cover of Tanoak (<i>Lithocarpus densiflorus</i>) is ≥ 25%	
..... <i>Sequoia sempervirens</i>(other) YG alliance	
..... <i>Sequoia sempervirens</i>-<i>Lithocarpus densiflorus</i> association(11)	

- 8A'. Vegetation not as above 8B
- 8B. Cover of Red alder (*Alnus rubra*) is $\geq 25\%$ and it is $>$ than the cover of *Pseudotsuga menziesii* ***Sequoia sempervirens*-(other) YG alliance**
***Sequoia sempervirens*-*Alnus rubra* association(16)**
- 8B'. Vegetation not as above 8C
- 8C. Cover of Douglas-fir (*Pseudotsuga menziesii*) is $\geq 25\%$
..... ***Sequoia sempervirens*-(other) YG alliance**
***Sequoia sempervirens*- *Pseudotsuga menziesii* association(16)**
- 8C'. Other conifer cover may be present..... ***Sequoia sempervirens*-(other) YG alliance**
***Sequoia sempervirens*-(Other conifer) association (16)**
- 8'. Vegetation not as above (cover of trees $\geq 36''$ dbh is $\geq 25\%$) 9
9. The individual cover of *Acer macrophyllum*, *Acer circinatum*, or *Umbellularia californica* is $\geq 5\%$ or the combined cover of *Carex obnupta*, *Lysichiton americanus*, and/or *Oenanthe sarmentosa* is $\geq 5\%$ cover indicating moist habitat conditions. Forests on river and creek terraces***Sequoia sempervirens* Mature Forest alliance**
***Sequoia sempervirens*-*Acer macrophyllum*-*Umbellularia californica* association(12)**
- 9'.Vegetation not as above 10
10. Combined cover of Tanoak (*Lithocarpus densiflorus*) and Pacific Madrone (*Arbutus menziesii*) is $> 30\%$ and the individual cover of each of these species is $\geq 5\%$
..... 10A
- 10A. Herbaceous cover is $< 5\%$ ***Sequoia sempervirens* Mature Forest alliance**
***Sequoia sempervirens*-*Arbutus menziesii* association(13)**
- 10A'. Vegetation not as above ***Sequoia sempervirens* Mature Forest alliance**
***Sequoia sempervirens*-*Arbutus menziesii* association(13)**
- 10'. Vegetation not as above 11

11. Combined cover of shrubs *Vaccinium ovatum*, *Vaccinium parvifolium*, *Gaultheria shallon*, and *Rhododendron macrophyllum* is > the combined cover of herbaceous plants *Polystichum munitum*, *Dryopteris expansa*, *Dryopteris carthusiana*, *Athyrium filix-femina*, *Blechnum spicant*, *Oxalis oregana*, *Asarum caudatum*, *Prosartes hookeri*, and *Prosartes smithii* ***Sequoia sempervirens* Mature Forest alliance**
***Sequoia sempervirens/Vaccinium ovatum* association(1)**
- 11'. Vegetation not as above ***Sequoia sempervirens* Mature Forest alliance**
***Sequoia sempervirens/Polystichum munitum* association(1)**
- 7'. Vegetation not as above 12
12. Combined cover of Douglas-fir (*Pseudotsuga menziesii*) and Tanoak (*Lithocarpus densiflorus*) $\geq 25\%$ and it is > the combined cover of all other tree species 13
13. Cover of Jeffrey Pine (*Pinus jeffreyi*) is $\geq 10\%$. Combined cover of Idaho Fescue (*Festuca idahoensis*), California Fescue (*Festuca californica*), Blue Wildrye (*Elymus glaucus* ssp. *glaucus*), California Oatgrass (*Danthonia californica*), Prairie Junegrass (*Koeleria macrantha*), Lemmon's Needlegrass (*Achnatherum lemmonii*), *Aspidotis densa*, *Hastingsia serpenticola*, *Sidalcea malviflora*, *Perideridia oregano*, *Horkelia sericata*, *Triteleia bridgesii*, and *Sisyrinchium bellum* $\geq 10\%$. Little Bald Hills ***Pinus jeffreyi* alliance**
***Pinus jeffreyi/Festuca idahoensis* association(7)**
- 13'. Vegetation not as above 14
14. Coastal Redwood (*Sequoia sempervirens*) trees resprout from stumps after logging or cover of trees $\geq 36"$ dbh is < 25%. Stand exhibits young growth characteristics. **Cover of redwood > 5%**. Cover of Douglas-fir (*Pseudotsuga menziesii*) is > the cover of coastal redwood. At least 2 species from the following group are present - *Tsuga heterophylla*, *Frangula purshiana*, *Galium triflorum*, *Claytonia sibirica*, *Oxalis oregana*, *Blechnum spicant*, *Trillium ovatum*, *Carex hendersonii*, and *Asarum caudatum*
..... ***Sequoia sempervirens*-(other) YG alliance**
***Pseudotsuga menziesii-Sequoia sempervirens* association(2)**
- 14'. Vegetation not as above..... 14A
- 14A. Cover of tanoak (*Lithocarpus densiflorus*) is $\geq 5\%$ and the cover of at least 2 species from the following group is $\geq 5\%$ - *Arbutus menziesii*, *Pinus attenuata*, *Umbellularia californica*, *Chrysolepis chrysophylla*, *Frangula californica*, *Amelanchier alnifolia*, *Rhododendron occidentale*, *Lithocarpus densiflorum* var. *echinoides*, *Lonicera hispidula*, *Polygala californica*, *Iris tenuissima*, *Xerophyllum tenax*, and *Boschniakia strobilacea* ***Pseudotsuga menziesii-Lithocarpus densiflorus* YG alliance**

<i>Pseudotsuga menziesii-Lithocarpus densiflorus-Arbutus menziesii association(14)</i>	
14A'. Vegetation not as above	14B
14B. Cover of Tanoak (<i>Lithocarpus densiflorus</i>) $\geq 5\%$	
..... <i>Pseudotsuga menziesii-Lithocarpus densiflorus YG alliance</i>	
..... <i>Pseudotsuga menziesii-Lithocarpus densiflorus-Other association(14)</i>	
14B' Vegetation not as above	14C
14C. Cover of Douglas-fir (<i>Pseudotsuga menziesii</i>) is $\geq 90\%$ of the total tree cover	
..... <i>Pseudotsuga menziesii-(other)YG alliance</i>	
..... <i>Pseudotsuga menziesii association(3)</i>	
14C'. Vegetation not as above	14D
14D. Cover of red alder (<i>Alnus rubra</i>) is $\geq 5\%$	
..... <i>Pseudotsuga menziesii-(other) YG alliance</i>	
..... <i>Pseudotsuga menziesii-Alnus rubra association(15)</i>	
14D'. Vegetation not as above	<i>Pseudotsuga menziesii-(other) YG alliance</i>
	<i>Pseudotsuga menziesii-OtherAssociation(3)</i>
12'. Vegetation not as above	15
15. Cover of Western hemlock (<i>Tsuga heterophylla</i>) is $\geq 25\%$ cover and it is > the cover of other individual tree species in the overstory. The cover of coastal redwood (<i>Sequoia sempervirens</i>) in the understory is > 5%	
..... <i>Tsuga heterophylla alliance</i>	
..... <i>Tsuga heterophylla-Sequoia sempervirens association(9)</i>	
15'. Vegetation not as above	15A
15A. Cover of Port Orford Cedar (<i>Chamaecyparis lawsoniana</i>) is $\geq 25\%$ cover and it is > the cover of other individual tree species present in the overstory. The cover of Douglas-fir (<i>Pseudotsuga menziesii</i>) is > 5%	
..... <i>Chamaecyparis lawsoniana alliance</i>	
..... <i>Chamaecyparis lawsoniana-Pseudotsuga menziesii association(10)</i>	
15A'. Vegetation not as above	15B

- 15B. Cover of a single tree species is $\geq 25\%$ [appropriate single species alliance]
Other conifer – [tree species] association(17)
Where [tree species] is the species designation of the tree species with the
greatest cover.
- 15B'. Vegetation not as above 15C
- 15C. Cover of broadleaf species is $\geq 10\%$
..... **Montane conifer-hardwood mixed alliance**
Other conifer-hardwood association(17)
- 15C'. Vegetation not as above **Other conifer mixed alliance**
Other conifer mixed association(17)
- 1'. Vegetation not as above. Combined cover of all broadleaved tree species is > the combined cover
of all conifer tree species 16
16. Cover of red alder (*Alnus rubra*) is $\geq 25\%$ and it is $\geq$ the combined cover of all other tree
species..... 17
17. Combined cover of at least three species from the following group - *Acer macrophyllum*,
Acer circinatum, *Carex obnupta*, *Oenanthe sarmentosa*, *Tolmiea menziesii*, *Chrysosplenium*
glechomifolium, *Mimulus dentatus*, *Lysichiton americanus*, *Hydrophyllum tenuipes* is $\geq 3\%$.
Forests on river and creek terraces **Alnus rubra-(other) alliance**
Alnus rubra/Carex obnupta association(18)
- 17'. Vegetation not as above 18
18. Cover of Sitka Spruce is > 5% and it is > the cover of all other conifer species. Red Alder
(*Alnus rubra*) stands on coastal bluff often with flag-shaped crowns. They differ from Red
Alder stands that occur more inland in the absence of common species typical of Redwood
forests **Picea sitchensis-(other) alliance**
Alnus rubra-Picea sitchensis association(28)
- 18'. Vegetation not as above..... 18A
- 18A. Combined cover of coastal redwood (*Sequoia sempervirens*), Douglas-fir (*Pseudotsuga*
menziesii), western hemlock (*Tsuga heterophylla*), and tanoak (*Lithocarpus densiflorus*) is $\geq$
5% and the cover of coastal redwood $\geq 1\%$. One or more from the following shrubs
Vaccinium ovatum, *Vaccinium*, *parvifolium*, *Rhododendron macrophyllum* is present. Stands
that replaced Coastal Redwood forests after logging
.....**Sequoia sempervirens-(other) YG alliance**

Alnus rubra-Sequoia sempervirens association(27)

- 18A'. Vegetation not as above 18B
- 18B. Cover of Douglas-fir (*Pseudotsuga menziesii*) is > 5%
..... ***Pseudotsuga menziesii-(other) YG alliance***
Alnus rubra-Pseudotsuga menziesii association(29)
- 18B'. Vegetation not as above ***Alnus rubra-(other) alliance***
Alnus rubra-(other) association(26)
- 16'. Vegetation not as above 19
19. Combined cover of at least three species from the following group is $\geq 5\%$ - *Carex obnupta*, *Oenanthe sarmentosa*, *Tolmiea menziesii*, *Hydrophyllum tenuipes*, *Mimulus dentatus*, *Chrysosplenium glechomifolium*, and *Lysichiton americanum*. If less than three species from this group are present, then their combined cover $\geq 5\%$. Riparian forests on river and creek terraces.
..... 20
20. Cover of Big-Leaf Maple (*Acer macrophyllum*) is $\geq 25\%$ and it is > the combined cover of all other tree species ***Acer macrophyllum alliance***
..Acer macrophyllum/Hydrophyllum tenuipes association(19)
- 20'. Vegetation not as above 20A
- 20A. Cover of California Bay (*Umbellularia californica*) is $\geq 25\%$ and it is > the combined cover of all other tree species ***Umbellularia californica alliance***
Umbellularia californica/Carex obnupta association(20)
- 20A'. Vegetation not as above 20B
- 20B. Cover of a single tree species is $\geq 25\%$ [appropriate single species alliance]
Other hardwood – [tree species] association(30)
Where [tree species] is the species designation of the tree species with the greatest cover.
- 20B'. Vegetation not as above 20C
- 20C. Cover of conifer species is $\geq 10\%$ ***Montane conifer-broadleaf mixed alliance***
Other conifer-hardwood association(30)

20C'. Vegetation not as above	Montane hardwood mixed alliance Other Hardwood mixed association(30)
19'. Vegetation not as above	21
21. Cover of oak (<i>Quercus</i> sp.) tree species is $\geq 25\%$ and it is > the cover of all other tree species	22
22. Cover of Oregon White Oak (<i>Quercus garryana</i>) is $\geq 25\%$ and it is > the combined cover of all other tree species	Quercus garryana alliance Quercus garryana/Festuca californica association(21)
22'. Cover of Canyon Live Oak (<i>Quercus chrysolepis</i>) is $\geq 25\%$ and it is > the combined cover of all other tree species	Quercus chrysolepis alliance Quercus chrysolepis association(22)
21'. Vegetation not as described	23
23. Cover of Golden Chinquapin (<i>Chrysolepis chrysophylla</i>) is $\geq 25\%$ and it is > the combined cover of all other tree species. Common Beargrass (<i>Xerophyllum tenax</i>) may be present in the herb layer	Chrysolepis chrysophylla alliance
23'. Vegetation not as above	24
24. Cover of Monterey X Knobcone Pine cross (<i>Pinus radiata</i> X <i>attenuata</i>) $\geq 10\%$	Pinus radiata X attenuata YG alliance Pinus radiataXattenuata-Sequoia sempervirens-Lithocarpus densiflorus association(8)
24'. Vegetation not as above	25
25. Cover of Tanoak (<i>Lithocarpus densiflorus</i>) is $\geq 25\%$ and it is > the combined cover of all other tree species	26
26. Coastal Redwood (<i>Sequoia sempervirens</i>) trees sprout from stumps after logging. Cover of Douglas-fir (<i>Pseudotsuga menziesii</i>) is > cover of Coastal Redwood. At least 2 species from the following group are present <i>Tsuga heterophylla</i> , <i>Frangula purshiana</i> , <i>Rubus ursinus</i> , <i>Polystichum munitum</i> , <i>Blechnum spicant</i> , <i>Galium triflorum</i> , <i>Oxalis oregana</i> , <i>Viola sempervirens</i> , <i>Trillium ovatum</i>	Sequoia sempervirens-(other) YG alliance Lithocarpus densiflorus-Sequoia sempervirens association(24)
26'. Vegetation not as above	27

27. At least 2 species from the following group are present *Arbutus menziesii*, *Pinus attenuata*, *Umbellularia californica*, *Chrysolepis chrysophylla*, *Frangula californica*, *Amelanchier alnifolia*, *Rhododendron occidentale*, *Lithocarpus densiflorum* var. *echinoides*, *Lonicera hispidula*, *Polygala californica*, *Iris tenuissima*, *Xerophyllum tenax*, *Boschniakia strobilacea*
..... ***Pseudotsuga menziesii*-*Lithocarpus densiflorus* YG alliance**
***Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Arbutus menziesii* association(25)**
- 27'.Vegetation not as above ***Lithocarpus densiflorus*-(other) alliance**
***Lithocarpus densiflorus* – Other association(31)**
- 25'. Vegetation not as above 25A
- 25A. Cover of a single tree species is $\geq 25\%$
..... **[appropriate single species alliance]**
Other hardwood – [tree species] association(32)
Where [tree species] is the species designation of the tree species with the greatest cover.
- 25B. Cover of conifer species is $\geq 10\%$
..... **Montane conifer-broadleaf mixed alliance**
Other conifer-hardwood association(32)
- 25B'.Vegetation not as above
..... **Montane hardwood mixed alliance**
Other Hardwood mixed association(32)

Key to Shrublands

1. Combined cover of shrubs Hairy Manzanita (*Arctostaphylos columbiana*), Pinemat Manzanita (*A. nevadensis*), Dwarf Tanoak (*Lithocarpus densiflorus* v. *echinoides*), Huckleberry Oak (*Quercus vacciniifolia*), Dwarf Juniper (*Juniperus communis*), California coffeeberry (*Frangula californica*), and/or Giant Chinquapin (*Chrysolepis chrysophylla*) is $\geq 25\%$ 2
2. Cover of Hairy Manzanita (*Arctostaphylos columbiana*) is $\geq 10\%$ and it is > the cover of other individual shrub species 3
3. Cover of Western White Pine (*Pinus monticola*) is > than the combined cover of Lodgepole Pine (*Pinus contorta* var. *murrayana*) and Knobcone Pine (*Pinus attenuata*). Combined cover of at least two shrub species from the following group: Huckleberry Oak (*Quercus vacciniifolia*), Dwarf Juniper (*Juniperus communis*), California Coffeeberry (*Frangula californica*), and Pinemat Manzanita (*Arctostaphylos nevadensis*) is $\geq 2\%$
..... ***Arctostaphylos columbiana shrubland alliance***
Pinus monticola/Arctostaphylos columbiana association(33)
- 3'. Cover of Knobcone Pine (*Pinus attenuata*) is $\geq$ than combined cover of Western White Pine (*Pinus monticola*) and Lodgepole Pine (*Pinus contorta* var. *murrayana*), if the latter two species are present ***Arctostaphylos columbiana shrubland alliance***
Pinus attenuata/Arctostaphylos columbiana association(34)
- 2'. Vegetation not as above 4
4. Cover of Huckleberry Oak (*Quercus vacciniifolia*) is $\geq 10\%$ and it is > the cover of other individual shrub species ***Quercus vacciniifolia shrubland alliance***
Quercus vacciniifolia shrubland association(35)
- 4'. Vegetation not as above 4A
- 4A. Cover of Dwarf Tanoak (*Lithocarpus densiflorus* v. *echinoides*) is $\geq 10\%$ and it is > the cover of other individual shrub species
..... ***Lithocarpus densiflorus v. echinoides shrubland alliance***
Lithocarpus densiflorus v. echinoides shrubland association(36)
- 4A'. Vegetation not as above ***Other Dry Mixed shrubland alliance***
Dry-[shrub species] Shrubland association(51)
Where [shrub species] is the species designation of the shrub species having the greatest cover.

- 1'. Vegetation not as above 5
5. Combined cover of willows (*Salix spp.*) is > the combined cover of all other shrub species..... 6
6. Coastal Willow (*Salix hookeriana*) cover is $\geq 25\%$ and it is > the cover of all other individual willow species. Coastal dunes ***Salix hookeriana shrubland alliance***
Salix hookeriana association(37)
- 6'. Vegetation not as above 6A
- 6A. Combined cover of Arroyo Willow (*Salix lasiolepis*) and Shining Willow (*Salix lucida*) is $\geq 25\%$ and it is > the combined cover of all other willow species. Riparian habitats..... ***Salix lasiolepis shrubland alliance***
Salix lasiolepis-Salix lucida association(38)
- 6A'. Vegetation not as above..... ***Salix shrubland alliance***
Salix Mixed association(40)
- 5'. Vegetation not as above 7
7. Combined cover of Bramble berries (*Rubus spp.*) is > the combined cover of all other shrub species 8
8. Cover of California Blackberry (*Rubus ursinus*) is $\geq 25\%$ and it is > the cover of all other shrub species ***Rubus (parviflorus, spectabilis, ursinus) shrubland alliance***
Rubus ursinus-Heracleum lanatum association(41)
- 8'. Vegetation not as above 8A
- 8A. Cover of Thimbleberry (*Rubus parviflorus*) is $\geq 25\%$ and it is > the cover of all other shrub species..... ***Rubus (parviflorus, spectabilis, ursinus) shrubland alliance***
Rubus parviflorus-Tellima grandiflora association(42)
- 8A'. Vegetation not as above 8B
- 8B. Cover of Himalayan Blackberry (*Rubus armeniacus*) is $\geq 25\%$ and it is > the cover of all other shrub species ***Rubus armeniacus semi-natural shrubland stands(?)***
Rubus armeniacus-Rubus ursinus stands(43)(?)
- 8B'. Vegetation not as above 8C

- 8C. Cover of Salmonberry (*Rubus spectabilis*) is $\geq 25\%$ and it is $>$ the cover of all other shrub species ***Rubus (parviflorus, spectabilis, ursinus) shrubland alliance***
Rubus spectabilis stands(44)
- 8C'. Vegetation not as above ***Rubus shrubland alliance***
Rubus-[shrub species] association(52)
Where ***[shrub species]*** is the species designation of the shrub species having the greatest cover.
- 7'. Vegetation not as above 10
9. Cover of Coyote Brush (*Baccharis pilularis*) is $\geq 25\%$ and it is $>$ the cover of all other shrub species ***Baccharis pilularis shrubland alliance***
Baccharis pilularis-Polystichum munitum association(45)
- 9'. Vegetation not as above 11
11. Cover of Wavyleaf Silktassel (*Garrya elliptica*) is $\geq 25\%$ and it is $>$ the cover of all other shrub species ***Garrya elliptica provisional shrubland alliance***
Garrya elliptica shrubland association(46)
- 11'. Vegetation not as above 12
12. Cover of Salal (*Gaultheria shallon*) is $\geq 25\%$ and it is $>$ the cover of all other shrub species ***Gaultheria shallon provisional shrubland alliance***
Gaultheria shallon association(47)
- 12'. Vegetation not as above 12A
- 12A. Cover of Golden Yarrow (*Eriophyllum stoechadifolium*) is $\geq 25\%$ and it is $>$ the cover of all other shrub species ***Eriophyllum stoechadifolium provisional shrubland alliance***
Eriophyllum stoechadifolium/Angelica hendersonii association(48)
- 12A'. Vegetation not as above ***Shrub Other alliance***
Other-[shrub species] shrubland association(53)
Where ***[shrub species]*** is the species designation of the shrub species having the greatest cover.

Key to Herbaceous Vegetation

1. Cover of aquatic herbaceous species > 50% of relative cover composition. Sites with at least one of the following wetland attributes present: hydric soil, hydrophytic vegetation, wetland hydrology (flooded ponds, permanent and seasonal wetlands, seeps, and meadows with soils saturated throughout growing season). 2
2. Cover of floating or submerged (not emergent plants) is > 50% of relative cover. If ponds are drained, plants are prostrate on the surface of the ground 3
3. Cover of Yellow Pond-Lily (*Nuphar lutea* ssp. *polysepala*) is > 50% relative cover composition ***Nuphar lutea provisional herbaceous alliance***
Nuphar lutea herbaceous association(73)
- 3'. Vegetation not as above 4
4. Cover of Floating Pondweed (*Potamogeton natans*) is > 50% relative cover composition ***Stuckenia-Potamogeton herbaceous alliance***
Potamogeton natans herbaceous association(74)
- 4'. Vegetation not as above 4A
- 4A. Cover of Swaying Bulrush (*Scirpus subterminalis*) is > 50% relative cover composition ***(Alliance unknown)***
Scirpus subterminalis herbaceous association(75)
- 4A'. Vegetation not as above ***Other-[herb species] Aquatic Herbaceous(83)***
Where [herb species] is the species designation of the herbaceous species having the greatest cover.
- 2'. Vegetation not as above 5
5. Cover of sedges (*Carex* spp.) and Tufted Hairgrass (*Deschampsia cespitosa*) is $\geq$ 50% of relative cover composition. If cover of Tufted Hairgrass (*Deschampsia cespitosa*) is > cover of sedges, then cover of Blister Sedge (*Carex vesicaria*) is $\geq$ 10% 6
6. Cover of Slough Sedge (*Carex obnupta*) has $\geq$ 50% relative cover composition ***Carex obnupta herbaceous alliance***
Carex obnupta herbaceous association(76)
- 6'. Vegetation not as above 6A

- 6A. Cover of Blister Sedge (*Carex vesicaria*) is $\geq 10\%$. Combined cover of *Carex vesicaria* and Tufted Hairgrass (*Deschampsia cespitosa*) is $\geq 50\%$ relative cover composition
..... ***Carex (utriculata, vesicaria) herbaceous alliance***
Carex vesicaria-Deschampsia cespitosa herbaceous association(77)
- 6A'. Vegetation not as above ***Other Aquatic Herbaceous(83)***
- 5'. Vegetation not as above 7
7. Cover of Broad leaved Cattail (*Typha latifolia*) is $\geq 50\%$ relative cover composition.....
..... ***Typha (angustifolia, domingensis, latifolia) herbaceous alliance***
Typha latifolia herbaceous association(78)
- 7'. Vegetation not as above 8
- 8 . Cover of Reed Canarygrass (*Phalaris arundinacea*) is $> 50\%$ relative cover composition
..... ***(Phalaris arundinacea Alliance?)***
Phalaris arundinacea herbaceous association(79)
- 8'. Vegetation not as above 9
9. Cover of Panicked Bulrush (*Scirpus microcarpus*) is $> 50\%$ relative cover composition
..... ***Scirpus microcarpus herbaceous alliance***
Scirpus microcarpus herbaceous association(80)
- 9'. Vegetation not as above 10
10. Cover of Northwest Mannagrass (*Glyceria occidentalis*) is $> 50\%$ relative cover composition ***Glyceria occidentalis provisional herbaceous alliance***
Glyceria occidentalis herbaceous association(81)
- 10'. Vegetation not as above 10A
- 10A. Cover of European Bur-Reed (*Sparganium emersum*) is $\geq 25\%$ and it is
 $>$ cover of the other individual herbaceous species
..... ***Sparganium (angustifolium) herbaceous alliance***
Sparganium emersum herbaceous association(82)
- 10A'. Vegetation not as above
..... ***Other Aquatic-[herb species] Herbaceous(83)***
Where ***[herb species]*** is the species designation of the herbaceous species
having the greatest cover.

1'. Vegetation not as above	11
11. Cover of dune herbaceous species is > 50% of relative cover composition. Stands on coastal dunes and beaches dominated by plants adapted to sandy substrate and salt spray.	12
12. Cover of perennial grasses is > 50% of relative cover composition	13
13. Cover of American Dunegrass (<i>Leymus mollis</i>) is $\geq$ 5% and it is > 50% relative cover composition	<i>Leymus mollis herbaceous alliance</i> <i>Leymus mollis-Abronia latifolia herbaceous association</i> (64)
13'. Vegetation not as above	13A
13A. Cover of European Beachgrass (<i>Ammophila arenaria</i>) is $\geq$ 5% and it is > 50% relative cover composition	<i>Ammophila arenaria semi-natural herbaceous alliance</i> (?) <i>Ammophila arenaria semi-natural herbaceous stands</i> (65)
13A'. Vegetation not as above	<i>Other Dune-[herb species] Herbaceous</i> (85) Where [herb species] is the species designation of the herbaceous species having the greatest cover.
12'. Cover of forbs is $\geq$ 50% of relative cover composition	14
14. Cover of European Sea Rocket (<i>Cakile maritima</i>) is $\geq$ 1% and it is > 50% relative cover composition. On the leading edge of beaches.	<i>Cakile maritima semi-natural provisional herbaceous stands</i> (66)
14'. Vegetation not as above	15
15. Cover of Beach Morning Glory (<i>Calystegia soldanella</i>) is $\geq$ 1% and it is > 50% relative cover composition	<i>Abronia latifolia-Ambrosia chamissonis herbaceous alliance</i> <i>Calystegia soldanella herbaceous association</i> (67)
15'. Vegetation not as above	15A
15A. Cover of Yellow Sand Verbena (<i>Abronia latifolia</i>) is $\geq$ 1% and it is > 50% relative cover composition	<i>Abronia latifolia-Ambrosia chamissonis herbaceous alliance</i> <i>Abronia latifolia-Erigeron glaucus herbaceous association</i> (68)

- 15A'. Vegetation not as above 15B
- 15B. Cover of Silver Bur Ragweed (*Ambrosia chamissonis*) is $\geq 1\%$ and it is $> 50\%$
relative cover composition
..... ***Abronia latifolia-Ambrosia chamissonis herbaceous alliance***
Ambrosia chamissonis association(69)
- 15B'. Vegetation not as above 15C
- 15C. Cover of Camphor Tansy (*Tanacetum camphoratum*) is $\geq 1\%$ and it is $> 50\%$
relative cover composition
..... ***Abronia latifolia-Ambrosia chamissonis herbaceous alliance***
Tanacetum camphoratum herbaceous association(70)
- 15C'. Vegetation not as above ***Other Dune-[herb species] Herbaceous(85)***
Where ***[herb species]*** is the species designation of the herbaceous species
having the greatest cover.
- 11'. Vegetation not as above 16
16. **Stands located directly on the coast**, on slopes facing the ocean, coastal bluffs, terraces, and
rocky outcrops..... 17
17. Cover of perennial grasses Common Velvet Grass (*Holcus lanatus*), Orchardgrass (*Dactylis
glomerata*), Sweet Vernal Grass (*Anthoxanthum odoratum*), Redtop (*Agrostis gigantea*),
Kentucky Bluegrass (*Poa pratensis*) individually or in combination is $\geq 25\%$. Two of the
following species may be present: *Rubus ursinus*, *Frangula purshiana*, *Heracleum lanatum*,
Marah oreganus, and/or *Polystichum munitum*. Grasslands on coastal bluffs and terraces often
surrounded by shrublands
..... ***Holcus lanatus-Anthoxanthum odoratum semi-natural herbaceous stands***
Holcus lanatus-Heracleum lanatum semi-natural herbaceous stands(54)
- 17'. Cover of succulent plants from Stonecrop (*Crassulaceae*) family is $> 2\%$. Cover of
perennial grasses $< 15\%$ 18
18. Cover of Powdery Liveforever (*Dudleya farinosa*) is $\geq 5\%$. Cover of *Dudleya farinosa*
alone or in combination with *Erigeron glaucus*, *Plantago maritima*, *Daucus pusillus*,
Fragaria chiloensis, *Madia sativa*, or *Eriophyllum stoechadifolium* $\geq 25\%$. Cover of Coyote
Brush (*Baccharis pilularis*) is $< 5\%$. Coastal bluff steep rocky slopes, outcrops
..... ***Dudleya farinosa provisional herbaceous alliance***
Dudleya farinosa-Erigeron glaucus herbaceous association(55)

- 18'. Vegetation not as above 18A
- 18A. Cover of Broadleaf Stonecrop (*Sedum spathulifolium*) is $\geq 5\%$. *Dudleya farinosa* is absent or has $< 1\%$ cover. Rocky outcrops, shady cliffs, boulders
..... ***Sedum spathulifolium* provisional herbaceous alliance**
***Sedum spathulifolium*-*Tellima grandiflora* herbaceous association(56)**
- 18A'. Vegetation not as above ***Other Coastal*-[herb species] *Herbaceous*(86)**
Where [herb species] is the species designation of the herbaceous species having the greatest cover.
- 16'. Stands not located as above 19
19. Cover of White Sweetclover (*Melilotus alba*), Common St. Johnswort (*Hypericum perforatum*), or Jepson's Blue Wildrye (*Elymus glaucus* ssp. *jepsonii*) individually or in combination is $> 2\%$. **Stands on gravelly or sandy river bars.**
..... 20
20. Cover of Oregon Telegraph Weed (*Heterotheca oregona*), Soapwort (*Saponaria officinalis*), Idaho Fescue (*Festuca idahoensis*), California Oatgrass (*Danthonia californica*), Pacific Ninebark (*Physocarpus capitatus*), Riverbank Lupine (*Lupinus rivularis*), Scotch Broom (*Cytisus scoparius*), and French Broom (*Genista monspessulana*) individually or in combination is $> 10\%$. **Gravelly and sandy bars of Smith River**
..... ***Heterotheca oregona* provisional herbaceous alliance**
***Heterotheca oregona*-*Saponaria officinalis* herbaceous association(57)**
- 20'. Vegetation not as above 20A
- 20A. Vegetation not as above. Cover of non-native forbs Shortpod Mustard (*Hirschfeldia incana*), Jerusalem Oak Goosefoot (*Chenopodium botrys*), Mexican Tea (*Chenopodium ambrosioides*), Pennyroyal (*Mentha pulegium*), and Common Nipplewort (*Lapsana communis*) individually or in combination is $\geq 5\%$. Cover of native herbs such as Tall Flatsedge (*Cyperus eragrostis*), Variableleaf Collomia (*Collomia heterophylla*), Slender Hairgrass (*Deschampsia elongata*), Toad Rush (*Juncus bufonius*) if present, cover $\leq 2\%$.
Gravelly and sandy bars of Redwood Creek
Hirschfeldia incana*-*Chenopodium botrys
provisional semi-natural herbaceous stands(58)
- 20A'. Vegetation not as above ***Other Riverine*-[herb species] *Herbaceous*(87)**
Where [herb species] is the species designation of the herbaceous species having the greatest cover.

19'. Vegetation not as above	21
21. Cover of Idaho Fescue (<i>Festuca idahoensis</i>), California Fescue (<i>Festuca californica</i>), Blue Wildrye (<i>Elymus glaucus</i> ssp. <i>glaucus</i>), California Oatgrass (<i>Danthonia californica</i>), Prairie Junegrass (<i>Koeleria macrantha</i>), Lemmon's Needlegrass (<i>Achnatherum lemmonii</i>), <i>Carex concinnoides</i>, <i>Perideridia oregana</i>, <i>Aspidotis densa</i>, <i>Horkelia sericata</i>, and <i>Hastingsia serpentinicola</i> individually or in combination is $\geq 20\%$. Combined cover of Short shrubs Siskiyou Mat (<i>Ceanothus pumilus</i>), Pinemat Manzanita (<i>Arctostaphylos nevadensis</i>), and saplings of Jeffrey Pine (<i>Pinus jeffreyi</i>) is $< 10\%$. Serpentine barrens on slopes and ridges on Little Bald Hills..... <i>Festuca idahoensis herbaceous alliance Ceanothus pumilus/Festuca idahoensis herbaceous association</i>(59)	
21'. Vegetation not as above	22
22. Cover of Tall Oatgrass (<i>Arrhenatherum elatius</i>), Annual Dogtail (<i>Cynosurus echinatus</i>), Soft Brome (<i>Bromus hordeaceus</i>), Silver Hairgrass (<i>Aira caryophyllea</i>), and Pacific Woodrush (<i>Luzula comosa</i>) individually or in combination is $\geq 25\%$. Bald Hills. These grasslands may differ in the abundance of non-native species as well as in the amount of remaining natives. Additional types of stands may be recognized if more data are collected<i>Arrhenatherum elatius-Cynosurus echinatus semi-natural herbaceous stands</i>(60)	
22'. Vegetation not as above	23
23. Combined cover of <i>Carex obnupta</i> and <i>Deschampsia cespitosa</i> is $\geq 10\%$ <i>Carex obnupta-Deschampsia cespitosa association</i>(61)	
23'. Vegetation not as above	24
24. Combined cover of forb species tolerant to grazing/trampling <i>Trifolium repens</i>, <i>Prunella vulgaris</i>, <i>Taraxacum officinale</i>, and <i>Bellis perennis</i> is $\geq 5\%$. Average height of herbs ≤ 25 cm. <i>Moderately to intensively grazed, mowed, and/or trampled grasslands on roadsides and lawns.</i> <i>Agrostis (gigantea, stolonifera)-Trifolium repens-Prunella vulgaris semi-natural herbaceous stands</i>(62)	
24'. Vegetation not as above	24A
24A. Vegetation not as above. Combined cover of <i>Agrostis gigantea</i> and <i>Agrostis stolonifera</i> $\geq 25\%$. Average height of herbs is >25 cm. Ungrazed or slightly grazed grasslands <i>Agrostis gigantea-Agrostis stolonifera semi-natural herbaceous stands</i>(63)	

24A'. Vegetation not as above 25

25. Herbaceous cover is $\geq 10\%$ 26

26. Graminoid cover is $\geq 50\%$ relative cover composition.....

..... **Other Grassland-[herb species] stands(88)** Where [herb species] is the species designation of the herbaceous species having the greatest cover.

26'. Vegetation not as above

..... **Other Herbaceous-[herb species] stands(88)** Where [herb species] is the species designation of the herbaceous species having the greatest cover.

25'. Vegetation not as above **Return to 5. in Main Key**

Appendix B. Redwood National and State Parks Descriptions for Manual of California Vegetation Association (Generalized Alliance) Level

This section includes descriptions for individual vegetation types mostly as delimited by Solomeshch for this project and as represented by releve plot data collected and assigned by Solomeshch. The types were assigned at the level of the second edition of the Manual of California Vegetation (MCV) (Sawyer et al. 2009), using names offered by those authors (if applicable) or by Solomeshch (representing potential additions to the MCV treatment). MCV associations are approximately equivalent to USNVC associations and include more vegetation in California than currently is described by the USNVC (USNVC 2015). In most cases, MCV associations also are equivalent to a single Generalized Alliance unit as applied in the mapping for this project. Generally, the original Solomeshch names and treatments were retained. A small number of multiple Solomeshch types were described together as single association, in cases in which the types were floristically similar, in which they also were not treated individually (were “lumped”) by the Generalized Alliance mapping of this project, and for which a single association of Sawyer et al. (2009) could be applied. In most cases, the original Solomeshch names were assigned; in a few cases, a name of Sawyer et al. (2009) was applied, where it seemed more applicable to the RNSP unit.

Each description provides a concept summary, environmental and floristic descriptions, and a synthesis table. The synthesis table provides a summary of constancy, average cover, and the range of cover for individual vascular plant species across all plots that were assigned to the type by Solomeshch. A translation or “crosswalk” of the RNSP units to the multiple levels of the USNVC is also given. The USNVC relationships also are summarized in Table C1 for all types that were identified at RNSP.

Nomenclature for plant taxa in this report generally follows USDA-NRCS (2015). Exceptions have been made in cases in which an alternative name for a plant taxon has been applied in the naming of a vegetation type by this project, by the Manual of California Vegetation (Sawyer et al. 2009), or by USNVC (2015). In these cases, the alternative name has been applied *both* in the vegetation type name and in references to occurrences of the taxon, for clarity (e.g. *Lithocarpus densiflorus* is used in vegetation names by this project, by Sawyer et al. (2009), and by the USNVC (2015), whereas USDA-NRCS (2015) applies the equivalent name *Notholithocarpus densiflorus* to the species itself.) For such name references that are equivalent but differ, translations between alternative taxa names used by this project, by USDA-NRCS (2015) and by the second edition of the Jepson Manual (JM2) (Baldwin et al. 2012) are listed in Table C2.

Nomenclature for individual plant taxa in the PLOTS database that was created for this project follows USDA-NRCS (2015).

List B1. Manual of California Vegetation (MCV) associations observed at Redwood National and State Parks, as recognized by U.S. National Vegetation Classification hierarchy.

Class: Forest & Woodland (1)
Subclass: Temperate & Boreal Forest & Woodland (1.B)
Formation: Warm Temperate Forest & Woodland (1.B.1)
Division: Californian Warm Temperate Forest (1.B.1.Nc)
Macrogroup: California Forest & Woodland (M009)
Group: Californian Conifer Forest & Woodland (G198)
MCV Association: <i>Pinus attenuata</i> / <i>Lithocarpus densiflorus</i> var. <i>echinoides</i> association
Group: Californian Moist Coastal Mixed Evergreen Forest (G208)
MCV Association: <i>Chrysolepis chrysophylla</i> / <i>Xerophyllum tenax</i> association
MCV Association: <i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> - <i>Arbutus menziesii</i> association
MCV Association: <i>Umbellularia californica</i> / <i>Carex obnupta</i> association
Formation: Cool Temperate Forest & Woodland (1.B.2)
Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)
Macrogroup: Southern Vancouverian Montane-Foothill Forest (M023)
Group: Californian Montane Conifer Forest & Woodland (G344)
MCV Association: <i>Pinus jeffreyi</i> / <i>Festuca idahoensis</i> association
MCV Association: <i>Pinus monticola</i> - <i>Pinus contorta</i> / <i>Lithocarpus densiflorus</i> var. <i>echinoides</i> / <i>Quercus vaccinifolia</i> association
Macrogroup: Vancouverian Lowland & Montane Forest (M024)
Group: Californian Coastal Redwood Forest (G235)
MCV Association: <i>Alnus rubra</i> - <i>Sequoia sempervirens</i> Young Growth association
MCV Association: <i>Chamaecyparis lawsoniana</i> association
MCV Association: <i>Lithocarpus densiflorus</i> - <i>Sequoia sempervirens</i> Young Growth association
MCV Association: <i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> - <i>Sequoia sempervirens</i> Young Growth association
MCV Association: <i>Sequoia sempervirens</i> - <i>Acer macrophyllum</i> - <i>Umbellularia californica</i> association
MCV Association: <i>Sequoia sempervirens</i> - <i>Pseudotsuga menziesii</i> - <i>Lithocarpus densiflorus</i> / <i>Vaccinium ovatum</i> association
MCV Association: <i>Sequoia sempervirens</i> / <i>Vaccinium ovatum</i> / <i>Polystichum munitum</i> association
Group: North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest (G237)
MCV Association: <i>Alnus rubra</i> / <i>Rubus spectabilis</i> - <i>Sambucus racemosa</i> association
Group: North Pacific Maritime Douglas-fir - Western Hemlock Forest (G240)
MCV Association: <i>Tsuga heterophylla</i> association
Group: North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest (G235)
MCV Association: <i>Picea sitchensis</i> / <i>Gaultheria shallon</i> association
Macrogroup: Southern Vancouverian Dry Foothill Forest (M886)
Group: Cascadian Oregon White Oak - Conifer Forest & Woodland (G206)
Alliance: None recognized
MCV Association: <i>Quercus garryana</i> / <i>Festuca californica</i> association
Formation: Temperate Flooded & Swamp Forest (1.B.3)
Division: Vancouverian Flooded & Swamp Forest (1.B.3.Ng)
Macrogroup: Vancouverian Flooded & Swamp Forest (M035)
Group: North Pacific Lowland Riparian Forest & Woodland (G254)
MCV Association: <i>Acer macrophyllum</i> / <i>Hydrophyllum tenuipes</i> association
Alliance: None recognized
MCV Association: <i>Alnus rubra</i> / <i>Carex obnupta</i> association
Group: North Pacific Maritime Hardwood - Conifer Swamp (G256)
MCV Association: <i>Picea sitchensis</i> / <i>Lysichiton americanus</i> association

Class: Grassland & Shrubland (2)

Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

Formation: Mediterranean Scrub & Grassland (2.B.1)

Division: Californian Scrub (2.B.1.Na)

Macrogroup: Californian Coastal Scrub (M044)

Group: Californian North Coastal Mesic & Scrub (G662)

MCV Association: *Baccharis pilularis* association

MCV Association: *Eriophyllum stoechadifolium* / *Angelica hendersonii* association

MCV Association: *Garrya elliptica* association

Formation: Temperate Grassland and Shrubland (2.B.2)

Division: Western North American Grassland & Shrubland (2.B.2.Na)

Macrogroup: Southern Vancouverian Lowland Grassland & Shrubland (M050)

Group: Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie (G488)

MCV Association: *Ceanothus pumilus*/*Festuca idahoensis* association

MCV Association: *Gaultheria shallon* association

MCV Association: *Rubus parviflorus*/*Tellima grandiflora* association

MCV Association: *Rubus ursinus*/*Heracleum lanatum* association

Macrogroup: Western North American Ruderal Grassland & Shrubland (M493)

Group: Southern Vancouverian Lowland Ruderal Grassland & Shrubland (G648)

MCV Association: *Agrostis gigantea*-*Agrostis stolonifera* association

MCV Association: *Arrhenatherum elatius*-*Cynosurus echinatus* association

MCV Association: *Holcus lanatus*-*Heracleum lanatum* association

Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

Macrogroup: Pacific Coastal Cliff & Bluff Vegetation (M058)

Group: North Pacific Coastal Scrub & Herb Cliff & Bluff (G554)

MCV Association: *Dudleya farinosa*-*Erigeron glaucus* association

MCV Association: *Sedum spathulifolium*-*Tellima grandiflora* association

Macrogroup: Pacific Coastal Beach & Dune Vegetation (M059)

Group: North Pacific Maritime Coastal Scrub & Herb Beach & Dune (G498)

MCV Association: Dune Herbaceous Vegetation

MCV Association: *Leymus mollis* association

Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

Group: North Pacific Maritime Coastal Ruderal Shrub & Grass Dune (G647)

MCV Association: *Ammophila arenaria* association

MCV Association: *Cakile maritima* association

Subclass: Shrub & Herb Wetland (2.C)

Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

Group: Vancouverian Wet Shrubland (G322)

Alliance: None recognized

MCV Association: *Heterotheca oregona*-*Saponaria officinalis* association

Alliance: None recognized

MCV Association: *Salix lasiolepis*-*Salix lucida* association

Group: Vancouverian Freshwater Coastal Marsh & Meadow (G517)

Alliance: None recognized

MCV Association: *Carex obnupta* association

Alliance: None recognized

MCV Association: *Carex vesicaria*-*Deschampsia cespitosa* association

Alliance: None recognized

MCV Association: *Glyceria occidentalis* association

Class: Grassland & Shrubland (2) (continued)

Macrogroup: Western North American Ruderal Wet Shrubland, Meadow & Marsh (M301)

Group: Western North American Ruderal Wet Shrubland, Meadow & Marsh (G524)

Alliance: None recognized

MCV Association: *Hirschfeldia incana-Chenopodium botrys* association

Alliance: None recognized

MCV Association: *Phalaris arundinacea* association

Macrogroup: Arid West Interior Freshwater Emergent Marsh (M888)

Group: Arid West Interior Freshwater Emergent Marsh (G531)

Alliance: None recognized

MCV Association: *Scirpus microcarpus* association

Alliance: None recognized

MCV Association: *Typha latifolia* association

Class: Aquatic Vegetation (5)

Subclass: Freshwater Aquatic Vegetation (5.B)

Formation: Temperate & Boreal Freshwater Aquatic Vegetation (5.B.2)

Division: North American Freshwater Aquatic Vegetation (5.B.2.Na)

Macrogroup: Western North American Freshwater Aquatic Vegetation (M109)

Group: Western North American Temperate Freshwater Aquatic Bed (G544)

Alliance: None recognized

MCV Association: *Nuphar lutea* association

Alliance: None recognized

MCV Association: *Potamogeton natans* association

Alliance: None recognized

MCV Association: *Scirpus subterminalis* association

Alliance: None recognized

MCV Association: *Sparganium emersum* association

Table B1. Translation between plant taxon names as used in vegetation nomenclature (USNVC, MCV, this project) and those names as used for individual species by USDA PLANTS and Jepson Manual, second edition (JM2), where different.

Name used in report	Name used by USDA-PLANTS ^a	Name used by JM2 ^b
<i>Chenopodium ambrosioides</i>	<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants
<i>Chenopodium botrys</i>	<i>Dysphania botrys</i> (L.) Mosyakin & Clemants	<i>Dysphania botrys</i> (L.) Mosyakin & Clemants
<i>Festuca arundinacea</i>	<i>Festuca arundinacea</i> (Schreb.) Dumort	<i>Festuca arundinacea</i> Schreb.
<i>Glyceria occidentalis</i>	<i>Glyceria</i> × <i>occidentalis</i> (Piper) J. C. Nelson	<i>Glyceria occidentalis</i> (Piper) J. C. Nelson
<i>Heracleum lanatum</i>	<i>Heracleum maximum</i> W. Bartram	<i>Heracleum maximum</i> W. Bartram
<i>Leymus mollis</i>	<i>Leymus mollis</i> (Trin.) Pilg.	<i>Elymus mollis</i> Trin. ssp. <i>mollis</i>
<i>Lithocarpus densiflorus</i>	<i>Notholithocarpus densiflorus</i> (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oh	<i>Notholithocarpus densiflorus</i> (Hook. & Arn.) P.S. Manos, C.H. Cannon, & S.H. Oh
<i>Nuphar lutea</i>	<i>Nuphar lutea</i> (L.) Sm. subsp. <i>polysepala</i> (Engelm.) E.O. Beal	<i>Nuphar polysepala</i> Engelm.
<i>Salix lucida</i>	<i>Salix lucida</i> Muhl.	<i>Salix lasiandra</i> Benth.
<i>Scirpus subterminalis</i>	<i>Schoenoplectus subterminalis</i> (Torr.) Soják	<i>Schoenoplectus subterminalis</i> (Torr.) Soják
<i>Tanacetum camphoratum</i>	<i>Tanacetum camphoratum</i> Less	<i>Tanacetum bipinnatum</i> (L.) Sch. Bip.

a: USDA-NRCS (2015)

b: Baldwin et al. (2012)

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***Pinus attenuata*/Lithocarpus densiflorus var. echinoides association**

LOCAL TYPE CONCEPT:

Dry woodlands with *Pinus attenuata* (knobcone pine) the dominant tree species or co-dominant with *Pseudotsuga menziesii* (Douglas-fir) and/or *Lithocarpus densiflorus* var. *densiflorus* (tanoak).

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW129 (D18_062611), REDW178 (D55_072221), REDW187 (A34), REDW188 (A35), REDW189 (A36), REDW190 (A37), REDW191 (A38), REDW193 (A40), REDW194 (A41), REDW204 (A51)

VEGETATION:

The open tree stratum is dominated by *Pinus attenuata* (knobcone pine), with *Pseudotsuga menziesii* (Douglas-fir) also present and often co-dominant. The shrub stratum species is moderately dense to dense, with *Arctostaphylos columbiana* (hairy manzanita), *Rhododendron macrophyllum* (Pacific rhododendron), *Vaccinium ovatum* (evergreen huckleberry), *Chrysolepis chrysophylla* var. *minor* (giant chinquapin), *Lithocarpus densiflorus* var. *echinoides* (shrub tanoak), and *Gaultheria shallon* (salal) the most constant and abundant species. The herbaceous stratum has relatively low cover (usually <2%) and low species richness. The most constant species are *Xerophyllum tenax* (common beargrass), *Pteridium aquilinum* (bracken fern), and *Boschniakia strobilacea* (California groundcone).

Due to its open tree canopy, this vegetation would be termed a Woodland or Wooded Shrubland, rather than a Forest, in terms of the USNVC. Plots REDW188 and REDW191 were assigned by Solomeshch to the *Pinus attenuata* - *Arctostaphylos columbiana* Shrubland association. The plots were located in the same vicinity as those assigned to the *Pinus attenuata*/Lithocarpus densiflorus var. *echinoides* association, and a shrubland type was not mapped separately. Therefore, shrubland stands are treated as more open versions of this association.

ENVIRONMENT:

Plots assigned to this vegetation occurred northern part of RNSP in the Little Bald Hills and in the Mill Creek Acquisition Area, on various mapped geologic substrates (Franciscan complex metasedimentary (greywacke and metagraywacke), Josephine ophiolite, the Wimer Formation, an erosional surface of estuarine sedimentary substrates of Miocene age, and landslide deposits. Slopes ranged from 5% to 35%. Aspects were generally south (southeast to southwest) or relatively level, and elevations ranged from 400 to 2,080 feet (123 to 640 meters) above sea level. The landform positions were upper slopes or relatively broad and gentle ridge tops.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Warm Temperate Forest & Woodland (1.B.1)

USNVC Division: Californian Warm Temperate Forest (1.B.1.Nc)

USNVC Macrogroup: Californian Forest and Woodland (M009)
USNVC Group: Californian Conifer Forest & Woodland (G198)
USNVC Alliance: *Pinus attenuata* - *Pinus coulteri* - *Pinus sabiniana* Woodland Alliance (A3356)
USNVC Association: *Pinus attenuata* / *Arctostaphylos nevadensis* Woodland (CEGL000763) (in part)
GENERALIZED ALLIANCE MAP CLASS (this project): *Pinus attenuata* Forest
MCV Alliance: *Pinus attenuata* Forest Alliance (Sawyer et al. 2009)
MCV Association: *Pinus attenuata*/*Lithocarpus densiflorus* var. *echinoides* (Solomeshch)

Table B2. Synthesis table for most constant vascular plant taxa recorded in *Pinus attenuata*/*Lithocarpus densiflorus* var. *echinoides* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus attenuata</i>	Tree	100%	11.6	1-29
<i>Pseudotsuga menziesii</i>	Tree	100%	5.8	few-28
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	20%	3.8	0-23
<i>Umbellularia californica</i>	Tree	10%	0.4	0-4
<i>Arbutus menziesii</i>	Tree	10%	0.3	0-3
<i>Chamaecyparis lawsoniana</i>	Tree	10%	0.1	0-0.5
<i>Rhododendron macrophyllum</i>	Shrub	100%	11.0	1-25
<i>Arctostaphylos columbiana</i>	Shrub	90%	18.5	0-35
<i>Vaccinium ovatum</i>	Shrub	90%	12.8	0-40
<i>Gaultheria shallon</i>	Shrub	90%	4.8	0-20
<i>Chrysopsis chrysophylla</i>	Shrub/Tree	80%	14.0	0-26
<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	Shrub	80%	9.9	0-40
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	30%	2.1	0-10
<i>Vaccinium parvifolium</i>	Shrub	30%	1.6	0-10
<i>Amelanchier alnifolia</i>	Shrub	30%	0.2	0-0.5
<i>Quercus</i> sp.	Shrub	20%	1.8	0-15
<i>Quercus vaccinifolia</i>	Shrub	20%	1.6	0-15
<i>Rosa gymnocarpa</i>	Shrub	20%	0.6	0-3
<i>Juniperus communis</i>	Shrub	20%	0.1	0-few
<i>Rhododendron occidentale</i>	Shrub	10%	0.3	0-3
<i>Arctostaphylos nevadensis</i>	Shrub	10%	0.1	0-few
<i>Holodiscus discolor</i>	Shrub	10%	0.1	0-few
<i>Physocarpus capitatus</i>	Shrub	10%	0.1	0-few
<i>Rosa</i> sp.	Shrub	10%	0.1	0-few
<i>Rubus ursinus</i>	Shrub	10%	0.1	0-few
<i>Arceuthobium campylopodum</i>	Epiphyte	10%	0.1	0-few
<i>Xerophyllum tenax</i>	Herb	90%	2.0	0-3
<i>Pteridium aquilinum</i>	Herb	70%	1.0	0-1
<i>Boschniakia strobilacea</i>	Herb	40%	0.2	0-few
<i>Anemone</i> sp.	Herb	30%	0.1	0-few
<i>Lotus aboriginus</i>	Herb	20%	0.1	0-few
<i>Galium</i> sp.	Herb	20%	0.1	0-few
<i>Iris tenuissima</i>	Herb	20%	0.1	0-few
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	20%	0.1	0-few
<i>Xerophyllum tenax</i>	Herb	10%	0.1	0-3
<i>Prosartes hookeri</i>	Herb	10%	0.1	0-few
<i>Festuca californica</i>	Herb	10%	0.1	0-few
<i>Iris</i> sp.	Herb	10%	0.1	0-few
<i>Lathyrus nevadensis</i> subsp. <i>nevadensis</i>	Herb	10%	0.1	0-few
<i>Maianthemum racemosum</i> subsp. <i>racemosum</i>	Herb	10%	0.1	0-few
<i>Polystichum munitum</i>	Herb	10%	0.1	0-few
<i>Pyrola picta</i>	Herb	10%	0.1	0-few
<i>Veratrum insolitum</i>	Herb	10%	0.1	0-few
<i>Viola sempervirens</i>	Herb	10%	0.1	0-few
<i>Zigadenus fremontii</i>	Herb	10%	0.1	0-few

Herb stratum species recorded in plots at 13% frequency and at less than 0.1% mean cover include *Carex concinnoides*, *Chimaphila* sp., *Goodyera oblongifolia*, *Lathyrus* sp., *Lilium* sp., *Polygala californica*, *Pyrola* sp., and *Whipplea modesta*.

***Chrysolepis chrysophylla/Xerophyllum tenax* association**

LOCAL TYPE CONCEPT:

Dry woodlands with *Chrysolepis chrysophylla* var. *chrysophylla* (giant chinquapin) the dominant tree species and/or codominant with *Lithocarpus densiflorus* var. *densiflorus* (tanoak).

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW192 (A39), REDW240 (A86), REDW241 (A87a), REDW244 (A87B)

VEGETATION:

The tree stratum is dominated by *Chrysolepis chrysophylla* var. *chrysophylla* (giant chinquapin), with *Lithocarpus densiflorus* var. *densiflorus* (tanoak) usually present and often co-dominant. *Pseudotsuga menziesii* (Douglas-fir) usually is present at low cover. The most constant, and usually most abundant, shrub stratum species is *Vaccinium ovatum* (evergreen huckleberry). *Rhododendron macrophyllum* (Pacific rhododendron) and *Gaultheria shallon* (salal) are relatively constant and occasionally contribute substantial cover. The herbaceous stratum has relatively low cover (usually <10%). The most constant species are *Xerophyllum tenax* (common beargrass), *Pteridium aquilinum* (bracken fern), and *Chimaphila menziesii* (little prince's pine).

ENVIRONMENT:

Since two plots were located very near each other, three sites are described. Plots assigned to this type were in the northern part of RNSP (Mill Creek Acquisition Area), with three sites in the watershed of Rock Creek, a tributary to the South Fork of the Smith River and one site in the upper Bummer Lake Creek drainage. Two of the sites were on areas mapped as the Wimer Formation, an erosional surface of estuarine sedimentary substrates of Miocene age of limited distribution in RNSP, and two sites were mapped as the Broken Formation (Franciscan complex). Slopes ranged from 10% to 30%, aspects were east (northeast to southeast), and elevations ranged from 1,680 to 2,240 feet (517 to 689 meters) above sea level. The landform positions were mostly upper slopes near flat ridge tops.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Warm Temperate Forest & Woodland (1.B.1)

USNVC Division: Californian Warm Temperate Forest (1.B.1.Nc)

USNVC Macrogroup: Californian Forest and Woodland (M009)

USNVC Group: California Moist Coastal Mixed Evergreen Forest (G208)

USNVC Alliance: *Pseudotsuga menziesii* - *Lithocarpus densiflorus* Forest Alliance (A0106)

USNVC Association: *Pseudotsuga menziesii* / *Lithocarpus densiflorus* - *Chrysolepis chrysophylla* Forest (CEGL000074)

GENERALIZED ALLIANCE MAP CLASS (this project): Montane Hardwood Mixed Forest (in part)

MCV Alliance: *Lithocarpus densiflorus* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Chrysolepis chrysophylla/Xerophyllum tenax* (Solomeshch) (= *Lithocarpus densiflorus*-*Chrysolepis chrysophylla* (Sawyer et al. 2009))

Table B3. Synthesis table for all vascular plant taxa recorded in *Chrysolepis chrysophylla/Xerophyllum tenax* association at Redwood National and State Parks (# plots=4).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Chrysolepis chrysophylla</i>	Tree	100%	58.7	36-78
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	100%	18.9	1.5-35
<i>Pseudotsuga menziesii</i>	Tree	75%	4.9	0-10
<i>Arbutus menziesii</i>	Tree	50%	1.0	0-3
<i>Pinus attenuata</i>	Tree	25%	0.4	0-1.5
<i>Sequoia sempervirens</i>	Tree	25%	0.1	0-few
<i>Vaccinium ovatum</i>	Shrub	100%	21.0	4-40
<i>Gaultheria shallon</i>	Shrub	100%	4.4	few-10
<i>Rhododendron macrophyllum</i>	Shrub	75%	4.5	0-10
<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	Shrub	25%	1.3	0-5
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	25%	0.1	0-few
<i>Xerophyllum tenax</i>	Herb	100%	4.3	3-6
<i>Pteridium aquilinum</i>	Herb	100%	2.6	few-4
<i>Chimaphila menziesii</i>	Herb	50%	0.3	0-few
<i>Prosartes smithii</i>	Herb	25%	0.1	0-few
<i>Lotus crassifolius</i>	Herb	25%	0.1	0-few
<i>Frangula purshiana</i>	Herb	25%	<0.1	0-trace

***Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Arbutus menziesii* association**

LOCAL TYPE CONCEPT:

Dry forests or woodlands with *Pseudotsuga menziesii* (Douglas-fir) the dominant tree species, or co-dominant with *Lithocarpus densiflorus* var. *densiflorus* (tanoak), and with *Sequoia sempervirens* (coast redwood) absent or infrequent.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW163 (D35_071621), REDW173 (D49_071821), REDW174 (A25), REDW179 (D53_072222), REDW181 (A29), REDW186 (A33), REDW195 (A42), REDW230 (A76), REDW231 (A77), REDW236 (A82), REDW238 (A84), REDW243 (MC55_081312)

VEGETATION:

The tree stratum is dominated by *Pseudotsuga menziesii* (Douglas-fir), with *Lithocarpus densiflorus* var. *densiflorus* (tanoak) usually present and co-dominant. Relatively constant low to moderately high cover species include *Umbellularia californica* (California bay), *Arbutus menziesii* (Pacific madrone), *Tsuga heterophylla* (western hemlock), and *Pinus attenuata* (knobcone pine). The most constant, and usually most abundant, shrub stratum species is *Vaccinium ovatum* (evergreen huckleberry). *Rhododendron macrophyllum* (Pacific rhododendron) and *Frangula californica* subsp. *californica* (= *Rhamnus californica* subsp. *californica*) (California buckthorn) are relatively constant shrubs and occasionally contribute substantial cover. Less constant shrub species that contribute low to modest cover include *Vaccinium parvifolium* (red huckleberry), *Rosa* sp. (rose), *Lonicera hispidula* (pink honeysuckle), *Lithocarpus densiflorus* var. *echinoides* (shrub tanoak), *Rhododendron occidentale* (western azalea), *Rubus ursinus* (Pacific blackberry), *Gaultheria shallon* (salal), and *Amelanchier alnifolia* (Saskatoon serviceberry). The herbaceous stratum has relatively low cover (usually <5%). The most constant species are *Polystichum munitum* (western sword fern), *Polygala californica* (California milkwort), *Pteridium aquilinum* (bracken fern), *Goodyera oblongifolia* (western rattlesnake plantain), *Iris tenuissima* (longtube iris), *Viola sempervirens* (redwood violet), *Xerophyllum tenax* (common beargrass), *Prosartes hookeri* (= *Disporum hookeri*) (drops-of-gold), and *Festuca* sp. (fescue).

ENVIRONMENT:

Six plots assigned to this vegetation were in the watershed of Rock Creek, a tributary to the South Fork of the Smith River, where it apparently occurs extensively, usually on steep slopes. All of these plots were on areas mapped as the Franciscan complex Broken Formation (non-serpintinic). Five plots were in the Little Bald Hills (upper Bummer Lake Creek and East Fork of Mill Creek drainages), usually on gentler slopes. A single plot was in the watershed of Rock Creek, a direct tributary to the Smith River just north of Houichi). The latter six plots were from areas mapped as Josephine ophiolite (serpintinic). Slopes ranged from 7 to 55%, aspects were east to south to west and level (i.e., usually other than north-facing), and elevations ranged from 200 to 2,200 feet (12 to 468 meters) above sea level. The landform positions were described as ridge tops or middle to upper slopes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Warm Temperate Forest & Woodland (1.B.1)

USNVC Division: Californian Warm Temperate Forest (1.B.1.Nc)

USNVC Macrogroup: Californian Forest and Woodland (M009)

USNVC Group: California Moist Coastal Mixed Evergreen Forest (G208)

USNVC Alliance: *Pseudotsuga menziesii* - *Lithocarpus densiflorus* Forest Alliance (A0106)

USNVC Association: *Pseudotsuga menziesii* / *Lithocarpus densiflorus* / *Vaccinium ovatum* Forest (CEGL000080)

GENERALIZED ALLIANCE MAP CLASS (this project): *Pseudotsuga menziesii*-(Other) YG Mixed Forest (in part)

MCV Alliance: *Pseudotsuga menziesii*-*Lithocarpus densiflorus* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Arbutus menziesii* (Solomeshch) (= *Pseudotsuga menziesii*-*Lithocarpus densiflorus*-(*Chamaecyparis lawsoniana*-*Tsuga heterophylla*)/*Vaccinium ovatum* (Sawyer et al. 2009))

Table B4. Synthesis table for most constant vascular plant taxa recorded in *Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Arbutus menziesii* association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pseudotsuga menziesii</i>	Tree	100%	34.7	4-58
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	83%	30.1	0-87
<i>Umbellularia californica</i>	Tree	75%	5.9	0-29
<i>Arbutus menziesii</i>	Tree	67%	5.7	0-24
<i>Tsuga heterophylla</i>	Tree	58%	3.9	0-25
<i>Pinus attenuata</i>	Tree	50%	4.1	0-20
<i>Chamaecyparis lawsoniana</i>	Tree	42%	1.4	0-6.5
<i>Quercus chrysolepis</i>	Tree	17%	5.0	0-33
<i>Chrysolepis chrysophylla</i>	Tree	17%	1.3	0-15
<i>Vaccinium ovatum</i>	Shrub	100%	21.6	4-65
<i>Rhododendron macrophyllum</i>	Shrub	83%	5.0	0-25
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	75%	6.3	0-25
<i>Vaccinium parvifolium</i>	Shrub	75%	2.0	0-5
<i>Rosa</i> sp.	Shrub	58%	0.7	0-3
<i>Lonicera hispidula</i>	Shrub	50%	0.3	0-few
<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	Shrub	42%	6.3	0-35
<i>Rhododendron occidentale</i>	Shrub	42%	2.7	0-20
<i>Rubus ursinus</i>	Shrub	42%	1.3	0-7
<i>Gaultheria shallon</i>	Shrub	42%	0.4	0-3
<i>Amelanchier alnifolia</i>	Shrub	42%	0.2	0-few
<i>Holodiscus discolor</i>	Shrub	33%	0.5	0-4
<i>Quercus vaccinifolia</i>	Shrub	25%	1.8	0-15
<i>Toxicodendron diversilobum</i>	Shrub	25%	0.3	0-3
<i>Polystichum munitum</i>	Herb	92%	1.2	0-7
<i>Polygala californica</i>	Herb	67%	0.3	0-few
<i>Pteridium aquilinum</i>	Herb	58%	0.3	0-few
<i>Goodyera oblongifolia</i>	Herb	58%	0.2	0-few
<i>Iris tenuissima</i>	Herb	50%	0.2	0-few
<i>Viola sempervirens</i>	Herb	50%	0.2	0-few
<i>Xerophyllum tenax</i>	Herb	42%	0.4	0-3
<i>Prosartes hookeri</i>	Herb	42%	0.2	0-few
<i>Festuca</i> sp.	Herb	42%	0.2	0-few
<i>Whipplea modesta</i>	Herb	33%	0.5	0-5
<i>Chimaphila menziesii</i>	Herb	33%	0.2	0-few
<i>Festuca californica</i>	Herb	33%	0.1	0-few
<i>Galium</i> sp.	Herb	33%	0.1	0-few
<i>Vancouveria</i> sp.	Herb	25%	0.3	0-3
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	25%	0.3	0-3
<i>Anemone</i> sp.	Herb	25%	0.1	0-few
<i>Carex</i> sp.	Herb	25%	0.1	0-few

Species recorded in plots at less than 17% frequency and at less than 1% mean cover include *Sequoia sempervirens*, *Pinus monticola*, *Pinus jeffreyi*, *Tsuga heterophylla* (all trees), *Arctostaphylos* sp., *Mahonia nervosa* var. *nervosa*, *Lonicera* sp., *Rosa gymnocarpa*, *Quercus* sp., *Arctostaphylos nevadensis*, *Juniperus communis*, *Sambucus racemosa*, *Hedera helix* (all shrubs), *Festuca idahoensis*, *Agrostis* sp., *Bromus vulgaris*, *Chimaphila* sp., *Chimaphila umbellata*, *Iris innominata*, *Melica* sp., *Vancouveria chrysantha*, *Boschniakia strobilacea*, *Hierochloe occidentalis*, *Aquilegia formosa*, *Bromus* sp., *Carex concinnoides*, *Elymus* sp., *Galium ambiguum* subsp. *siskiyouense*, *Hieracium albiflorum*, *Luzula* sp., *Maianthemum racemosum* subsp. *racemosum*, *Oxalis oregana*, *Pyrola picta*, *Sidalcea* sp., *Trillium ovatum*, *Achillea millefolium*, *Lathyrus* sp., *Ligusticum californicum*, *Lilium* sp., *Lycopodium clavatum*, *Maianthemum* sp., *Maianthemum stellatum*, *Pyrola* sp., *Trifolium* sp., and *Triteleia laxa* (all herbs).

***Umbellularia californica*/Carex obnupta association**

LOCAL TYPE CONCEPT:

Mesic forests of stream terraces with *Umbellularia californica* (California bay) the sole dominant tree species and with hydrophytic herbs often present at low cover.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

EDW055 (255), REDW298 (A139), REDW321 (A190)

VEGETATION:

The tree stratum is strongly dominated by *Umbellularia californica* (California bay). Subdominant associates may include *Acer macrophyllum* (bigtooth maple), *Sequoia sempervirens* (coast redwood), *Alnus rubra* (red alder), *Pseudotsuga menziesii* (Douglas-fir), and/or *Picea sitchensis* (Sitka spruce). The most constant shrub stratum species include *Rubus spectabilis* (salmonberry), *Rubus ursinus* (Pacific blackberry), *Vaccinium ovatum* (evergreen huckleberry), and *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn). The herbaceous stratum is relatively species rich and is comprised of mostly mesophytic species, often with some associated hydrophytes that occur at low cover. *Polystichum munitum* (western sword fern) is constant and usually contributes relatively high cover. Relatively constant low cover species include *Athyrium filix-femina* (lady fern), *Carex* sp. (sedges), *Oxalis oregana* (redwood sorrel), *Carex obnupta* (slough sedge), *Galium triflorum* (fragrant bedstraw), *Stachys ajugoides* (bugle hedgenettle), *Bromus vulgaris* (Columbia brome), *Melica subulata* (Alaska oniongrass), *Marah oreganus* (coast man-root), *Pteridium aquilinum* (bracken fern), and *Polypodium glycyrrhiza* (licorice fern).

ENVIRONMENT:

Two plots assigned to this vegetation occurred along Redwood Creek, and a third plot was along Prairie Creek. All plots were on geologic substrates mapped as stream or alluvial deposits. Slopes ranged from near level to 5%, and elevations ranged from 80 to 180 feet (25 to 55 meters) above sea level. The landform positions were described as “high terrace” or “river terrace.”

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Warm Temperate Forest & Woodland (1.B.1)

USNVC Division: Californian Warm Temperate Forest (1.B.1.Nc)

USNVC Macrogroup: Californian Forest and Woodland (M009)

USNVC Group: California Moist Coastal Mixed Evergreen Forest (G208)

USNVC Alliance: *Pseudotsuga menziesii* - *Lithocarpus densiflorus* Forest Alliance (A0106)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Umbellularia californica* Forest

MCV Alliance: *Umbellularia californica* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Umbellularia californica*/Carex obnupta (Solomeshch)

Table B5. Synthesis table for all vascular plant taxa recorded in *Umbellularia californica*/*Carex obnupta* association at Redwood National and State Parks (# plots=3).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Umbellularia californica</i>	Tree	100%	72.2	62-85
<i>Acer macrophyllum</i>	Tree	67%	5.4	0-10
<i>Sequoia sempervirens</i>	Tree	67%	2.7	0-5
<i>Alnus rubra</i>	Tree	33%	5.3	0-16
<i>Pseudotsuga menziesii</i>	Tree	33%	3.3	0-10
<i>Picea sitchensis</i>	Tree	33%	1.7	0-5
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	33%	0.5	0-1.5
<i>Rubus spectabilis</i>	Shrub	100%	10.2	few-20
<i>Rubus ursinus</i>	Shrub	100%	3.2	few-5
<i>Frangula purshiana</i>	Shrub	67%	1.0	0-3
<i>Vaccinium parvifolium</i>	Shrub	67%	0.3	0-few
<i>Corylus cornuta</i>	Shrub	33%	1.0	0-3
<i>Sambucus racemosa</i>	Shrub	33%	0.2	0-few
<i>Vaccinium ovatum</i>	Shrub	33%	0.2	0-few
<i>Polystichum munitum</i>	Herb	100%	60.0	55-65
<i>Athyrium filix-femina</i>	Herb	100%	2.5	few-4
<i>Carex</i> sp.	Herb	100%	2.2	few-3
<i>Oxalis oregana</i>	Herb	100%	2.2	few-3
<i>Carex obnupta</i>	Herb	100%	1.3	few-3
<i>Galium triflorum</i>	Herb	100%	1.3	few-3
<i>Stachys ajugoides</i>	Herb	100%	0.5	few
<i>Bromus vulgaris</i>	Herb	67%	2.0	0-3
<i>Melica subulata</i>	Herb	67%	2.0	0-3
<i>Marah oreganus</i>	Herb	67%	1.2	0-3
<i>Pteridium aquilinum</i>	Herb	67%	1.2	0-3
<i>Polypodium glycyrrhiza</i>	Herb	67%	0.3	0-0.5
<i>Aralia californica</i>	Herb	33%	1.3	0-4
<i>Ranunculus repens</i>	Herb	33%	1.0	0-3
<i>Tolmiea menziesii</i>	Herb	33%	1.0	0-3
<i>Adenocaulon bicolor</i>	Herb	33%	0.2	0-few
<i>Blechnum spicant</i>	Herb	33%	0.2	0-few
<i>Dicentra formosa</i>	Herb	33%	0.2	0-few
<i>Dryopteris expansa</i>	Herb	33%	0.2	0-few
<i>Hydrophyllum</i> sp.	Herb	33%	0.2	0-few
<i>Luzula parviflora</i>	Herb	33%	0.2	0-few
<i>Mimulus dentatus</i>	Herb	33%	0.2	0-few
<i>Moehringia</i> sp.	Herb	33%	0.2	0-few
<i>Oenanthe sarmentosa</i>	Herb	33%	0.2	0-few
<i>Osmorhiza berteroi</i>	Herb	33%	0.2	0-few
<i>Poa</i> sp.	Herb	33%	0.2	0-few
<i>Urtica dioica</i>	Herb	33%	0.2	0-few
<i>Vancouveria</i> sp.	Herb	33%	0.2	0-few
<i>Viola glabella</i>	Herb	33%	0.2	0-few
<i>Whipplea modesta</i>	Herb	33%	0.2	0-few

***Pinus jeffreyi*/Festuca idahoensis association**

LOCAL TYPE CONCEPT:

Dry woodlands with *Pinus jeffreyi* (Jeffrey pine) the dominant tree species or co-dominant with *Pseudotsuga menziesii* (Douglas-fir), usually on ophiolitic (serpentinic) soils.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW022 (224), REDW025 (234), REDW026 (235), REDW027 (237), REDW028 (238), REDW029 (239), REDW180 (D51_072223), REDW182 (A30), REDW183 (A31a), REDW184 (A31b), REDW205 (A52)

VEGETATION:

The fairly open tree stratum is dominated by *Pinus jeffreyi* (Jeffrey pine) or by *Pinus jeffreyi* and *Pseudotsuga menziesii* (Douglas-fir). The most constant, and usually most abundant, shrub stratum species is *Frangula californica* subsp. *californica* (= *Rhamnus californica* subsp. *californica*) (California buckthorn). Relatively constant (mostly low cover) shrubs are *Holodiscus discolor* (oceanspray), *Ceanothus pumilus* (dwarf ceanothus), *Arctostaphylos nevadensis* (pinemat manzanita), and *Rosa gymnocarpa* (dwarf rose). The herbaceous stratum is dominated by graminoids, with *Festuca idahoensis* (Idaho fescue) the most abundant species overall and *Festuca californica* (California fescue), *Danthonia californica* (California oatgrass), *Agrostis* sp. (bentgrass), *Elymus glaucus* (blue wildrye), *Carex concinnoides* (northwestern sedge), *Luzula comosa* (Pacific woodrush), and/or *Koeleria macrantha* (prairie junegrass) frequent components. A relatively high diversity of low cover forbs is present, including *Aspidotis densa* (Indian's dream), *Sidalcea malviflora* (dwarf checkerbloom), *Achillea millefolium* (yarrow), *Hastingsia serpenticola* (Klamath rushlily), *Sanicula graveolens* (northern sanicle), *Perideridia oregana* (Oregon yampah), *Horkelia sericata* (silky horkelia), *Eriophyllum lanatum* (common woollysunflower), *Zigadenus* sp. (= *Toxicoscordion* sp.) (death camas), *Triteleia bridgesii* (Bridges' brodiaea), *Erigeron* sp. (fleabane), *Sisyrinchium bellum* (western blue-eyed grass), *Trifolium longipes* (longstalk cover), *Agoseris* sp. (agoseris), *Polystichum munitum* (western sword fern), *Cerastium arvense* (field chickweed), *Galium ambiguum* subsp. *siskiyouense* (Siskiyou bedstraw), and *Ranunculus occidentalis* (western buttercup).

ENVIRONMENT:

All plots assigned to this vegetation occurred in the Little Bald Hills, in the upper parts of the Bummer Lake Creek drainage, on areas mapped as Josephine ophiolite, a serpentinic substrate. Slopes were generally gentle, ranging from 3% to 20%, with one plot each on a 35% slope. Aspects were various, and elevations ranged from 1,560 to 2,040 feet (480 to 628 meters) above sea level. The landform positions were relatively gentle upper slopes and broad ridge tops.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)
USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)
USNVC Macrogroup: Southern Vancouverian Montane-Foothill Forest (M023)
USNVC Group: Californian Montane Conifer Forest & Woodland (G344)
USNVC Alliance: *Pinus jeffreyi* - *Pinus washoensis* Mixed Conifer Woodland Alliance (A3676)
USNVC Association: None recognized
GENERALIZED ALLIANCE MAP CLASS (this project): *Pinus jeffreyi* Forest
MCV Alliance: *Pinus jeffreyi* Forest Alliance (Sawyer et al. 2009)
MCV Association: *Pinus jeffreyi*/*Festuca idahoensis* (Solomeshch, Sawyer et al. 2009)

Table B6. Synthesis table for most constant vascular plant taxa recorded in *Pinus jeffreyi*/*Festuca idahoensis* association at Redwood National and State Parks (# plots=11).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus jeffreyi</i>	Tree	100%	31.2	11-43
<i>Pseudotsuga menziesii</i>	Tree	100%	13.9	few-43
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	91%	13.5	0-50
<i>Holodiscus discolor</i>	Shrub	82%	1.5	0-3
<i>Ceanothus pumilus</i>	Shrub	82%	1.1	0-4
<i>Arctostaphylos nevadensis</i>	Shrub	64%	4.3	0-20
<i>Rosa gymnocarpa</i>	Shrub	45%	0.2	0-few
<i>Festuca idahoensis</i>	Herb	100%	30.5	5-45
<i>Festuca californica</i>	Herb	100%	7.5	few-35
<i>Danthonia californica</i>	Herb	100%	4.2	few-10
<i>Agrostis</i> sp.	Herb	100%	3.5	few-10
<i>Elymus glaucus</i>	Herb	100%	3.3	few-7
<i>Aspidotis densa</i>	Herb	100%	0.5	trace-few
<i>Carex concinnoides</i>	Herb	91%	3.1	0-7
<i>Sidalcea malviflora</i>	Herb	91%	2.1	0-5
<i>Achillea millefolium</i>	Herb	91%	1.4	0-3
<i>Hastingsia serpenticola</i>	Herb	91%	1.4	0-3
<i>Sanicula graveolens</i>	Herb	91%	1.1	0-3
<i>Perideridia oregana</i>	Herb	82%	1.5	0-3
<i>Luzula comosa</i>	Herb	82%	1.1	0-3
<i>Horkelia sericata</i>	Herb	82%	0.9	0-3
<i>Eriophyllum lanatum</i>	Herb	82%	0.6	0-3
<i>Zigadenus</i> sp.	Herb	82%	0.4	0-few
<i>Triteleia bridgesii</i>	Herb	82%	0.4	0-few
<i>Erigeron</i> sp.	Herb	82%	0.4	0-few
<i>Sisyrinchium bellum</i>	Herb	82%	0.4	0-few
<i>Trifolium longipes</i>	Herb	73%	1.6	0-4
<i>Agoseris</i> sp.	Herb	73%	0.4	0-few
<i>Polystichum munitum</i>	Herb	64%	0.8	0-3
<i>Koeleria macrantha</i>	Herb	64%	0.7	0-5
<i>Cerastium arvense</i>	Herb	64%	0.5	0-3
<i>Galium ambiguum</i> subsp. <i>siskiyouense</i>	Herb	64%	0.5	0-3
<i>Ranunculus occidentalis</i>	Herb	64%	0.3	0-few
<i>Lomatium dissectum</i>	Herb	55%	0.5	0-3
<i>Luzula parviflora</i>	Herb	55%	0.3	0-few
<i>Vicia</i> sp.	Herb	55%	0.3	0-few
<i>Bromus laevipes</i>	Herb	55%	0.3	0-few
<i>Prunella vulgaris</i>	Herb	55%	0.2	0-few
<i>Deschampsia cespitosa</i>	Herb	45%	1.9	0-7
<i>Viola cuneata</i>	Herb	45%	0.7	0-3

Species recorded in plots at less than 40% frequency and at less than 6% mean cover include *Lithocarpus densiflorus* var. *densiflorus*, *Umbellularia californica*, *Tsuga heterophylla*, *Chamaecyparis lawsoniana*, *Quercus chrysolepis*, *Arbutus menziesii*, *Pinus attenuata* (all trees), *Arctostaphylos columbiana*, *Berberis* sp., *Vaccinium parvifolium*, *Vaccinium ovatum*, *Amelanchier alnifolia*, *Rubus ursinus*, *Quercus vacciniifolia*, *Mahonia aquifolium*, *Arctostaphylos* sp., *Rosa* sp., *Lonicera* sp. (all shrubs), *Brodiaea elegans*, *Melica* sp., *Viola* sp., *Iris* sp., *Calystegia atriplicifolia* subsp. *buttensis*, *Lathyrus* sp., *Phlox* sp., *Trifolium* sp., *Chlorogalum* sp., *Melica geyeri*, *Bromus carinatus*, *Iris tenuissima*, *Polygala californica*, *Calochortus tolmiei*, *Trifolium breweri*, *Whipplea modesta*, *Calystegia* sp., *Goodyera oblongifolia*, *Carex* sp., *Achnatherum lemmonii*, *Anthoxanthum odoratum*, *Poa* sp., *Phlox diffusa*, *Triteleia laxa*, *Eriogonum nudum*, *Gilia capitata*, *Madia madioides*, and *Dodecatheon hendersonii* (all herbs).

***Pinus monticola*-*Pinus contorta*/*Lithocarpus* var. *echinoides*-*Quercus vaccinifolia* association**

LOCAL TYPE CONCEPT:

Dry woodlands with *Pinus monticola* (western white pine) and/or *Pinus contorta* (lodgepole pine) dominant or co-dominant in the tree stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW229 (A75), REDW232 (A78), REDW239 (A85), REDW245 (MC49_081411), REDW246 (MC50_081412), REDW247 (MC48_081413), REDW248 (MC47_081414), REDW324 (MC37), REDW325 (MC19)

VEGETATION:

The open tree stratum usually is dominated by *Pinus monticola* (western white pine). *Pinus contorta* (lodgepole pine) dominant in one of the nine stands. *Pseudotsuga menziesii* (Douglas-fir), *Umbellularia californica* (California bay), and/or *Pinus attenuata* (knobcone pine) frequently are present at low cover. The shrub stratum species is moderately dense to dense, with some combination of *Lithocarpus densiflorus* var. *echinoides* (shrub tanoak), *Arctostaphylos columbiana* (hairy manzanita), and/or *Quercus vaccinifolia* (huckleberry oak) usually providing most of the cover. Fairly constant low to moderate cover shrub species include *Vaccinium parvifolium* (red huckleberry), *Frangula californica* subsp. *californica* (= *Rhamnus californica* subsp. *californica*) (California buckthorn), *Juniperus communis* (common juniper), *Arctostaphylos nevadensis* (pinemat manzanita), *Ceanothus pumilus* (dwarf ceanothus), *Mahonia aquifolium* (Oregon grape), *Rhododendron occidentale* (western azalea), and *Garrya* sp. (silktassel). The herbaceous stratum has relatively low cover (usually <10%) and low species richness. The most constant herbaceous taxa are *Xerophyllum tenax* (common beargrass), *Galium* sp. (bedstraw), *Melica* sp. (melicgrass), *Carex* sp. (a sedge), *Anemone* sp. (anemone), *Gentiana affinis* (pleated gentian), and *Lilium bolanderi* (Bolander's lily).

Due to its open tree canopy, this vegetation might be termed a Woodland or Wooded Shrubland, rather than a Forest, in terms of the USNVC. Plots REDW229, REDW232, REDW245, and REDW325 originally were assigned by Solomeshch to the *Pinus monticola*-*Arctostaphylos columbiana* Shrubland association. Several were located in the same vicinity as those assigned to the *Pinus monticola*-*Pinus contorta*/*Lithocarpus* var. *echinoides*-*Quercus vaccinifolia* association, and a shrubland type was not mapped separately. Therefore, shrubland stands are treated as more open versions of this association.

ENVIRONMENT:

All plots assigned to this vegetation occurred in the Mill Creek Acquisition Area in the northern part of RNSP, in the watershed of Rock Creek, a tributary to the South Fork of the Smith River, on areas mapped as metasedimentary substrates (greywacke and metagreywacke) of the Franciscan complex (including the Broken Formation). Slopes ranged from 7% to 35%, aspects were various, and elevations mostly ranged from 1,600 to 3,200 feet (492 to 985 meters) above sea level, with most

plots at least 2,800 feet (862 meters) above sea level. The landform positions were usually relatively gentle upper slopes and ridge tops.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Southern Vancouverian Montane-Foothill Forest (M023)

USNVC Group: Californian Montane Conifer Forest & Woodland (G344)

USNVC Alliance: *Abies concolor* - *Pseudotsuga menziesii* Coastal, Cascade & Sierran Forest Alliance (A3674)

USNVC Association: *Pinus monticola* - *Pseudotsuga menziesii* / *Quercus vaccinifolia* - *Lithocarpus densiflorus* Woodland (CEGL003449)

GENERALIZED ALLIANCE MAP CLASS (this project): *Pinus monticola* Forest

MCV Alliance: *Pinus monticola* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Pinus monticola*-*Pinus contorta*/*Lithocarpus densiflorus* v. *echinoides*-*Quercus vaccinifolia* (Solomeshch) (= *Pinus monticola*-*Pinus contorta* ssp. *contorta*/*Lithocarpus densiflorus* var. *echinoides* (Sawyer et al. 2009))

Table B7. Synthesis table for most constant vascular plant taxa recorded in *Pinus monticola*-*Pinus contorta*/*Lithocarpus densiflorus* var. *echinoides*-*Quercus vaccinifolia* association at Redwood National and State Parks (# plots=9).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus monticola</i>	Tree	89%	9.9	0-24
<i>Pseudotsuga menziesii</i>	Tree	78%	2.4	0-4.5
<i>Umbellularia californica</i>	Tree	67%	1.4	0-5
<i>Pinus attenuata</i>	Tree	56%	2.0	0-3
<i>Pinus contorta</i>	Tree	22%	5.4	0-24
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	11%	7.2	0-65
<i>Arbutus menziesii</i>	Tree	11%	0.6	0-5.5
<i>Arctostaphylos columbiana</i>	Shrub	100%	11.2	3-30
<i>Lithocarpus densiflorus</i> var. <i>echinoides</i>	Shrub	89%	29.9	0-55
<i>Vaccinium parvifolium</i>	Shrub	89%	6.9	0-15
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	89%	3.1	0-5
<i>Juniperus communis</i>	Shrub	89%	2.8	0-5
<i>Quercus vaccinifolia</i>	Shrub	78%	13.3	0-30
<i>Arctostaphylos nevadensis</i>	Shrub	67%	5.1	0-20
<i>Ceanothus pumilus</i>	Shrub	67%	1.3	0-7
<i>Mahonia aquifolium</i>	Shrub	67%	0.3	0-few
<i>Rhododendron occidentale</i>	Shrub	56%	3.7	0-15
<i>Garrya</i> sp.	Shrub	56%	1.1	0-5
<i>Holodiscus discolor</i>	Shrub	44%	0.5	0-3
<i>Rosa gymnocarpa</i>	Shrub	44%	0.2	0-few
<i>Rhododendron macrophyllum</i>	Shrub	33%	2.0	0-10
<i>Vaccinium ovatum</i>	Shrub	33%	1.5	0-10
<i>Amelanchier alnifolia</i>	Shrub	33%	0.2	0-few
<i>Xerophyllum tenax</i>	Herb	89%	2.4	0-6
<i>Galium</i> sp.	Herb	89%	0.4	0-few
<i>Melica</i> sp.	Herb	67%	0.6	0-3
<i>Carex</i> sp.	Herb	56%	0.6	0-3
<i>Anemone</i> sp.	Herb	56%	0.3	0-few
<i>Gentiana affinis</i>	Herb	56%	0.3	0-few
<i>Lilium bolanderi</i>	Herb	56%	0.2	0-few
<i>Iris tenuissima</i>	Herb	44%	0.8	0-3
<i>Festuca californica</i>	Herb	44%	0.5	0-3
<i>Pyrola picta</i>	Herb	44%	0.2	0-few
<i>Viola lobata</i> subsp. <i>lobata</i>	Herb	44%	0.2	0-few
<i>Iris innominata</i>	Herb	33%	0.7	0-3
<i>Lupinus</i> sp.	Herb	33%	0.4	0-3
<i>Erigeron</i> sp.	Herb	33%	0.2	0-few
<i>Vicia</i> sp.	Herb	33%	0.2	0-few
<i>Zigadenus</i> sp.	Herb	33%	0.2	0-few
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	33%	0.1	0-few
<i>Carex concinnoides</i>	Herb	22%	0.4	0-3

Species recorded in plots at 22% frequency or less and at less than 0.3% mean cover include *Sequoia sempervirens* (tree), *Gaultheria shallon*, *Ceanothus velutinus*, *Baccharis pilularis*, *Rubus ursinus* (all shrubs), *Agrostis* sp., *Lathyrus* sp., *Polygala californica*, *Pteridium aquilinum*, *Silene californica*, *Veratrum insolitum*, *Whipplea modesta*, *Luzula* sp., *Achillea millefolium*, *Achnatherum lemmonii*, *Allium* sp., *Calystegia* sp., *Chimaphila umbellata*, *Cordylanthus* sp., *Prosartes hookeri*, *Eriophyllum lanatum*, *Festuca idahoensis*, *Hieracium albiflorum*, *Hieracium* sp., *Iris* sp., *Ligusticum* sp., *Monardella* sp., *Perideridia oregana*, *Phlox* sp., *Vancouveria* sp., *Viola* sp., *Anaphalis margaritacea*, *Boschniakia strobilacea*, *Chimaphila menziesii*, *Goodyera oblongifolia*, and *Maianthemum stellatum* (all herbs).

***Alnus rubra*-*Sequoia sempervirens* Young Growth association**

LOCAL TYPE CONCEPT:

Young (post-logging) growth mesic forests of upland slopes with *Alnus rubra* (red alder) the most abundant (highest cover) tree species and with *Sequoia sempervirens* (coast redwood) present to important.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW087 (60321), REDW146 (N24_070911), REDW147 (N25_070912), REDW148 (N23_070913), REDW176 (A27), REDW207 (A54), REDW208 (A55), REDW209 (A56), REDW210 (A57), REDW227 (A73), REDW228 (A74), REDW355 (A191)

VEGETATION:

The tree stratum is dominated by *Alnus rubra* (red alder), with *Sequoia sempervirens* (coast redwood) also present and sometimes co-dominant. *Lithocarpus densiflorus* var. *densiflorus* (tanoak) is often present and may contribute significant cover. *Pseudotsuga menziesii* (Douglas-fir) and/or *Tsuga heterophylla* (western hemlock) often are present at low to modest cover. The most abundant shrub stratum species are *Vaccinium ovatum* (evergreen huckleberry), *Rubus ursinus* (Pacific blackberry), *Rhododendron macrophyllum* (Pacific rhododendron), *Gaultheria shallon* (salal), *Vaccinium parvifolium* (red huckleberry), and *Mahonia nervosa* var. *nervosa* (Cascade barberry). *Polystichum munitum* (western sword fern) is the most constant and abundant species of the herbaceous stratum, often reaching high cover. Highly to moderately constant low cover species include *Claytonia sibirica* (candy flower), *Galium triflorum* (fragrant bedstraw), *Bromus vulgaris* (Columbia brome), *Viola sempervirens* (redwood violet), *Oxalis oregana* (redwood sorrel), *Athyrium filix-femina* (lady fern), and *Trientalis borealis* subsp. *latifolia* (broadleaf starflower).

ENVIRONMENT:

Plots assigned to this vegetation occurred throughout RNSP, usually on geologic substrates mapped as the Franciscan complex (e.g., Redwood Creek schist and Broken Formation), and occasionally as stream terrace deposits. Slopes ranged from 15% to 45%, aspects were various, and elevations ranged from 240 to 1,240 feet (74 to 382 meters) above sea level. The landform positions were mostly slopes (upper to lower), with one plot along a small stream. This type appears to be successional to the *Sequoia sempervirens*/*Vaccinium ovatum*/*Polystichum munitum* association and the two associations occupy similar settings.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Sequoia sempervirens*-(Other) Young Growth Forest (in part)

MCV Alliance: *Alnus rubra* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Alnus rubra-Sequoia sempervirens* (second growth) Solomeshch

Table B8. Synthesis table for most constant vascular plant taxa recorded in *Alnus rubra*-*Sequoia sempervirens* Young Growth association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	100%	67.8	40-82
<i>Sequoia sempervirens</i>	Tree	92%	12.3	0-28
<i>Pseudotsuga menziesii</i>	Tree	67%	4.0	0-11
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	58%	8.1	0-60
<i>Tsuga heterophylla</i>	Tree	58%	2.0	0-6.5
<i>Picea sitchensis</i>	Tree	33%	4.4	0-36
<i>Acer macrophyllum</i>	Tree	17%	1.2	0-10
<i>Vaccinium ovatum</i>	Shrub	75%	2.4	0-5
<i>Rubus ursinus</i>	Shrub	67%	5.2	0-30
<i>Rhododendron macrophyllum</i>	Shrub	58%	1.8	0-5
<i>Gaultheria shallon</i>	Shrub	58%	1.3	0-10
<i>Vaccinium parvifolium</i>	Shrub	58%	0.5	0-3
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	50%	1.3	0-10
<i>Frangula purshiana</i>	Shrub/Tree	50%	0.6	0-5
<i>Sambucus racemosa</i>	Shrub	42%	1.1	0-5
<i>Rubus spectabilis</i>	Shrub	33%	6.5	0-70
<i>Ribes</i> sp.	Shrub	17%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	32.9	0.5-80
<i>Claytonia sibirica</i>	Herb	92%	2.2	0-10
<i>Galium triflorum</i>	Herb	75%	0.5	0-3
<i>Bromus vulgaris</i>	Herb	67%	0.9	0-5
<i>Viola sempervirens</i>	Herb	67%	0.3	0-0.5
<i>Oxalis oregana</i>	Herb	58%	1.5	0-15
<i>Athyrium filix-femina</i>	Herb	50%	0.4	0-3
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	50%	0.3	0-few
<i>Carex</i> sp.	Herb	42%	0.5	0-5
<i>Festuca</i> sp.	Herb	42%	0.4	0-3
<i>Dryopteris expansa</i>	Herb	42%	0.2	0-few
<i>Moehringia</i> sp.	Herb	33%	0.6	0-3
<i>Stachys ajugoides</i>	Herb	33%	0.3	0-3
<i>Blechnum spicant</i>	Herb	33%	0.2	0-few
<i>Luzula parviflora</i>	Herb	25%	0.1	0-few
<i>Trillium ovatum</i>	Herb	25%	0.1	0-few
<i>Dicentra formosa</i>	Herb	25%	0.1	0-few
<i>Marah oreganus</i>	Herb	17%	0.4	0-5
<i>Pteridium aquilinum</i>	Herb	17%	0.3	0-3
<i>Ranunculus repens</i>	Herb	17%	0.3	0-3
<i>Osmorhiza berteroi</i>	Herb	17%	0.1	0-few
<i>Poa</i> sp.	Herb	17%	0.1	0-few
<i>Stellaria</i> sp.	Herb	17%	0.1	0-few
<i>Holcus lanatus</i>	Herb	17%	0.1	0-few
<i>Juncus</i> sp.	Herb	17%	0.1	0-few

Species recorded in plots at less than 17% frequency and at less than 0.4% mean cover include *Abies grandis*, *Arbutus menziesii*, *Umbellularia californica* (all trees), *Rubus parviflorus*, *Lonicera hispidula* (both shrubs), *Prosartes smithii*, *Polypodium scolieri*, *Dactylis glomerata*, *Agrostis* sp., *Asarum caudatum*, *Carex hendersonii*, *Dryopteris* sp., *Elymus* sp., *Galium aparine*, *Glyceria* sp., *Heracleum lanatum*, *Iris douglasiana*, *Lilium columbianum*, *Phalaris arundinacea*, *Prunella vulgaris*, *Rumex obtusifolius*, *Trisetum* sp., *Whipplea modesta*, *Cardamine californica*, *Carex hookeriana*, *Mimulus dentatus*, *Tellima grandiflora*, and *Veronica anagallis-aquatica* (all herbs).

***Chamaecyparis lawsoniana* association**

LOCAL TYPE CONCEPT:

Dry woodlands with *Chamaecyparis lawsoniana* (Port Orford cedar) either the sole dominant tree species or co-dominant with *Pseudotsuga menziesii* (Douglas-fir), usually on ophiolitic (serpentinic) soils.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW175 (A26)

VEGETATION:

In the single plot attributed to this vegetation, the tree stratum is strongly dominated by *Chamaecyparis lawsoniana* (Port Orford cedar). *Pseudotsuga menziesii* (Douglas-fir) is present at lower, but significant, cover, and both *Lithocarpus densiflorus* var. *densiflorus* (tanoak) and *Umbellularia californica* (California bay) occur at low cover. The shrub and herbaceous strata both have relatively low cover (<5%). In the shrub stratum, *Vaccinium ovatum* (evergreen huckleberry) is the most abundant species, with *Vaccinium parvifolium* (red huckleberry), *Frangula californica* subsp. *californica* (= *Rhamnus californica* subsp. *californica*) (California buckthorn), *Holodiscus discolor* (oceanspray), and *Rubus ursinus* (Pacific blackberry) occurring in small amounts. In the herbaceous stratum, *Polystichum munitum* (western sword fern) is the most abundant species, with *Bromus vulgaris* (Columbia brome), *Carex* sp. (a sedge), *Iris tenuissima* (longtube iris), *Polygala californica* (California milkwort), *Festuca idahoensis* (Idaho fescue), *Prosartes hookeri* (= *Disporum hookeri*) (drops-of-gold), *Goodyera oblongifolia* (western rattlesnake plantain), and *Vancouveria* sp. (insideout flower) occurring in small amounts.

This type was not mapped individually, but stands were found during the thematic accuracy assessment.

ENVIRONMENT:

The single plot occurred along the Little Bald Hills Trail. The site is on a gentle (10-25%), west-facing slope on a geologic substrate mapped as Josephine ophiolite. The plot data describe the site as a ridge top.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Chamaecyparis lawsoniana* Forest Alliance (A0104)

USNVC Association: *Chamaecyparis lawsoniana* - *Pseudotsuga menziesii* / *Lithocarpus densiflorus* / *Gaultheria shallon* Forest (CEGL000043)

GENERALIZED ALLIANCE MAP CLASS (this project): Montane Conifer-Mixed Forest (in part)

MCV Alliance: *Chamaecyparis lawsoniana* Forest Alliance (Sawyer et al. 2009)

MCV Association: None recognized

Table B9. Synthesis table for all vascular plant taxa recorded in *Chamaecyparis lawsoniana* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Chamaecyparis lawsoniana</i>	Tree	100%	52.2	40-60
<i>Pseudotsuga menziesii</i>	Tree	100%	15.0	15
<i>Lithocarpus densiflorus</i>	Tree	100%	4.5	4-5
<i>Umbellularia californica</i>	Tree	100%	0.5	few
<i>Vaccinium ovatum</i>	Shrub	100%	3.0	1-5
<i>Vaccinium parvifolium</i>	Shrub	100%	0.5	few
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	100%	0.5	few
<i>Holodiscus discolor</i>	Shrub	100%	0.5	few
<i>Rubus ursinus</i>	Shrub	100%	0.5	few
<i>Polystichum munitum</i>	Herb	100%	3.0	1-5
<i>Bromus vulgaris</i>	Herb	100%	0.5	few
<i>Carex</i> sp.	Herb	100%	0.5	few
<i>Festuca idahoensis</i>	Herb	100%	0.5	few
<i>Iris tenuissima</i>	Herb	100%	0.5	few
<i>Polygala californica</i>	Herb	100%	0.5	few
<i>Prosartes hookeri</i>	Herb	100%	0.1	trace
<i>Goodyera oblongifolia</i>	Herb	100%	0.1	trace
<i>Vancouveria</i> sp.	Herb	100%	0.1	trace

***Lithocarpus densiflorus*-*Sequoia sempervirens* Young Growth association**

LOCAL TYPE CONCEPT:

Young (post-logging) growth mesic forests with *Lithocarpus densiflorus* var. *densiflorus* (tanoak) the most abundant (highest cover) tree species and with *Pseudotsuga menziesii* (Douglas-fir) and *Sequoia sempervirens* (coast redwood) either co-dominant or important.

REDW222 (A68), REDW223 (A69), REDW224 (A70), REDW225 (A71), REDW226 (A72)

VEGETATION:

The tree stratum is dominated by *Lithocarpus densiflorus* var. *densiflorus* (tanoak), with *Sequoia sempervirens* (coast redwood) also present and sometimes co-dominant. *Pseudotsuga menziesii* (Douglas-fir) is present at low to modest cover. *Tsuga heterophylla* (western hemlock) often is present at low cover. The most abundant, shrub stratum species are *Vaccinium ovatum* (evergreen huckleberry) and *Rhododendron macrophyllum* (Pacific rhododendron). Highly constant to fairly constant low cover shrubs include *Rubus ursinus* (Pacific blackberry), *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn), and *Gaultheria shallon* (salal). A variety of species occur at usually low cover in the herbaceous stratum, including *Polystichum munitum* (western sword fern), *Viola sempervirens* (redwood violet), *Trillium ovatum* (Pacific trillium), and *Blechnum spicant* (deer fern). The overall composition of this vegetation is very similar to that of the *Pseudotsuga menziesii* - *Lithocarpus densiflorus* - *Sequoia sempervirens* Young Growth Forest, with a primary difference being the relative abundances of *Lithocarpus densiflorus* var. *densiflorus* and *Pseudotsuga menziesii*.

ENVIRONMENT:

Four plots assigned to this vegetation were in close proximity to one another in a steep tributary drainage to the East Fork of Mill Creek; the fifth was in the drainage of Fortyfour Creek, a tributary of Redwood Creek. Geologic substrates were mapped as Franciscan complex (Redwood Creek schist and Broken Formation). Slopes ranged from 20% to 55%, aspects were various, and elevations ranged from 820 to 1,440 feet (252 to 443 meters) above sea level. The landform positions were described as slopes. This type appears to be successional to the *Sequoia sempervirens*/*Vaccinium ovatum*/*Polystichum munitum* association and seems to occupy similar settings.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)

USNVC Association: *Pseudotsuga menziesii* - *Sequoia sempervirens* / *Rhododendron macrophyllum* / *Vaccinium ovatum* Forest (CEGL000082) (in part)

GENERALIZED ALLIANCE MAP CLASS (this project): *Sequoia sempervirens*-(Other) YG Mixed Forest (in part)

MCV Alliance: *Lithocarpus densiflorus* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Lithocarpus densiflorus*-*Sequoia sempervirens* (second growth) (Solomeshch)

Table B10. Synthesis table for all vascular plant taxa recorded in *Lithocarpus densiflorus*-*Sequoia sempervirens* Young Growth association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	100%	59.8	46-83
<i>Sequoia sempervirens</i>	Tree	100%	29.3	4-60
<i>Pseudotsuga menziesii</i>	Tree	100%	14.3	5-21
<i>Tsuga heterophylla</i>	Tree	80%	2.4	0-6.5
<i>Alnus rubra</i>	Tree	40%	5.0	0-20
<i>Arbutus menziesii</i>	Tree	20%	0.8	0-4
<i>Vaccinium ovatum</i>	Shrub	100%	13.0	3-40
<i>Rhododendron macrophyllum</i>	Shrub	100%	5.3	few-15
<i>Rubus ursinus</i>	Shrub	100%	0.2	trace-few
<i>Frangula purshiana</i>	Shrub	80%	0.2	0-few
<i>Gaultheria shallon</i>	Shrub	60%	0.7	0-3
<i>Lonicera hispidula</i>	Shrub	40%	0.0	0-trace
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	20%	0.1	0-few
<i>Vaccinium parvifolium</i>	Shrub	20%	<0.1	0-trace
<i>Polystichum munitum</i>	Herb	100%	2.9	trace-6
<i>Viola sempervirens</i>	Herb	100%	0.4	trace-few
<i>Trillium ovatum</i>	Herb	80%	0.4	0-few
<i>Blechnum spicant</i>	Herb	60%	1.0	0-4
<i>Galium triflorum</i>	Herb	40%	0.2	0-few
<i>Oxalis oregana</i>	Herb	40%	0.2	0-few
<i>Prosartes hookeri</i>	Herb	40%	0.1	0-few
<i>Goodyera oblongifolia</i>	Herb	40%	0.0	0-trace
<i>Athyrium filix-femina</i>	Herb	20%	0.6	0-3
<i>Dryopteris expansa</i>	Herb	20%	0.1	0-few
<i>Pteridium aquilinum</i>	Herb	20%	0.1	0-few
<i>Achlys triphylla</i>	Herb	20%	<0.1	0-trace
<i>Cardamine californica</i>	Herb	20%	<0.1	0-trace
<i>Hierochloe occidentalis</i>	Herb	20%	<0.1	0-trace

***Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Sequoia sempervirens* Young Growth association**

LOCAL TYPE CONCEPT:

Young (post-logging) growth mesic forests with *Pseudotsuga menziesii* (Douglas-fir) the dominant tree species and with *Sequoia sempervirens* (coast redwood) either co-dominant or important and with *Lithocarpus densiflorus* var. *densiflorus* (tanoak) usually present at low cover.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW082 (A2_052822), REDW105 (D85_061711), REDW106 (D84_061712), REDW107 (D82_061713), REDW112 (61912), REDW164 (D60_071721), REDW165 (A19), REDW166 (A20), REDW167 (A21), REDW168 (A22), REDW206 (A53), REDW211 (A58)

VEGETATION:

The tree stratum is dominated by *Pseudotsuga menziesii* (Douglas-fir), with *Sequoia sempervirens* (coast redwood) also present and sometimes co-dominant. *Lithocarpus densiflorus* var. *densiflorus* (tanoak) usually is present at low to modest cover. *Tsuga heterophylla* (western hemlock) often is present at low cover. The most abundant shrub stratum species are *Vaccinium ovatum* (evergreen huckleberry) and *Rhododendron macrophyllum* (Pacific rhododendron). Highly constant to fairly constant low cover shrubs include *Gaultheria shallon* (salal), *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn), *Vaccinium parvifolium* (red huckleberry), *Mahonia nervosa* var. *nervosa* (Cascade barberry), and *Rubus ursinus* (Pacific blackberry). A variety of species occur in the herbaceous stratum, usually at low cover. These include *Polystichum munitum* (western sword fern), *Viola sempervirens* (redwood violet), *Galium triflorum* (fragrant bedstraw), *Trillium ovatum* (Pacific trillium), *Whipplea modesta* (modesty), *Oxalis oregana* (redwood sorrel), *Pteridium aquilinum* (bracken fern), *Prosartes hookeri* (= *Disporum hookeri*) (drops-of-gold), *Bromus vulgaris* (Columbia brome), *Blechnum spicant* (deer fern), *Claytonia sibirica* (candy flower), *Asarum caudatum* (creeping wildginger), *Trientalis borealis* subsp. *latifolia* (broadleaf starflower), and *Goodyera oblongifolia* (western rattlesnake plantain). The overall composition of this vegetation is very similar to that of the *Lithocarpus densiflorus*-*Sequoia sempervirens* Young Growth association, with a primary difference being the relative abundances of *Pseudotsuga menziesii* and *Lithocarpus densiflorus* var. *densiflorus*.

ENVIRONMENT:

Plots assigned to this vegetation occurred throughout RNSP, usually on geologic substrates mapped as the Franciscan complex (e.g., Redwood Creek schist and Broken Formation), and occasionally as stream terrace deposits. Slopes ranged from 5% to 35%, aspects were various, and elevations ranged from 580 to 1,570 feet (178 to 483 meters) above sea level. The landform positions were relatively level ridge tops or slopes (upper to toe slopes). This type appears to be successional to the *Sequoia sempervirens*/*Vaccinium ovatum*/*Polystichum munitum* association and occupies similar settings.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)
USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)
USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)
USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)
USNVC Group: Californian Coastal Redwood Forest (G235)
USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)
USNVC Association: *Pseudotsuga menziesii* - *Sequoia sempervirens* / *Rhododendron macrophyllum* / *Vaccinium ovatum* Forest (CEGL000082) (in part)
GENERALIZED ALLIANCE MAP CLASS (this project): *Sequoia sempervirens*-(Other) YG Mixed Forest (in part)
MCV Alliance: *Pseudotsuga menziesii*-*Lithocarpus densiflorus* Forest Alliance (Sawyer et al. 2009)
MCV Association: *Pseudotsuga menziesii*-*Sequoia sempervirens* (second growth) (Solomeshch)

Table B11. Synthesis table for most constant vascular plant taxa recorded in *Pseudotsuga menziesii*-*Lithocarpus densiflorus*-*Sequoia sempervirens* Young Growth association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pseudotsuga menziesii</i>	Tree	100%	57.3	38-79
<i>Sequoia sempervirens</i>	Tree	100%	23.5	15-45
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	92%	9.0	0-35
<i>Tsuga heterophylla</i>	Tree	67%	1.3	0-6
<i>Alnus rubra</i>	Tree	42%	0.7	0-4
<i>Chamaecyparis lawsoniana</i>	Tree	25%	0.2	0-1
<i>Abies grandis</i>	Tree	8%	0.4	0-5
<i>Vaccinium ovatum</i>	Shrub	100%	8.8	few-30
<i>Gaultheria shallon</i>	Shrub	100%	1.8	trace-4
<i>Rhododendron macrophyllum</i>	Shrub	92%	4.3	0-20
<i>Frangula purshiana</i>	Shrub	92%	0.5	0-2
<i>Vaccinium parvifolium</i>	Shrub	75%	0.6	0-3
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	58%	1.2	0-4
<i>Rubus ursinus</i>	Shrub	58%	0.2	0-few
<i>Sambucus racemosa</i>	Shrub	17%	0.1	0-few
<i>Ilex aquifolium</i>	Shrub	17%	0.1	0-few
<i>Lonicera</i> species	Shrub	17%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	3.7	0.5-7
<i>Viola sempervirens</i>	Herb	100%	1.6	0.5-5
<i>Galium triflorum</i>	Herb	92%	0.8	0-3
<i>Trillium ovatum</i>	Herb	92%	0.4	0-few
<i>Whipplea modesta</i>	Herb	83%	0.4	0-few
<i>Oxalis oregana</i>	Herb	75%	1.1	0-7
<i>Pteridium aquilinum</i>	Herb	67%	0.7	0-3
<i>Prosartes hookeri</i>	Herb	67%	0.2	0-few
<i>Bromus vulgaris</i>	Herb	58%	0.4	0-3
<i>Blechnum spicant</i>	Herb	50%	0.6	0-5
<i>Claytonia sibirica</i>	Herb	50%	0.5	0-3
<i>Asarum caudatum</i>	Herb	50%	0.4	0-3
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	50%	0.3	0-few
<i>Goodyera oblongifolia</i>	Herb	50%	0.2	0-few
<i>Lilium columbianum</i>	Herb	42%	0.2	0-few
<i>Cardamine californica</i>	Herb	42%	0.1	0-few
<i>Carex hendersonii</i>	Herb	42%	0.1	0-few
<i>Festuca elmeri</i>	Herb	33%	0.2	0-few
<i>Osmorhiza berteroi</i>	Herb	25%	0.1	0-few
<i>Athyrium filix-femina</i>	Herb	25%	0.1	0-few
<i>Lathyrus vestitus</i>	Herb	25%	0.1	0-few
<i>Iris douglasiana</i>	Herb	25%	0.1	0-few
<i>Dryopteris expansa</i>	Herb	25%	0.1	0-few
<i>Listera caurina</i>	Herb	25%	0.1	0-few
<i>Festuca</i> species	Herb	17%	0.3	0-3
<i>Prosartes smithii</i>	Herb	17%	0.1	0-few
<i>Hieracium albiflorum</i>	Herb	17%	<0.1	0-trace

Species recorded in plots at less than 10% frequency and at less than 0.1% mean cover include *Rubus spectabilis* (shrub), *Campanula* sp., *Corallorrhiza maculata*, *Hierochloa occidentalis*, *Lathyrus* sp., *Luzula parviflora*, *Marah oreganus*, *Stachys ajugoides*, *Trisetum* sp., *Vancouveria hexandra*, *Actaea rubra*, *Equisetum* sp., *Hydrophyllum tenuipes*, *Polypodium glycyrrhiza*, *Polypodium scolieri*, and *Scoliopus bigelovii* (all herbs).

***Sequoia sempervirens* -*Acer macrophyllum*-*Umbellularia californica* association**

LOCAL TYPE CONCEPT:

Mature mesic forests of stream terraces with *Sequoia sempervirens* (coast redwood) a dominant or co-dominant tree species and with co-dominance or significant cover contributed by a combination of *Tsuga heterophylla* (western hemlock), *Acer macrophyllum* (bigtooth maple), *Umbellularia californica* (California bay), and/or *Alnus rubra* (red alder). *Pseudotsuga menziesii* (Douglas-fir) usually is absent or unimportant. Hydrophytic herbs may be present, usually at low cover.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW006 (207), REDW017 (218), REDW018 (219), REDW019 (220), REDW020 (221), REDW021 (222), REDW052 (252), REDW054 (254), REDW171 (A24), REDW263 (A126), REDW264 (A127), REDW266 (A129), REDW267 (A130), REDW268 (A131), REDW270 (A133)

VEGETATION:

The tree stratum is strongly dominated by *Sequoia sempervirens* (coast redwood). Relatively constant tree species that also may contribute significant cover include *Tsuga heterophylla* (western hemlock), *Acer macrophyllum* (bigtooth maple), *Lithocarpus densiflorus* var. *densiflorus* (tanoak), *Umbellularia californica* (California bay), and *Alnus rubra* (red alder). *Rubus spectabilis* (salmonberry) and *Acer circinatum* (vine maple) are relatively constant in the shrub stratum, and one of these species is usually the most abundant species in this stratum. Relatively constant low cover shrub species include *Vaccinium ovatum* (evergreen huckleberry), *Vaccinium parvifolium* (red huckleberry), *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn), and *Gaultheria shallon* (salal). The herbaceous stratum is relatively species rich and is comprised mostly of mesophytic species, with some hydrophytes present at least at low cover. The most constant and abundant species are *Polystichum munitum* (western sword fern) and *Oxalis oregana* (redwood sorrel). Other constant (usually low cover) species include *Dryopteris expansa* (spreading woodfern), *Stachys ajugoides* (bugle hedgenettle), *Athyrium filix-femina* (lady fern), *Blechnum spicant* (deer fern), *Carex obnupta* (slough sedge), *Prosartes smithii* (= *Disporum smithii*) (largeflower fairybells), *Trillium ovatum* (Pacific trillium), and *Galium triflorum* (fragrant bedstraw).

ENVIRONMENT:

Plots occurred throughout RNSP, usually on geologic substrates mapped as marine terrace deposits or alluvial substrates. Slopes ranged from near level to 20%, aspects were various, and elevations ranged from 80 to 520 feet (25 to 160 meters) above sea level. The landform positions were nearly always terraces or stream terraces.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Sequoia sempervirens* Mature Forest (in part)

MCV Alliance: *Sequoia sempervirens* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Sequoia sempervirens*-*Acer macrophyllum*-*Umbellularia californica* (Solomeshch, Sawyer et al. 2009)

Table B12. Synthesis table for most constant vascular plant taxa recorded in *Sequoia sempervirens*-*Acer macrophyllum*-*Umbellularia californica* association at Redwood National and State Parks (# plots=15).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Sequoia sempervirens</i>	Tree	100%	52.9	11-92
<i>Tsuga heterophylla</i>	Tree	73%	12.1	0-58
<i>Acer macrophyllum</i>	Tree	60%	7.2	0-30
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	60%	2.6	0-19
<i>Umbellularia californica</i>	Tree	53%	4.5	0-24
<i>Alnus rubra</i>	Tree	47%	4.9	0-26
<i>Picea sitchensis</i>	Tree	40%	3.1	0-16
<i>Vaccinium ovatum</i>	Shrub	93%	3.0	0-15
<i>Vaccinium parvifolium</i>	Shrub	87%	2.1	0-5
<i>Rubus spectabilis</i>	Shrub	73%	11.8	0-50
<i>Frangula purshiana</i>	Shrub/Tree	67%	1.7	0-14
<i>Acer circinatum</i>	Shrub/Tree	60%	7.6	0-26
<i>Gaultheria shallon</i>	Shrub	60%	1.5	0-5
<i>Sambucus racemosa</i>	Shrub	53%	0.2	0-few
<i>Corylus cornuta</i>	Shrub	47%	4.4	0-30
<i>Ribes</i> sp.	Shrub	40%	0.9	0-3
<i>Menziesia ferruginea</i>	Shrub	33%	0.8	0-5
<i>Rubus ursinus</i>	Shrub	27%	0.4	0-5
<i>Rubus parviflorus</i>	Shrub	27%	0.3	0-3
<i>Polystichum munitum</i>	Herb	100%	40.0	few-65
<i>Oxalis oregana</i>	Herb	100%	22.2	few-55
<i>Dryopteris expansa</i>	Herb	93%	2.3	0-10
<i>Stachys ajugoides</i>	Herb	87%	0.6	0-3
<i>Athyrium filix-femina</i>	Herb	73%	3.7	0-10
<i>Blechnum spicant</i>	Herb	73%	3.3	0-25
<i>Carex obnupta</i>	Herb	67%	4.4	0-55
<i>Prosartes smithii</i>	Herb	67%	0.3	0-few
<i>Trillium ovatum</i>	Herb	60%	0.3	0-few
<i>Galium triflorum</i>	Herb	60%	0.3	0-few
<i>Asarum caudatum</i>	Herb	53%	1.2	0-7
<i>Maianthemum dilatatum</i>	Herb	47%	1.2	0-5
<i>Pteridium aquilinum</i>	Herb	40%	0.3	0-3
<i>Luzula parviflora</i>	Herb	40%	0.1	0-few
<i>Marah oreganus</i>	Herb	33%	0.2	0-few
<i>Streptopus amplexifolius</i>	Herb	33%	0.2	0-few
<i>Melica subulata</i>	Herb	33%	0.1	0-few
<i>Lysichiton americanus</i>	Herb	27%	0.7	0-5
<i>Carex deweyana</i>	Herb	27%	0.1	0-few
<i>Carex</i> sp.	Herb	27%	0.1	0-few
<i>Claytonia sibirica</i>	Herb	27%	0.1	0-few

Species recorded in plots at less than 25% frequency and at less than 0.4% mean cover include *Pseudotsuga menziesii*, *Chamaecyparis lawsoniana* (both trees), *Euonymus occidentalis* var. *occidentalis*, *Toxicodendron diversilobum*, *Mahonia nervosa* var. *nervosa*, *Cornus* sp., *Lonicera involucrata*, *Ribes cruentum* var. *cruentum*, (all shrubs), *Mimulus dentatus*, *Oenanthe sarmentosa*, *Bromus vulgaris*, *Trisetum* sp., *Vancouveria hexandra*, *Equisetum telmateia*, *Tolmiea menziesii*, *Hydrophyllum tenuipes*, *Polypodium glycyrrhiza*, *Viola* sp., *Trientalis borealis* subsp. *latifolia*, *Adenocaulon bicolor*, *Cardamine californica*, *Chrysosplenium glechomifolium*, *Iris douglasiana*, *Osmorhiza berteroi*, *Whipplea modesta*, *Actaea rubra*, *Dicentra formosa*, *Holcus lanatus*, *Juncus* sp., *Moneses uniflora*, *Polypodium scolieri*, and *Tellima grandiflora* (all herbs).

***Sequoia sempervirens*-*Pseudotsuga menziesii*-*Lithocarpus densiflorus*/*Vaccinium ovatum* association**

LOCAL TYPE CONCEPT:

Mature mesic forests of upland slopes with *Sequoia sempervirens* (coast redwood) and *Lithocarpus densiflorus* var. *densiflorus* (tanoak) co-dominant, sometimes along with *Pseudotsuga menziesii* (Douglas-fir) and/or *Tsuga heterophylla* (western hemlock).

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW050 (250), REDW051 (251), REDW056 (256), REDW150 (C16_071022), REDW151 (C17_071023)

VEGETATION:

The tree stratum is dominated by *Sequoia sempervirens* (coast redwood) and *Lithocarpus densiflorus* var. *densiflorus* (tanoak). *Tsuga heterophylla* (western hemlock) and *Pseudotsuga menziesii* (Douglas-fir) are constant associates that may contribute significant cover. The abundance of *Lithocarpus densiflorus* var. *densiflorus* (tanoak) is characteristic of this vegetation among older growth *Sequoia sempervirens*-dominated forest types. The most abundant, shrub stratum species are *Vaccinium ovatum* (evergreen huckleberry) and *Rhododendron macrophyllum* (Pacific rhododendron); abundance of the latter species is characteristic of this vegetation among *Sequoia sempervirens*-dominated forest types. *Vaccinium parvifolium* (red huckleberry) is fairly constant, usually at low cover. The herbaceous stratum has relatively low cover (<1% to 3%). The most constant species are *Polystichum munitum* (western sword fern), *Trillium ovatum* (Pacific trillium), *Trientalis borealis* subsp. *latifolia* (broadleaf starflower), *Viola sempervirens* (redwood violet), *Whipplea modesta* (modesty), and *Iris douglasiana* (Douglas iris).

Since *Arbutus menziesii* is neither constant nor abundant in this vegetation, the Sawyer et al. (2009) name has been applied to this vegetation as more appropriate.

ENVIRONMENT:

All five plots assigned to this vegetation were clustered within 1 mile (1.6 km) of one another, on slopes along a short reach of Redwood Creek, between Harry Weir Creek and Tom McDonald Creek. The geologic substrate is mapped as Redwood Creek schist. Slopes ranged mostly from 25% to 35%, aspects were mostly south to southwest (one northwest), and elevations ranged from 240 to 640 feet (74 to 197 meters) above sea level. The landform positions were described as middle to lower slopes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)

USNVC Association: *Pseudotsuga menziesii* - *Sequoia sempervirens* / *Rhododendron macrophyllum* / *Vaccinium ovatum* Forest (CEGL000082)

MCV Alliance: *Sequoia sempervirens* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Sequoia sempervirens* - *Pseudotsuga menziesii* - *Lithocarpus densiflorus* / *Vaccinium ovatum* (Sawyer et al. 2009) (= *Sequoia sempervirens*-*Arbutus menziesii* (Solomeshch))

Table B13. Synthesis table for all vascular plant taxa recorded in *Sequoia sempervirens*-*Pseudotsuga menziesii*-*Lithocarpus densiflorus*/*Vaccinium ovatum* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	100%	48.8	35-68
<i>Sequoia sempervirens</i>	Tree	100%	38.7	30-46
<i>Tsuga heterophylla</i>	Tree	100%	17.4	3-35
<i>Pseudotsuga menziesii</i>	Tree	100%	10.5	6-16
<i>Umbellularia californica</i>	Tree	40%	0.1	0-few
<i>Arbutus menziesii</i>	Tree	20%	0.7	0-3.5
<i>Alnus rubra</i>	Tree	20%	0.1	0-few
<i>Vaccinium ovatum</i>	Shrub	80%	35.0	0-60
<i>Rhododendron macrophyllum</i>	Shrub	80%	16.0	0-35
<i>Vaccinium parvifolium</i>	Shrub	80%	3.3	0-15
<i>Gaultheria shallon</i>	Shrub	40%	1.0	0-5
<i>Lonicera hispidula</i>	Shrub	40%	0.2	0-few
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	40%	0.0	0-trace
<i>Corylus cornuta</i>	Shrub	20%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	1.0	few-3
<i>Trillium ovatum</i>	Herb	100%	0.5	few
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	80%	0.4	0-few
<i>Viola sempervirens</i>	Herb	60%	0.3	0-few
<i>Whipplea modesta</i>	Herb	60%	0.3	0-few
<i>Iris douglasiana</i>	Herb	60%	0.2	0-few
<i>Galium triflorum</i>	Herb	40%	0.1	0-few
<i>Maianthemum racemosum</i> subsp. <i>racemosum</i>	Herb	40%	0.1	0-few
<i>Anemone</i> sp.	Herb	20%	0.1	0-few
<i>Blechnum spicant</i>	Herb	20%	0.1	0-few
<i>Achlys triphylla</i>	Herb	20%	<0.1	0-trace
<i>Clintonia andrewsiana</i>	Herb	20%	<0.1	0-trace
<i>Prosartes smithii</i>	Herb	20%	<0.1	0-trace
<i>Hemitomes congestum</i>	Herb	20%	<0.1	0-trace
<i>Oxalis oregana</i>	Herb	20%	<0.1	0-trace

***Sequoia sempervirens/Vaccinium ovatum/Polystichum munitum* association**

LOCAL TYPE CONCEPT:

Mature mesic forests of upland slopes with *Sequoia sempervirens* (coast redwood) the dominant tree species or co-dominant with *Pseudotsuga menziesii* (Douglas-fir), *Tsuga heterophylla* (western hemlock), and/or *Picea sitchensis* (Sitka spruce), usually with *Lithocarpus densiflorus* var. *densiflorus* (tanoak) either present at low cover or absent.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW006 (207), REDW017 (218), REDW018 (219), REDW019 (220), REDW020 (221), REDW076 (TR14), REDW080 (TR21), REDW081 (A3_052821), REDW083 (52901), REDW085 (60221), REDW086 (60222), REDW088 (B9_060322), REDW089 (B40_060421), REDW090 (B41_060422), REDW091 (B29_060521), REDW092 (TR27_060522), REDW121 (62322), REDW145 (B30_070811), REDW161 (N50_071522), REDW169 (D61_071722), REDW271 (A134)

VEGETATION:

The tree stratum is strongly dominated by *Sequoia sempervirens* (coast redwood). Associated, and occasionally, codominant tree species include *Tsuga heterophylla* (western hemlock), *Pseudotsuga menziesii* (Douglas-fir), *Lithocarpus densiflorus* var. *densiflorus* (tanoak), and *Picea sitchensis* (Sitka spruce). The most constant, and usually the most abundant, shrub stratum species is *Vaccinium ovatum* (evergreen huckleberry). Other relatively constant shrubs include *Vaccinium parvifolium* (red huckleberry), *Gaultheria shallon* (salal), *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn), and *Menziesia ferruginea* (rusty menziesia). The herbaceous stratum is relatively species rich and is comprised of mostly mesophytic species. The most constant, and usually the most abundant, species is *Polystichum munitum* (western sword fern). *Oxalis oregana* (redwood sorrel) and *Blechnum spicant* (deer fern) are usually present and may occasionally co-dominate. Relatively constant (usually low cover) species include *Trillium ovatum* (Pacific trillium), *Galium triflorum* (fragrant bedstraw), *Trientalis borealis* subsp. *latifolia* (broadleaf starflower), *Viola sempervirens* (redwood violet), *Dryopteris expansa* (spreading woodfern), *Athyrium filix-femina* (lady fern), *Prosartes hookeri* (= *Disporum hookeri*) (drops-of-gold), and *Prosartes smithii* (= *Disporum smithii*) (largeflower fairybells).

ENVIRONMENT:

Plots assigned to this vegetation occurred throughout RNSP, usually on geologic substrates mapped as sedimentary (e.g., Prairie Creek and Broken (Franciscan complex) Formations), marine terrace deposits substrates and occasionally on stream terrace deposits and alluvial fans. Slopes ranged from near level to 55%, aspects were various, and elevations ranged from 40 to 1,520 feet (12 to 468 meters) above sea level. The landform positions were nearly always slopes (toe slope to upper slopes).

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: Californian Coastal Redwood Forest (G235)

USNVC Alliance: *Sequoia sempervirens* Forest Alliance (A3403)

USNVC Association: *Pseudotsuga menziesii* - *Sequoia sempervirens* / *Polystichum munitum* Forest (CEGL000081)

GENERALIZED ALLIANCE MAP CLASS (this project): *Sequoia sempervirens* Mature Forest (in part)

MCV Alliance: *Sequoia sempervirens* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Sequoia sempervirens/Vaccinium ovatum/Polystichum munitum* (Solomeshch)
(=*Sequoia sempervirens/Vaccinium ovatum/Polystichum munitum* (Sawyer et al. 2009))

Table B14 Synthesis table for most constant vascular plant taxa recorded in *Sequoia sempervirens*/*Vaccinium ovatum*/*Polystichum munitum* association at Redwood National and State Parks (# plots=21).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Sequoia sempervirens</i>	Tree	100%	53.8	32-90
<i>Tsuga heterophylla</i>	Tree	71%	8.2	0-44
<i>Pseudotsuga menziesii</i>	Tree	62%	6.7	0-26
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	62%	2.5	0-29
<i>Picea sitchensis</i>	Tree	38%	7.7	0-46
<i>Alnus rubra</i>	Tree	19%	4.1	0-39
<i>Umbellularia californica</i>	Tree	19%	0.1	0-1
<i>Vaccinium ovatum</i>	Shrub	100%	16.4	few-75
<i>Vaccinium parvifolium</i>	Shrub	90%	2.6	0-5
<i>Gaultheria shallon</i>	Shrub	86%	3.6	0-15
<i>Frangula purshiana</i>	Shrub	62%	0.7	0-6.5
<i>Menziesia ferruginea</i>	Shrub	48%	0.7	0-3
<i>Rubus spectabilis</i>	Shrub	43%	0.4	0-4
<i>Corylus cornuta</i>	Shrub	38%	0.3	0-3
<i>Rhododendron macrophyllum</i>	Shrub	29%	0.3	0-4
<i>Rubus ursinus</i>	Shrub	29%	0.2	0-3
<i>Rubus parviflorus</i>	Shrub	19%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	37.2	few-70
<i>Oxalis oregana</i>	Herb	95%	9.0	0-30
<i>Blechnum spicant</i>	Herb	81%	5.6	0-20
<i>Trillium ovatum</i>	Herb	81%	0.3	0-few
<i>Galium triflorum</i>	Herb	76%	0.5	0-3
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	71%	0.4	0-3
<i>Viola sempervirens</i>	Herb	62%	0.4	0-3
<i>Dryopteris expansa</i>	Herb	57%	0.6	0-5
<i>Athyrium filix-femina</i>	Herb	57%	0.3	0-3
<i>Prosartes hookeri</i>	Herb	57%	0.2	0-few
<i>Prosartes smithii</i>	Herb	48%	0.2	0-few
<i>Polypodium scolieri</i>	Herb	43%	0.1	0-few
<i>Dryopteris arguta</i>	Herb	33%	0.4	0-3
<i>Stachys ajugoides</i>	Herb	33%	0.2	0-3
<i>Vancouveria hexandra</i>	Herb	33%	0.2	0-few
<i>Carex hendersonii</i>	Herb	33%	0.1	0-few
<i>Maianthemum dilatatum</i>	Herb	29%	0.4	0-4
<i>Luzula parviflora</i>	Herb	29%	0.1	0-0.5
<i>Asarum caudatum</i>	Herb	24%	0.3	0-5
<i>Streptopus amplexifolius</i>	Herb	24%	0.1	0-few
<i>Claytonia sibirica</i>	Herb	19%	0.2	0-3
<i>Bromus vulgaris</i>	Herb	19%	0.1	0-few
<i>Adenocaulon bicolor</i>	Herb	19%	0.1	0-few

Species recorded in plots at less than 15% frequency and at less than 0.3% mean cover include *Acer macrophyllum*, *Chamaecyparis lawsoniana*, *Acer circinatum* (all trees), *Mahonia nervosa* var. *nervosa*, *Rosa gymnocarpa*, *Sambucus racemosa*, *Lonicera* sp., *Ribes* sp., *Rubus* sp., *Toxicodendron diversilobum*, *Rhus trilobata* (all shrubs), *Hierochloa occidentalis*, *Melica subulata*, *Festuca elmeri*, *Iris douglasiana*, *Pteridium aquilinum*, *Polypodium glycyrrhiza*, *Cardamine californica*, *Festuca* sp., *Vancouveria* sp., *Carex* sp., *Goodyera oblongifolia*, *Maianthemum racemosum* subsp. *racemosum*, *Lilium columbianum*, *Anemone deltoidea*, *Achlys californica*, *Adiantum aleuticum*, *Dryopteris* sp., *Marah oreganus*, *Moneses uniflora*, *Tellima grandiflora*, *Trisetum* sp., *Vancouveria planipetala*, *Whipplea modesta*, *Actaea rubra*, *Cirsium vulgare*, *Cortaderia jubata*, *Dactylis glomerata*, *Hemitomes congestum*, *Hieracium* sp., *Hypochaeris radicata*, *Lathyrus vestitus*, *Phacelia* sp., and *Trisetum cernuum* (all herbs).

***Alnus rubra*/Rubus spectabilis-Sambucus racemosa association**

LOCAL TYPE CONCEPT:

Mesic forests of the vicinity of the ocean coast with *Alnus rubra* (red alder) the most abundant species in the tree stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW057 (257), REDW277 (A146), REDW300 (A169), REDW301 (A170), REDW305 (A174), REDW306 (A175)

VEGETATION:

The tree stratum is dominated by *Alnus rubra* (red alder). *Picea sitchensis* (Sitka spruce) is a relatively constant associate tree at low cover. *Sambucus racemosa* (red elderberry), *Rubus ursinus* (Pacific blackberry), and *Rubus spectabilis* (salmonberry) are the most constant and abundant shrub stratum components. *Polystichum munitum* (western sword fern) is the most constant herbaceous stratum species and often contributes high cover. Relatively constant low cover herbs include *Athyrium filix-femina* (lady fern), *Stachys ajugoides* (bugle hedgenettle), *Heracleum lanatum* (= *Heracleum maximum*) (common cowparsnip), *Bromus vulgaris* (Columbia brome), *Carex* sp. (sedges), and *Marah oreganus* (coast man-root). The floristic similarity of this vegetation to that of the *Picea sitchensis*/*Gaultheria shallon* association and the relative abundance of less shade tolerant species suggest that it may be successional to the latter vegetation type.

ENVIRONMENT:

Plots assigned to this vegetation throughout RNSP, within 0.3 miles (0.5 km) of the Pacific Ocean shoreline. Geologic substrates were mapped as various formations of the Franciscan complex, often in the vicinity of areas mapped as landslides. Slopes were consistently steep, ranging from 35% to 55%, aspects were generally west (northwest to southwest), and elevations ranged from 90 to 520 feet (28 to 160 meters) above sea level. The landform positions were described as slopes (lower to middle).

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: North Pacific Red Alder - Bigleaf Maple - Douglas-fir Forest (G237)

USNVC Alliance: *Alnus rubra* - *Acer macrophyllum* Forest Alliance (A3385)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Alnus rubra*-(Other) Forest (in part)

MCV Alliance: *Alnus rubra* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Alnus rubra*/*Rubus spectabilis*-*Sambucus racemosa* (Sawyer et al. 2009) (= *Alnus rubra* Coastal Bluff association (Solomeshch))

Table B15. Synthesis table for all vascular plant taxa recorded in *Alnus rubra*/*Rubus spectabilis*-*Sambucus racemosa* association at Redwood National and State Parks (# plots=6).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	100%	75.9	65-81
<i>Picea sitchensis</i>	Tree	67%	3.3	0-6
<i>Sambucus racemosa</i>	Shrub	100%	17.6	few-35
<i>Rubus spectabilis</i>	Shrub	83%	15.4	0-55
<i>Rubus ursinus</i>	Shrub	67%	21.0	0-65
<i>Rubus parviflorus</i>	Shrub	33%	5.1	0-30
<i>Ribes</i> sp.	Shrub	33%	0.2	0-few
<i>Baccharis pilularis</i>	Shrub	17%	1.7	0-10
<i>Hedera helix</i>	Shrub	17%	0.8	0-5
<i>Myrica californica</i>	Shrub	17%	0.7	0-4
<i>Frangula purshiana</i>	Shrub	17%	0.5	0-3
<i>Gaultheria shallon</i>	Shrub	17%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	33.8	3-75
<i>Athyrium filix-femina</i>	Herb	83%	1.4	0-4
<i>Stachys ajugoides</i>	Herb	67%	2.4	0-7
<i>Heracleum lanatum</i>	Herb	67%	0.8	0-3
<i>Bromus vulgaris</i>	Herb	50%	0.9	0-5
<i>Carex</i> sp.	Herb	50%	0.8	0-4
<i>Marah oreganus</i>	Herb	50%	0.7	0-3
<i>Galium aparine</i>	Herb	33%	0.8	0-4
<i>Urtica dioica</i>	Herb	33%	0.6	0-3
<i>Dactylis glomerata</i>	Herb	33%	0.2	0-few
<i>Holcus lanatus</i>	Herb	33%	0.2	0-few
<i>Galium triflorum</i>	Herb	33%	0.1	0-few
<i>Maianthemum dilatatum</i>	Herb	33%	0.1	0-few
<i>Osmorhiza berteroi</i>	Herb	33%	0.1	0-few
<i>Carex obnupta</i>	Herb	17%	1.2	0-7
<i>Petasites frigidus</i>	Herb	17%	0.7	0-4
<i>Calamagrostis</i> sp.	Herb	17%	0.5	0-3
<i>Ranunculus repens</i>	Herb	17%	0.5	0-3
<i>Achillea millefolium</i>	Herb	17%	0.1	0-few
<i>Bromus</i> sp.	Herb	17%	0.1	0-few
<i>Claytonia sibirica</i>	Herb	17%	0.1	0-few
<i>Prosartes smithii</i>	Herb	17%	0.1	0-few
<i>Dryopteris expansa</i>	Herb	17%	0.1	0-few
<i>Equisetum telmateia</i>	Herb	17%	0.1	0-few
<i>Juncus</i> sp.	Herb	17%	0.1	0-few
<i>Moehringia</i> sp.	Herb	17%	0.1	0-few
<i>Polypodium scolieri</i>	Herb	17%	0.1	0-few
<i>Pteridium aquilinum</i>	Herb	17%	0.1	0-few
<i>Sonchus oleraceus</i>	Herb	17%	0.1	0-few
<i>Sonchus</i> sp.	Herb	17%	0.1	0-few
<i>Tellima grandiflora</i>	Herb	17%	0.1	0-few
<i>Tolmiea menziesii</i>	Herb	17%	0.1	0-few
<i>Erechtites minima</i>	Herb	17%	<0.1	0-trace
<i>Oenanthe sarmentosa</i>	Herb	17%	<0.1	0-trace

***Tsuga heterophylla* association**

LOCAL TYPE CONCEPT:

Mature mesic forests with *Tsuga heterophylla* (western hemlock) the only dominant tree species.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW212 (A59a)

VEGETATION:

In the single plot attributed to this vegetation, the tree stratum is strongly dominated by *Tsuga heterophylla* (western hemlock). The shrub stratum has relatively low cover (2-5%) and species richness; *Mahonia nervosa* var. *nervosa* (Cascade barberry) is the most abundant species. *Gaultheria shallon* (salal), *Rhododendron macrophyllum* (Pacific rhododendron), *Vaccinium ovatum* (evergreen huckleberry), *Vaccinium parvifolium* (red huckleberry), and *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn) also were recorded. The herbaceous stratum also has low (less than 2%) cover and species richness; *Galium triflorum* (fragrant bedstraw), *Oxalis oregana* (redwood sorrel), *Polystichum munitum* (western sword fern), and *Viola sempervirens* (redwood violet), *Prosartes smithii* (= *Disporum smithii*) (largeflower fairybells), *Dryopteris expansa* (spreading woodfern), and *Scoliopus bigelovii* (California fetid adderstongue) were recorded.

ENVIRONMENT:

The single plot assigned to this vegetation occurred near a ridge top at the upper end of the drainage of Fortyfour Creek, a tributary of Redwood Creek. The geologic substrate is mapped as Redwood Creek schist (Franciscan complex). The slope is east-facing and about 20%, and the elevation is approximately 1,440 feet (443 meters) above sea level. The landform position is described as an upper slope.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: North Pacific Maritime Douglas-fir - Western Hemlock Forest (G240)

USNVC Alliance: *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Rubus spectabilis* Wet Forest Alliance (A3377)

USNVC Association: *Pseudotsuga menziesii* - *Tsuga heterophylla* / *Mahonia nervosa* - *Polystichum munitum* Forest (CEGL005543)

GENERALIZED ALLIANCE MAP CLASS (this project): Montane Conifer-Mixed Forest (in part)

MCV Alliance: *Tsuga heterophylla* Forest Alliance (Sawyer et al. 2009)

MCV Association: None recognized

Table B16. Synthesis table for all vascular plant taxa recorded in *Tsuga heterophylla* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Tsuga heterophylla</i>	Tree	100%	71.6	70-75
<i>Pseudotsuga menziesii</i>	Tree	100%	3.0	1-5
<i>Sequoia sempervirens</i>	Tree	100%	1.0	few-1
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	100%	0.5	few
<i>Mahonia nervosa</i> var. <i>nervosa</i>	Shrub	100%	3.0	1-5
<i>Gaultheria shallon</i>	Shrub	100%	0.5	few
<i>Rhododendron macrophyllum</i>	Shrub	100%	0.5	few
<i>Vaccinium ovatum</i>	Shrub	100%	0.5	few
<i>Vaccinium parvifolium</i>	Shrub	100%	0.5	few
<i>Frangula purshiana</i>	Shrub	100%	0.1	trace
<i>Galium triflorum</i>	Herb	100%	0.5	few
<i>Oxalis oregana</i>	Herb	100%	0.5	few
<i>Polystichum munitum</i>	Herb	100%	0.5	few
<i>Viola sempervirens</i>	Herb	100%	0.5	few
<i>Prosartes smithii</i>	Herb	100%	0.1	trace
<i>Dryopteris expansa</i>	Herb	100%	0.1	trace
<i>Scoliopus bigelovii</i>	Herb	100%	0.1	trace

***Picea sitchensis*/Gaultheria shallon association**

LOCAL TYPE CONCEPT:

Mesic forests of the vicinity of the ocean coast with *Picea sitchensis* (Sitka spruce) the most abundant species in the tree stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW063 (263), REDW093 (B14_060621), REDW154 (A16a_071411), REDW155 (A16b), REDW219 (A65), REDW220 (A66), REDW296 (A166), REDW309 (A178), REDW311 (A180), REDW340 (A102)

VEGETATION:

The tree stratum is dominated by *Picea sitchensis* (Sitka spruce). *Alnus rubra* (red alder) and *Sequoia sempervirens* (coast redwood) are inconstant associate trees, and the former occasionally may contribute significant cover. *Gaultheria shallon* (salal) and *Vaccinium ovatum* (evergreen huckleberry) are the most constant and abundant shrub stratum components. Other relatively constant shrubs (all usually at low cover when present) are *Rubus spectabilis* (salmonberry), *Vaccinium parvifolium* (red huckleberry), *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn), *Rubus parviflorus* (thimbleberry), and *Rubus ursinus* (Pacific blackberry). The herbaceous stratum is relatively species rich and is comprised mostly of mesophytic species. Relatively constant species include *Polystichum munitum* (western sword fern) (which occasionally contributes high cover), *Prosartes smithii* (= *Disporum smithii*) (largeflower fairybells), *Viola sempervirens* (redwood violet), *Galium triflorum* (fragrant bedstraw), *Maianthemum dilatatum* (false lily of the valley), and *Pteridium aquilinum* (bracken fern). This vegetation is distinguished floristically from the *Picea sitchensis*/*Lysichiton americanus* association Forest by the absence or insignificance of hydrophytic species.

ENVIRONMENT:

Plots assigned to this vegetation occurred throughout RNSP within 0.6 miles (1 km) of the Pacific Ocean shoreline. Geologic substrates were mapped as the Prairie Creek Formation, various formations of the Franciscan complex, or alluvium. Slopes ranged from 10% to 50%, aspects were generally west (northwest to southwest), and elevations ranged from 30 to 440 feet (9 to 135 meters) above sea level. The landform positions were described as slopes (lower to upper).

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Vancouverian Lowland & Montane Forest (M024)

USNVC Group: North Pacific Western Hemlock - Sitka Spruce - Western Red-cedar Seasonal Rainforest (G751)

USNVC Alliance: *Tsuga heterophylla* - *Picea sitchensis* / *Rhytidiadelphus loreus* Forest Alliance (A3604)

USNVC Association: *Picea sitchensis* / *Gaultheria shallon* Forest (CEGL005524)

GENERALIZED ALLIANCE MAP CLASS (this project): *Picea sitchensis*-(Other) Forest

MCV Alliance: *Picea sitchensis* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Picea sitchensis*/*Gaultheria shallon* (Solomeshch)

Table B17. Synthesis table for most constant vascular plant taxa recorded in *Picea sitchensis*/*Gaultheria shallon* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Picea sitchensis</i>	Tree	100%	68.8	60-81
<i>Alnus rubra</i>	Tree	40%	4.1	0-31
<i>Sequoia sempervirens</i>	Tree	40%	2.8	0-5.5
<i>Tsuga heterophylla</i>	Tree	30%	1.4	0-5
<i>Gaultheria shallon</i>	Shrub	100%	19.0	few-60
<i>Vaccinium ovatum</i>	Shrub	100%	16.3	few-55
<i>Rubus spectabilis</i>	Shrub	70%	5.5	0-20
<i>Vaccinium parvifolium</i>	Shrub	70%	2.5	0-15
<i>Frangula purshiana</i>	Shrub	70%	1.3	0-5
<i>Rubus parviflorus</i>	Shrub	50%	2.1	0-15
<i>Rubus ursinus</i>	Shrub	50%	1.2	0-5
<i>Sambucus racemosa</i>	Shrub	30%	0.8	0-4
<i>Myrica californica</i>	Shrub	30%	0.4	0-3
<i>Menziesia ferruginea</i>	Shrub	20%	0.3	0-3
<i>Hedera helix</i>	Shrub	20%	0.1	0-few
<i>Prosartes smithii</i>	Herb	80%	0.6	0-3
<i>Polystichum munitum</i>	Herb	70%	15.5	0-55
<i>Viola sempervirens</i>	Herb	60%	1.2	0-7
<i>Galium triflorum</i>	Herb	60%	0.2	0-few
<i>Maianthemum dilatatum</i>	Herb	50%	4.0	0-30
<i>Pteridium aquilinum</i>	Herb	50%	0.9	0-5
<i>Blechnum spicant</i>	Herb	40%	1.2	0-5
<i>Athyrium filix-femina</i>	Herb	40%	1.0	0-3
<i>Dryopteris expansa</i>	Herb	40%	0.5	0-3
<i>Marah oreganus</i>	Herb	40%	0.5	0-3
<i>Polypodium scolopendri</i>	Herb	40%	0.2	0-few
<i>Luzula parviflora</i>	Herb	30%	0.2	0-few
<i>Osmorhiza berteroi</i>	Herb	30%	0.1	0-few
<i>Stachys ajugoides</i>	Herb	30%	0.1	0-few
<i>Trillium ovatum</i>	Herb	30%	0.1	0-few
<i>Bromus vulgaris</i>	Herb	20%	0.1	0-few
<i>Claytonia sibirica</i>	Herb	20%	0.1	0-few
<i>Trientalis borealis</i> subsp. <i>latifolia</i>	Herb	20%	0.1	0-few
<i>Carex</i> sp.	Herb	20%	0.1	0-few
<i>Iris douglasiana</i>	Herb	20%	0.1	0-few
<i>Lilium columbianum</i>	Herb	20%	0.1	0-few
<i>Moneses uniflora</i>	Herb	20%	0.1	0-few
<i>Oxalis oregana</i>	Herb	20%	0.1	0-few
<i>Trisetum</i> sp.	Herb	20%	0.1	0-few
<i>Erechtites minima</i>	Herb	20%	<0.1	0-trace

Species recorded in plots at 10% frequency and at less than 0.4% mean cover include *Umbellularia californica* (tree), *Baccharis pilularis*, *Corylus cornuta*, *Garrya elliptica* (all shrubs), *Senecio* sp., *Adenocaulon bicolor*, *Angelica hendersonii*, *Bromus diandrus*, *Claytonia washingtonensis*, *Prosartes hookeri*, *Festuca elmeri*, *Galium aparine*, *Heracleum lanatum*, *Hieracium* sp., *Luzula comosa*, *Melica subulata*, *Mimulus dentatus*, *Poa* sp., *Sonchus oleraceus*, *Tellima grandiflora*, *Viola* sp., *Carex obnupta*, *Dactylis glomerata*, *Dicentra formosa*, *Holcus lanatus*, and *Streptopus amplexifolius* (all herbs).

***Quercus garryana*/*Festuca californica* association**

LOCAL TYPE CONCEPT:

Mesic to dry woodlands or forests with *Quercus garryana* (Oregon white oak) the sole dominant tree species and with a grass-dominated herbaceous stratum dominated by shade-intolerant species.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW096 (C73_061001), REDW098 (C43_061221), REDW099 (C44_061222), REDW100 (C41_061223), REDW101 (C42_061224)

VEGETATION:

The tree stratum is strongly dominated by *Quercus garryana* (Oregon white oak), which is often the only tree species present. The shrub stratum usually has sparse to insignificant cover, and is comprised of several fairly constant species, including *Rubus ursinus* (Pacific blackberry), *Toxicodendron diversilobum* (Pacific poison-oak), *Rosa gymnocarpa* (dwarf rose), *Amelanchier alnifolia* (Saskatoon serviceberry), and *Holodiscus discolor* (oceanspray). The herbaceous stratum is dominated by a relatively diverse mixture of graminoids, including *Dactylis glomerata* (orchard grass), *Arrhenatherum elatius* (tall oatgrass), *Festuca californica* (California fescue), *Cynosurus echinatus* (bristly dogtail grass), *Melica subulata* (Alaska oniongrass), *Bromus vulgaris* (Columbia brome), *Bromus sterilis* (poverty brome), *Poa pratensis* (Kentucky bluegrass), and/or *Luzula comosa* (Pacific woodrush). A relatively high diversity of forbs is present; the most constant taxa are *Fragaria vesca* (woodland strawberry), *Lathyrus lanszwertii* var. *brownii* (Brown's pea), *Galium aparine* (cleavers), *Lathyrus nevadensis* subsp. *nevadensis* (Sierra Nevada pea), *Sanicula crassicaulis* (Pacific sanicle), *Claytonia perfoliata* (miner's lettuce), *Torilis arvensis* (spreading hedgeparsley), *Ranunculus occidentalis* (western buttercup), *Delphinium* sp. (larkspur), *Nemophila parviflora* (smallflower nemophila), *Taraxacum officinale* (common dandelion), *Osmorhiza berteroi* (sweetcicely), *Cerastium* sp. (chickweed), *Rumex acetosella* (sheep sorrel), *Circaea alpina* (small enchanter's nightshade), *Cynoglossum grande* (Pacific hound's tongue), *Marah oreganus* (coast man-root), *Polystichum munitum* (western sword fern), *Vicia sativa* subsp. *nigra* (common vetch), *Cirsium vulgare* (bull thistle), *Trillium* sp. (trillium), and *Dichelostemma ida-maia* (firecracker flower).

ENVIRONMENT:

All five plots assigned to this vegetation occurred in the Bald Hills area, in the vicinity of Schoolhouse Peak and Coyote Peak (upper parts of the Coyote Creek and Copper Creek drainages), on geologic substrates mapped as the Coyote Creek unit of the Franciscan complex. Slopes ranged from 10% to 20%, aspects were various, and elevations ranged from 2,320 to 2,960 feet (714 to 911 meters) above sea level. The landform positions were described as middle to upper slopes. This vegetation is often associated with the *Arrhenatherum elatius*-*Cynosurus echinatus* association, and the two types are compositionally similar.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Cool Temperate Forest & Woodland (1.B.2)

USNVC Division: Vancouverian Cool Temperate Forest (1.B.2.Nd)

USNVC Macrogroup: Southern Vancouverian Dry Foothill Forest (M886)

USNVC Group: Cascadian Oregon White Oak - Conifer Forest & Woodland (G206)

USNVC Alliance: *Quercus garryana* - *Pseudotsuga menziesii* / *Toxicodendron diversilobum* Forest & Woodland Alliance (A3328)

USNVC Association: *Quercus garryana* / *Toxicodendron diversilobum* / *Elymus glaucus* Woodland (CEGL000932)

GENERALIZED ALLIANCE MAP CLASS (this project): *Quercus garryana* Forest

MCV Alliance: *Quercus garryana* Woodland Alliance (Sawyer et al. 2009)

MCV Association: *Quercus garryana*/*Festuca californica* (Solomeshch) (= *Quercus garryana*/*Dactylis glomerata* (Sawyer et al. 2009))

Table B18. Synthesis table for most constant vascular plant taxa recorded in *Quercus garryana*/*Festuca californica* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Quercus garryana</i>	Tree	100%	50.9	41-58
<i>Rubus ursinus</i>	Shrub	100%	2.4	few-10
<i>Toxicodendron diversilobum</i>	Shrub	100%	1.9	few-4
<i>Rosa gymnocarpa</i>	Shrub	80%	0.4	0-few
<i>Amelanchier alnifolia</i>	Shrub	80%	0.3	0-few
<i>Holodiscus discolor</i>	Shrub	80%	0.3	0-few
<i>Dactylis glomerata</i>	Herb	100%	14.4	7-20
<i>Arrhenatherum elatius</i>	Herb	100%	13.0	10-15
<i>Fragaria vesca</i>	Herb	100%	8.8	4-15
<i>Festuca californica</i>	Herb	100%	6.2	trace-25
<i>Cynosurus echinatus</i>	Herb	100%	6.2	4-10
<i>Melica subulata</i>	Herb	100%	6.2	3-10
<i>Lathyrus lanszwertii</i> var. <i>brownii</i>	Herb	100%	3.7	few-7
<i>Galium aparine</i>	Herb	100%	3.4	3-5
<i>Lathyrus nevadensis</i> subsp. <i>nevadensis</i>	Herb	100%	3.4	3-4
<i>Bromus vulgaris</i>	Herb	100%	3.1	few-5
<i>Sanicula crassicaulis</i>	Herb	100%	2.9	few-4
<i>Claytonia perfoliata</i>	Herb	100%	2.4	few-5
<i>Torilis arvensis</i>	Herb	100%	2.0	few-3
<i>Ranunculus occidentalis</i>	Herb	100%	1.5	few-3
<i>Bromus sterilis</i>	Herb	100%	1.4	trace-3
<i>Delphinium</i> sp.	Herb	100%	1.3	trace-5
<i>Nemophila parviflora</i>	Herb	100%	0.5	few
<i>Taraxacum officinale</i>	Herb	100%	0.2	trace-few
<i>Poa pratensis</i>	Herb	80%	4.2	0-10
<i>Osmorhiza berteroi</i>	Herb	80%	3.8	0-7
<i>Cerastium</i> sp.	Herb	80%	0.9	0-3
<i>Rumex acetosella</i>	Herb	80%	0.7	0-3
<i>Circaea alpina</i>	Herb	80%	0.4	0-few
<i>Cynoglossum grande</i>	Herb	80%	0.4	0-few
<i>Luzula comosa</i>	Herb	80%	0.4	0-few
<i>Marah oreganus</i>	Herb	80%	0.4	0-few
<i>Polystichum munitum</i>	Herb	80%	0.4	0-few
<i>Vicia sativa</i> subsp. <i>nigra</i>	Herb	80%	0.4	0-few
<i>Cirsium vulgare</i>	Herb	80%	0.3	0-few
<i>Trillium</i> sp.	Herb	80%	0.3	0-few
<i>Dichelostemma ida-maia</i>	Herb	80%	0.2	0-few

Species recorded in plots at less than 80% frequency and at less than 1% mean cover include *Acer macrophyllum*, *Pseudotsuga menziesii*, *Quercus kelloggii*, *Arbutus menziesii*, *Malus sylvestris* (all trees), *Corylus cornuta*, *Ribes* sp., *Rubus leucodermis*, *Symphoricarpos albus*, *Symphoricarpos* sp., *Rubus armeniacus*, *Baccharis pilularis*, *Lonicera* sp. (all shrubs), *Elymus* sp., *Tellima grandiflora*, *Achillea millefolium*, *Brodiaea* sp., *Chlorogalum pomeridianum*, *Iris tenuissima*, *Lathyrus vestitus*, *Hypericum perforatum*, *Plantago lanceolata*, *Stellaria media*, *Viola* sp., *Bromus carinatus*, *Agrostis* sp., *Holcus lanatus*, *Iris douglasiana*, *Madia gracilis*, *Stachys ajugoides*, *Triteleia laxa*, *Triteleia* sp., *Vancouveria* sp., *Aquilegia formosa*, *Carex* sp., *Trifolium* sp., *Agoseris* sp., *Dodecatheon* sp., *Lilium columbianum*, *Agoseris grandiflora*, *Elymus glaucus*, *Glechoma hederacea*, *Hypochaeris radicata*, *Bromus hordeaceus*, *Carex hookeriana*, *Dichelostemma capitatum*, *Euphorbia* sp., *Festuca idahoensis*, *Poa* sp., *Rupertia physodes*, *Trillium chloropetalum*, *Adenocaulon bicolor*, *Cardamine californica*, *Lilium* sp., *Lotus micranthus*, *Lotus unifoliolatus* var. *unifoliolatus*, *Prunella vulgaris*, *Senecio* sp., *Sisyrinchium bellum*, and *Sonchus* sp. (all herbs).

***Acer macrophyllum*/Hydrophyllum tenuipes association**

LOCAL TYPE CONCEPT:

Mesic to somewhat hydric forests of stream terraces with *Acer macrophyllum* (bigtooth maple) the sole dominant tree species or co-dominant with *Alnus rubra* (red alder) in the tree stratum, and with at least some hydrophytic herbs usually present (may be at low cover).

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW049 (249), REDW177 (A28), REDW272 (A137), REDW273 (A140), REDW281 (A151)

VEGETATION:

The tree stratum is dominated by *Acer macrophyllum* (bigtooth maple). *Alnus rubra* (red alder) is fairly constant at low cover and occasionally may co-dominate this stratum. *Rubus spectabilis* (salmonberry) is the most constant and, usually, the most abundant shrub stratum species. Relatively constant shrub taxa that may also contribute significant cover include *Sambucus racemosa* (red elderberry) and *Ribes* sp. (currants/gooseberries). The herbaceous stratum is relatively species rich and is comprised of a mix of hydrophytic and mesophytic species. Highly constant species that may contribute high cover include *Polystichum munitum* (western sword fern) and *Carex obnupta* (slough sedge). Relatively constant low cover species include *Athyrium filix-femina* (lady fern), *Polypodium glycyrrhiza* (licorice fern), *Urtica dioica* (stinging nettle), *Oxalis oregana* (redwood sorrel), *Marah oreganus* (coast man-root), *Galium triflorum* (fragrant bedstraw), *Tolmiea menziesii* (pig a back plant), *Hydrophyllum tenuipes* (Pacific waterleaf), and *Cardamine californica* (milk maids).

ENVIRONMENT:

Three plots assigned to this vegetation were from along Redwood Creek, with one plot each along Prairie Creek and along Richardson Creek. The vegetation probably occurs throughout RNSP in suitable riparian habitat. All plots were on geologic substrates mapped as alluvial or stream terrace deposits. Slopes ranged from near level to 5%, and elevations ranged from 40 to 120 feet (12 to 37 meters) above sea level. The landform positions were described as “high terrace” or “river terrace.”

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Temperate Flooded & Swamp Forest (1.B.3)

USNVC Division: Vancouverian Flooded & Swamp Forest (1.B.3.Ng)

USNVC Macrogroup: Vancouverian Flooded & Swamp Forest (M035)

USNVC Group: North Pacific Lowland Riparian Forest & Woodland (G254)

USNVC Alliance: *Fraxinus latifolia* - *Populus balsamifera* ssp. *trichocarpa* - *Alnus* spp. Deciduous Riparian Forest Alliance (A3743)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Acer macrophyllum* Forest

MCV Alliance: *Acer macrophyllum* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Acer macrophyllum* /*Hydrophyllum tenuipes* (Solomeshch)

Table B19. Synthesis table for the most constant vascular plant taxa recorded in *Acer macrophyllum*/*Hydrophyllum tenuipes* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Acer macrophyllum</i>	Tree	100%	76.3	65-90
<i>Alnus rubra</i>	Tree	80%	12.1	0-31
<i>Picea sitchensis</i>	Tree	40%	3.0	0-10
<i>Umbellularia californica</i>	Tree	40%	2.7	0-10
<i>Lithocarpus densiflorus</i> var. <i>densiflorus</i>	Tree	40%	0.0	0-trace
<i>Sequoia sempervirens</i>	Tree	20%	2.9	0-15
<i>Populus balsamifera</i> subsp. <i>trichocarpa</i>	Tree	20%	2.0	0-10
<i>Rubus spectabilis</i>	Shrub	100%	28.6	3-65
<i>Sambucus racemosa</i>	Shrub	80%	2.7	0-10
<i>Ribes</i> sp.	Shrub	60%	6.1	0-15
<i>Frangula purshiana</i>	Shrub	40%	0.2	0-few
<i>Rubus parviflorus</i>	Shrub	20%	0.6	0-3
<i>Rubus ursinus</i>	Shrub	20%	0.1	0-few
<i>Carex obnupta</i>	Herb	100%	25.2	few-60
<i>Polystichum munitum</i>	Herb	100%	11.0	4-25
<i>Athyrium filix-femina</i>	Herb	100%	5.1	few-10
<i>Polypodium glycyrrhiza</i>	Herb	100%	0.5	few
<i>Urtica dioica</i>	Herb	80%	1.9	0-3
<i>Oxalis oregana</i>	Herb	80%	0.9	0-3
<i>Marah oreganus</i>	Herb	80%	0.4	0-few
<i>Galium triflorum</i>	Herb	80%	0.3	0-few
<i>Tolmiea menziesii</i>	Herb	60%	7.6	0-25
<i>Hydrophyllum tenuipes</i>	Herb	60%	3.2	0-15
<i>Cardamine californica</i>	Herb	60%	1.5	0-4
<i>Oenanthe sarmentosa</i>	Herb	40%	1.4	0-7
<i>Bromus vulgaris</i>	Herb	40%	0.9	0-4
<i>Carex</i> sp.	Herb	40%	0.9	0-4
<i>Claytonia sibirica</i>	Herb	40%	0.7	0-3
<i>Melica subulata</i>	Herb	40%	0.7	0-3
<i>Chrysosplenium glechomifolium</i>	Herb	40%	0.2	0-few
<i>Osmorhiza berteroi</i>	Herb	40%	0.2	0-few
<i>Pteridium aquilinum</i>	Herb	40%	0.2	0-few
<i>Stachys ajugoides</i>	Herb	40%	0.2	0-few
<i>Asarum caudatum</i>	Herb	20%	2.0	0-10
<i>Prosartes smithii</i>	Herb	20%	0.1	0-few
<i>Dryopteris expansa</i>	Herb	20%	0.1	0-few
<i>Equisetum telmateia</i>	Herb	20%	0.1	0-few
<i>Festuca</i> sp.	Herb	20%	0.1	0-few
<i>Galium aparine</i>	Herb	20%	0.1	0-few
<i>Hydrophyllum</i> sp.	Herb	20%	0.1	0-few
<i>Luzula parviflora</i>	Herb	20%	0.1	0-few
<i>Lysichiton americanus</i>	Herb	20%	0.1	0-few
<i>Maianthemum dilatatum</i>	Herb	20%	0.1	0-few
<i>Mimulus dentatus</i>	Herb	20%	0.1	0-few
<i>Stellaria</i> sp.	Herb	20%	0.1	0-few
<i>Tellima grandiflora</i>	Herb	20%	0.1	0-few
<i>Viola glabella</i>	Herb	20%	0.1	0-few

Species recorded at 20% frequency and < 0.1% mean cover: *Vaccinium ovatum*, *Epilobium* sp., and *Streptopus amplexifolius*.

***Alnus rubra*/Carex obnupta association**

LOCAL TYPE CONCEPT:

Mesic to hydric forests of stream terraces with *Alnus rubra* (red alder) the sole dominant tree species, and with at least some hydrophytic herbs present (may be low cover).

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW045 (245), REDW053 (253), REDW084 (52902), REDW156 (A17), REDW160 (N53_071521), REDW162 (N53_071522), REDW170 (A23), REDW218 (A64), REDW269 (A132), REDW284 (A154)

VEGETATION:

The tree stratum is dominated by *Alnus rubra* (red alder). *Picea sitchensis* (Sitka spruce) and *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn) are inconstant species, but can occasionally contribute significant cover. *Rubus spectabilis* (salmonberry) is the most constant and, usually, the most abundant shrub stratum species. Relatively constant low cover shrubs include *Rubus ursinus* (Pacific blackberry) and *Sambucus racemosa* (red elderberry). The herbaceous stratum is relatively species rich and is comprised of a mix of hydrophytic and mesophytic species. Highly constant species that may contribute high cover include *Polystichum munitum* (western sword fern), *Athyrium filix-femina* (lady fern), *Carex obnupta* (slough sedge), and *Tolmiea menziesii* (pig a back plant). Relatively constant low cover taxa include *Carex* sp. (sedges), *Marah oreganus* (coast man-root), *Oenanthe sarmentosa* (Pacific water parsley), *Ranunculus repens* (creeping buttercup), *Stachys ajugoides* (bugle hedgenettle), *Equisetum telmateia* (giant horsetail), *Claytonia sibirica* (candy flower), and *Galium triflorum* (fragrant bedstraw).

ENVIRONMENT:

Two plots each that were assigned to this vegetation occurred along Mill Creek, Prairie Creek, and Lost Man Creek, and one each occurred along Saugep Creek, Ossagon Creek, Redwood Creek, and the Espa Lagoon. The vegetation probably is present throughout RNSP in suitable riparian habitat, often near the Pacific Ocean. All plots were on geologic substrates mapped as alluvial or stream terrace deposits. Slopes ranged from near level to 9%, and elevations ranged from 30 to 240 feet (9 to 74 meters) above sea level. The landform positions were described as “valley” or “terrace.”

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Temperate Flooded & Swamp Forest (1.B.3)

USNVC Division: Vancouverian Flooded & Swamp Forest (1.B.3.Ng)

USNVC Macrogroup: Vancouverian Flooded & Swamp Forest (M035)

USNVC Group: North Pacific Lowland Riparian Forest & Woodland (G254)

USNVC Alliance: *Fraxinus latifolia* - *Populus balsamifera* ssp. *trichocarpa* - *Alnus* spp. Deciduous Riparian Forest Alliance (A3743)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Alnus rubra*-(Other) Forest (in part)

MCV Alliance: *Alnus rubra* Forest Alliance (Sawyer et al. 2009)

MCV Association: *Alnus rubra*/*Carex obnupta* (Solomeshch)

Table B20. Synthesis table for most constant vascular plant taxa recorded in *Alnus rubra*/*Carex obnupta* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	100%	69.5	41-82
<i>Frangula purshiana</i>	Tree/Shrub	40%	2.3	0-18
<i>Picea sitchensis</i>	Tree	40%	2.3	0-15
<i>Salix</i> sp.	Tree/Shrub	30%	0.8	0-4
<i>Acer macrophyllum</i>	Tree	30%	0.5	0-3
<i>Rubus spectabilis</i>	Shrub	100%	26.2	few-90
<i>Rubus ursinus</i>	Shrub	70%	5.6	0-30
<i>Sambucus racemosa</i>	Shrub	50%	4.4	0-35
<i>Ribes</i> sp.	Shrub	30%	4.1	0-35
<i>Rubus armeniacus</i>	Shrub	30%	1.8	0-10
<i>Vaccinium ovatum</i>	Shrub	30%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	17.6	0.5-90
<i>Athyrium filix-femina</i>	Herb	100%	4.5	0.5-15
<i>Carex obnupta</i>	Herb	90%	18.3	0-70
<i>Carex</i> sp.	Herb	80%	1.6	0-5
<i>Tolmiea menziesii</i>	Herb	60%	10.1	0-45
<i>Oenanthe sarmentosa</i>	Herb	60%	0.8	0-3
<i>Marah oreganus</i>	Herb	60%	0.7	0-4
<i>Ranunculus repens</i>	Herb	50%	7.3	0-60
<i>Stachys ajugoides</i>	Herb	50%	1.0	0-5
<i>Equisetum telmateia</i>	Herb	50%	0.8	0-3
<i>Claytonia sibirica</i>	Herb	50%	0.4	0-3
<i>Galium triflorum</i>	Herb	50%	0.2	0-few
<i>Asarum caudatum</i>	Herb	40%	0.8	0-4
<i>Oxalis oregana</i>	Herb	40%	0.7	0-5
<i>Galium aparine</i>	Herb	40%	0.5	0-3
<i>Mimulus dentatus</i>	Herb	40%	0.2	0-few
<i>Lysichiton americanus</i>	Herb	40%	0.2	0-few
<i>Urtica dioica</i>	Herb	30%	1.4	0-10
<i>Scirpus microcarpus</i>	Herb	30%	1.2	0-5
<i>Bromus vulgaris</i>	Herb	30%	0.9	0-5
<i>Stellaria</i> sp.	Herb	30%	0.7	0-4
<i>Chrysosplenium glechomifolium</i>	Herb	30%	0.2	0-few
<i>Veronica anagallis-aquatica</i>	Herb	30%	0.2	0-few
<i>Dryopteris expansa</i>	Herb	30%	0.1	0-few
<i>Polypodium glycyrrhiza</i>	Herb	30%	0.1	0-few

Species recorded in plots at less than 25% frequency include *Sequoia sempervirens*, *Malus fusca*, *Umbellularia californica*, *Tsuga heterophylla*, *Acer circinatum*, *Lithocarpus densiflorus* var. *densiflorus* (all trees), *Rubus parviflorus*, *Vaccinium parvifolium*, *Lonicera involucrata*, *Corylus cornuta*, *Gaultheria shallon*, *Myrica californica*, *Rosa* sp., *Rubus leucodermis* (all shrubs), *Heracleum lanatum*, *Holcus lanatus*, *Hydrophyllum tenuipes*, *Petasites frigidus*, *Blechnum spicant*, *Lathyrus* sp., *Maianthemum dilatatum*, *Melica subulata*, *Poa* sp., *Trillium angustipetalum*, *Cardamine californica*, *Festuca* sp., *Tellima grandiflora*, *Aralia californica*, *Phalaris arundinacea*, *Adiantum aleuticum*, *Agrostis* sp., *Cardamine* sp., *Carex deweyana*, *Dactylis glomerata*, *Prosartes smithii*, *Dryopteris* sp., *Juncus* sp., *Lapsana communis*, *Moehringia species*, *Prunella vulgaris*, *Rorippa species*, *Rumex* sp., *Scirpus* sp., *Senecio* sp., *Digitalis purpurea*, *Luzula parviflora*, *Mimulus* sp., *Mitella breweri*, *Osmorhiza berteroi*, *Pleuropogon refractus*, *Polypodium* sp., *Pteridium aquilinum*, *Rumex obtusifolius*, *Trillium chloropetalum*, *Trillium ovatum*, and *Viola* sp. (all herbs).

***Picea sitchensis*/Lysichiton americanus association**

LOCAL TYPE CONCEPT:

Mesic to hydric forests of stream terraces with *Picea sitchensis* (Sitka spruce) the leading dominant tree species, and with hydrophytic herbs present and often at high cover.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW213 (A59b), REDW214 (A60), REDW215 (A61), REDW216 (A62), REDW221 (A67), REDW249 (A111), REDW308 (A177), REDW310 (A179), REDW313 (A182)

VEGETATION:

The tree stratum is dominated by *Picea sitchensis* (Sitka spruce). *Alnus rubra* (red alder) is fairly constant at low cover and occasionally may co-dominate this stratum. *Rubus spectabilis* (salmonberry) and *Gaultheria shallon* (salal) are constant shrub stratum components. Other relatively constant shrub species (all usually at low cover when present) are *Vaccinium ovatum* (evergreen huckleberry), *Vaccinium parvifolium* (red huckleberry), *Rubus ursinus* (Pacific blackberry), *Menziesia ferruginea* (rusty menziesia), and *Frangula purshiana* (= *Rhamnus purshiana*) (cascara buckthorn). The herbaceous stratum is relatively species rich and is comprised of a mix of hydrophytic and mesophytic species. Constant species that are also often dominant or important include *Lysichiton americanus* (yellow skunk cabbage), *Carex obnupta* (slough sedge), *Athyrium filix-femina* (lady fern), *Blechnum spicant* (deer fern), and *Polystichum munitum* (western sword fern). Highly constant to fairly constant low cover species include *Oenanthe sarmentosa* (Pacific water parsley), *Maianthemum dilatatum* (false lily of the valley), *Stachys ajugoides* (bugle hedgenettle), *Chrysosplenium glechomifolium* (Pacific golden saxifrage), *Galium triflorum* (fragrant bedstraw), *Tolmiea menziesii* (pig a back plant), and *Dryopteris expansa* (spreading woodfern).

ENVIRONMENT:

This vegetation probably occurs along toe slopes with groundwater emergences throughout RNSP near the Pacific Ocean, often along small (often unnamed) streams. Three plots were clustered in the vicinity of Lagoon Pond, five were clustered in the area of Gold Beach, and one was along Skunk Cabbage Creek, a tributary to Prairie Creek. Most plots were within 0.5 mile (0.8 km) of the Pacific Ocean; the site along Skunk Cabbage Creek is about 1.9 miles (3 km) from the ocean. Most plots were on geologic substrates mapped as alluvium or alluvial fan deposits, with one on an area mapped as a marine terrace. Slopes are generally level to 5%, and elevations ranged from 30 to 280 feet (9 to 86 meters) above sea level. The landform positions were “valley” or “low terrace,” or “depression.”

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Forest & Woodland (1)

USNVC Subclass: Temperate & Boreal Forest & Woodland (1.B)

USNVC Formation: Temperate Flooded & Swamp Forest (1.B.3)

USNVC Division: Vancouverian Flooded & Swamp Forest (1.B.3.Ng)

USNVC Macrogroup: Vancouverian Flooded & Swamp Forest (M035)

USNVC Group: North Pacific Maritime Hardwood - Conifer Swamp (G256)
USNVC Alliance: *Tsuga heterophylla* - *Picea sitchensis* / *Lysichiton americanus* Swamp Forest & Woodland Alliance (A3756)
USNVC Association: *Picea sitchensis* / *Carex obnupta* - *Lysichiton americanus* Forest (CEGL000400)
GENERALIZED ALLIANCE MAP CLASS (this project): *Picea sitchensis* Saturated Forest
MCV Alliance: *Picea sitchensis* Forest Alliance (Sawyer et al. 2009)
MCV Association: *Picea sitchensis*/*Lysichiton americanus* (Solomeshch)

Table B21. Synthesis table for most constant vascular plant taxa recorded in *Picea sitchensis*/*Lysichiton americanus* association at Redwood National and State Parks (# plots=9).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Picea sitchensis</i>	Tree	100%	63.2	24-76
<i>Alnus rubra</i>	Tree	89%	12.5	0-36
<i>Sequoia sempervirens</i>	Tree	33%	0.8	0-3.5
<i>Tsuga heterophylla</i>	Tree	33%	0.5	0-3
<i>Rubus spectabilis</i>	Shrub	100%	16.3	3-55
<i>Gaultheria shallon</i>	Shrub	100%	6.6	few-15
<i>Vaccinium ovatum</i>	Shrub	89%	5.2	0-20
<i>Rubus ursinus</i>	Shrub	89%	2.1	0-5
<i>Vaccinium parvifolium</i>	Shrub	89%	1.8	0-5
<i>Menziesia ferruginea</i>	Shrub	78%	1.1	0-4
<i>Frangula purshiana</i>	Shrub	67%	0.6	0-3
<i>Rubus parviflorus</i>	Shrub	33%	0.4	0-3
<i>Sambucus racemosa</i>	Shrub	22%	0.8	0-4
<i>Lysichiton americanus</i>	Herb	100%	20.1	few-40
<i>Carex obnupta</i>	Herb	100%	18.4	few-60
<i>Athyrium filix-femina</i>	Herb	100%	7.1	3-20
<i>Blechnum spicant</i>	Herb	100%	3.4	trace-10
<i>Polystichum munitum</i>	Herb	89%	10.1	0-60
<i>Oenanthe sarmentosa</i>	Herb	89%	1.9	0-5
<i>Maianthemum dilatatum</i>	Herb	78%	0.7	0-3
<i>Stachys ajugoides</i>	Herb	67%	1.7	0-3
<i>Chrysosplenium glechomifolium</i>	Herb	67%	0.6	0-3
<i>Galium triflorum</i>	Herb	67%	0.3	0-0.5
<i>Tolmiea menziesii</i>	Herb	56%	2.8	0-15
<i>Dryopteris expansa</i>	Herb	56%	0.6	0-3
<i>Trisetum</i> sp.	Herb	56%	0.3	0-few
<i>Mimulus dentatus</i>	Herb	44%	0.8	0-3
<i>Oxalis oregana</i>	Herb	44%	0.6	0-4
<i>Carex</i> sp.	Herb	44%	0.5	0-3
<i>Viola sempervirens</i>	Herb	44%	0.2	0-few
<i>Cardamine</i> sp.	Herb	44%	0.2	0-few
<i>Prosartes smithii</i>	Herb	44%	0.0	0-trace
<i>Glyceria</i> sp.	Herb	33%	0.2	0-few
<i>Luzula parviflora</i>	Herb	33%	0.2	0-few
<i>Polypodium glycyrrhiza</i>	Herb	33%	0.1	0-few
<i>Asarum caudatum</i>	Herb	22%	1.2	0-10
<i>Pteridium aquilinum</i>	Herb	22%	0.5	0-4
<i>Equisetum telmateia</i>	Herb	22%	0.1	0-few
<i>Polypodium scolieri</i>	Herb	22%	0.1	0-few
<i>Ranunculus repens</i>	Herb	22%	0.1	0-few
<i>Moneses uniflora</i>	Herb	22%	0.0	0-trace

Species recorded in plots at less than 15% frequency include *Malus fusca*, *Chamaecyparis lawsoniana* (both trees), *Ribes* sp., *Lonicera involucrata*, *Salix* sp., *Hedera helix* (all shrubs), *Bromus suksdorfii*, *Bromus vulgaris*, *Cardamine californica*, *Erechtites minima*, *Mimulus floribundus*, *Moehringia* sp., *Poa* sp., *Senecio* sp., *Viola* sp., *Epilobium* sp., *Galium* sp., *Holcus lanatus*, *Rumex obtusifolius*, *Streptopus amplexifolius*, *Trillium ovatum*, and *Whipplea modesta* (all herbs).

***Baccharis pilularis*/Polystichum munitum association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Baccharis pilularis* (coyotebrush) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW058 (258), REDW119 (A3), REDW158 (71412), REDW157 (71422), REDW280 (A150), REDW293 (A163), REDW303 (A172), REDW336 (A97), REDW341 (A110), REDW342 (A145)

VEGETATION:

The shrub stratum is dominated by *Baccharis pilularis* (coyotebrush). *Rubus ursinus* (Pacific blackberry) is a moderately constant low to moderately high cover shrub. The most constant herbaceous stratum species (mostly present at low cover) are *Polystichum munitum* (western sword fern), *Marah oreganus* (coast man-root), *Galium aparine* (cleavers), *Pteridium aquilinum* (bracken fern), *Symphyotrichum chilense* (Pacific aster), *Heracleum lanatum* (= *Heracleum maximum*) (common cowparsnip), and *Achillea millefolium* (yarrow). The overall floristic composition of this vegetation is very similar to that of the *Rubus ursinus*/*Heracleum lanatum* association.

ENVIRONMENT:

This vegetation probably occurs along bluffs and slopes facing the Pacific Ocean throughout RNSP. All plots were within 0.25 mile (0.32 km) of the Pacific Ocean. Geologic substrates were mapped as various formations of the Franciscan complex or as landslides. Slopes were 35% to 55%, aspects were generally west (northwest to southwest), and elevations ranged from 40 to 560 feet (12 to 172 meters) above sea level. The landform positions were described as low to middle slopes or as coastal bluffs.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Mediterranean Scrub & Grassland (2.B.1)

USNVC Division: Californian Scrub (2.B.1.Na)

USNVC Macrogroup: California Coastal Scrub (M044)

USNVC Group: California North Coastal & Mesic Scrub (G662)

USNVC Alliance: *Baccharis pilularis* Shrubland Alliance (A0836)

USNVC Association: *Baccharis pilularis* / *Polystichum munitum* Shrubland (CEGL003195)

GENERALIZED ALLIANCE MAP CLASS (this project): *Baccharis pilularis* Shrubland

MCV Alliance: *Baccharis pilularis*/*Polystichum munitum* Shrubland Alliance (Sawyer et al. 2009)

MCV Association: *Baccharis pilularis*/*Polystichum munitum* (Solomeshch, Sawyer et al. 2009)

Table B22. Synthesis table for most constant vascular plant taxa recorded in *Baccharis pilularis*/*Polystichum munitum* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Baccharis pilularis</i>	Shrub	100%	68.3	50-93
<i>Rubus ursinus</i>	Shrub	100%	11.3	3-25
<i>Frangula purshiana</i>	Shrub	40%	1.0	0-5
<i>Gaultheria shallon</i>	Shrub	30%	2.6	0-25
<i>Rubus armeniacus</i>	Shrub	30%	1.5	0-10
<i>Garrya elliptica</i>	Shrub	30%	0.9	0-5
<i>Rosa</i> sp.	Shrub	30%	0.8	0-4
<i>Eriophyllum stoechadifolium</i>	Shrub	30%	0.6	0-5
<i>Diplacus aurantiacus</i> subsp. <i>aurantiacus</i>	Shrub	20%	1.1	0-10
<i>Polystichum munitum</i>	Herb	100%	4.1	few-15
<i>Marah oreganus</i>	Herb	90%	3.5	0-10
<i>Galium aparine</i>	Herb	80%	0.9	0-3
<i>Pteridium aquilinum</i>	Herb	70%	2.8	0-12
<i>Symphytotrichum chilense</i>	Herb	70%	1.0	0-4
<i>Heracleum lanatum</i>	Herb	60%	1.8	0-5
<i>Achillea millefolium</i>	Herb	60%	0.8	0-3
<i>Holcus lanatus</i>	Herb	50%	2.3	0-15
<i>Angelica hendersonii</i>	Herb	50%	1.5	0-3
<i>Plantago lanceolata</i>	Herb	50%	1.4	0-5
<i>Dactylis glomerata</i>	Herb	50%	1.1	0-4
<i>Agrostis</i> sp.	Herb	50%	1.0	0-5
<i>Bromus carinatus</i>	Herb	50%	1.0	0-5
<i>Anagallis arvensis</i>	Herb	50%	0.7	0-3
<i>Anthoxanthum odoratum</i>	Herb	40%	2.6	0-15
<i>Elymus</i> sp.	Herb	40%	0.7	0-3
<i>Equisetum telmateia</i>	Herb	40%	0.7	0-3
<i>Anaphalis margaritacea</i>	Herb	40%	0.5	0-3
<i>Sanicula crassicaulis</i>	Herb	40%	0.5	0-3
<i>Scrophularia californica</i>	Herb	40%	0.5	0-3
<i>Lathyrus</i> sp.	Herb	30%	0.7	0-3
<i>Leucanthemum vulgare</i>	Herb	30%	0.4	0-3
<i>Iris douglasiana</i>	Herb	30%	0.2	0-few
<i>Stellaria</i> sp.	Herb	30%	0.2	0-few
<i>Urtica dioica</i>	Herb	30%	0.2	0-few
<i>Artemisia suksdorfii</i>	Herb	20%	1.1	0-10

Species recorded in plots at < 20% constancy and less than 1% mean cover include *Picea sitchensis* (tree), *Rubus parviflorus*, *Sambucus racemosa*, *Toxicodendron diversilobum*, *Lonicera involucrata* (all shrubs), *Cardamine oligosperma*, *Glechoma hederacea*, *Lolium perenne*, *Lupinus* sp., *Poa* sp., *Cerastium arvense*, *Cirsium vulgare*, *Dudleya farinosa*, *Galium triflorum*, *Geranium dissectum*, *Pentagramma triangularis*, *Poa pratensis*, *Rumex acetosella*, *Sonchus oleraceus*, *Torilis nodosa*, *Epilobium* sp., *Rumex* sp., *Senecio* sp., *Vicia nigricans* subsp. *gigantea*, *Elymus glaucus*, *Lupinus rivularis*, *Arrhenatherum elatius*, *Calamagrostis nutkaensis*, *Sherardia arvensis*, *Athyrium filix-femina*, *Bromus hordeaceus*, *Daucus pusillus*, *Linum bienne*, *Stachys ajugoides*, *Vulpia bromoides*, *Aira praecox*, *Calamagrostis* sp., *Carduus pycnocephalus*, *Cerastium glomeratum*, *Claytonia sibirica*, *Cynosurus echinatus*, *Epilobium ciliatus*, *Erechtites minima*, *Erigeron* sp., *Hypochaeris radicata*, *Lotus crassifolius*, *Medicago lupulina*, *Petasites frigidus*, *Phacelia* sp., *Ranunculus repens*, *Sonchus arvensis*, *Sonchus asper*, *Sonchus* sp., *Stellaria media*, *Tellima grandiflora*, *Triteleia laxa*, *Vicia sativa* subsp. *nigra*, *Vicia sepium*, *Vicia* sp., *Briza maxima*, *Cerastium* sp., *Madia* sp., and *Pieria elegans* (all herbs).

***Eriophyllum stoechadifolium*/Angelica hendersonii association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Eriophyllum stoechadifolium* (lizard tail) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW060 (260), REDW302 (A171), REDW304 (A173)

VEGETATION:

The shrub stratum is dominated by *Eriophyllum stoechadifolium* (lizard tail). *Rubus ursinus* (Pacific blackberry) is present at low to moderate cover in all three plots. *Angelica hendersonii* (coast angelica) and *Festuca rubra* (red fescue) are present in the herbaceous stratum at low to moderately high cover in all three plots. Other herbaceous species occurring in all three plots (mostly present at low cover) are *Achillea millefolium* (yarrow), *Symphotrichum chilense* (Pacific aster), *Holcus lanatus* (velvetgrass), and *Sanicula crassicaulis* (Pacific sanicle).

ENVIRONMENT:

Two plots were observed in the vicinity of the Flint Ridge Trail overlook, and one was at the west end of the Damnation Trail; the vegetation may be more widespread in RNSP. It occurs along bluffs and slopes facing the Pacific Ocean. Geologic substrates were mapped as various formations of the Franciscan complex. Slopes were 35% to 85%, aspects were generally west or southwest, and elevations ranged from 40 to 160 feet (12 to 49 meters) above sea level. The landform positions were described as “top of the cliff,” “middle slope,” and “coastal bluff.” The environment is likely much like that of the *Baccharis pilularis*/*Polystichum munitum* association.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Mediterranean Scrub & Grassland (2.B.1)

USNVC Division: Californian Scrub (2.B.1.Na)

USNVC Macrogroup: California Coastal Scrub (M044)

USNVC Group: California North Coastal & Mesic Scrub (G662)

USNVC Alliance: *Baccharis pilularis* Shrubland Alliance (A0836)

USNVC Association: *Baccharis pilularis* - *Eriophyllum stoechadifolium* Shrubland (CEGL003190)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Mixed Shrubland (in part)

MCV Alliance: *Baccharis pilularis* Shrubland Alliance (Sawyer et al. 2009)

MCV Association: *Eriophyllum stoechadifolium*/Angelica hendersonii (Solomeshch)

Table B23. Synthesis table for all vascular plant taxa recorded in *Eriophyllum stoechadifolium*/*Angelica hendersonii* association at Redwood National and State Parks (# plots=3).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Eriophyllum stoechadifolium</i>	Shrub	100%	55.0	10-80
<i>Rubus ursinus</i>	Shrub	100%	5.5	few-13
<i>Baccharis pilularis</i>	Shrub	33%	0.2	0-few
<i>Gaultheria shallon</i>	Shrub	33%	0.2	0-few
<i>Rubus parviflorus</i>	Shrub	33%	0.2	0-few
<i>Angelica hendersonii</i>	Herb	100%	16.0	3-30
<i>Festuca rubra</i>	Herb	100%	7.0	few-20
<i>Achillea millefolium</i>	Herb	100%	1.3	few-3
<i>Symphytotrichum chilensis</i>	Herb	100%	1.3	few-3
<i>Holcus lanatus</i>	Herb	100%	0.5	few
<i>Sanicula crassicaulis</i>	Herb	100%	0.5	few
<i>Dactylis glomerata</i>	Herb	67%	1.8	0-5
<i>Lupinus</i> sp.	Herb	67%	1.8	0-5
<i>Anaphalis margaritacea</i>	Herb	67%	0.3	0-few
<i>Heracleum lanatum</i>	Herb	67%	0.3	0-few
<i>Iris douglasiana</i>	Herb	67%	0.3	0-few
<i>Stachys ajugoides</i>	Herb	67%	0.3	0-few
<i>Cirsium vulgare</i>	Herb	67%	0.2	0-few
<i>Dudleya farinosa</i>	Herb	67%	0.2	0-few
<i>Sonchus asper</i>	Herb	67%	0.2	0-few
<i>Agrostis</i> sp.	Herb	33%	1.3	0-4
<i>Poa pratensis</i>	Herb	33%	1.3	0-4
<i>Carex</i> sp.	Herb	33%	1.0	0-3
<i>Elymus elymoides</i>	Herb	33%	1.0	0-3
<i>Anagallis arvensis</i>	Herb	33%	0.2	0-few
<i>Calamagrostis nutkaensis</i>	Herb	33%	0.2	0-few
<i>Calamagrostis</i> sp.	Herb	33%	0.2	0-few
<i>Cardamine oligosperma</i>	Herb	33%	0.2	0-few
<i>Elymus glaucus</i>	Herb	33%	0.2	0-few
<i>Epilobium ciliatum</i>	Herb	33%	0.2	0-few
<i>Epilobium</i> sp.	Herb	33%	0.2	0-few
<i>Fragaria chiloensis</i>	Herb	33%	0.2	0-few
<i>Madia</i> sp.	Herb	33%	0.2	0-few
<i>Maianthemum dilatatum</i>	Herb	33%	0.2	0-few
<i>Marah oreganus</i>	Herb	33%	0.2	0-few
<i>Plantago lanceolata</i>	Herb	33%	0.2	0-few
<i>Polypodium glycyrrhiza</i>	Herb	33%	0.2	0-few
<i>Polystichum munitum</i>	Herb	33%	0.2	0-few
<i>Pteridium aquilinum</i>	Herb	33%	0.2	0-few
<i>Senecio</i> sp.	Herb	33%	0.2	0-few
<i>Aira caryophyllea</i>	Herb	33%	<0.1	0-trace
<i>Erigeron</i> sp.	Herb	33%	<0.1	0-trace
<i>Plantago</i> sp.	Herb	33%	<0.1	0-trace
<i>Tellima grandiflora</i>	Herb	33%	<0.1	0-trace

***Garrya elliptica* association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Garrya elliptica* (wavyleaf silktassel) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW337 (A98), REDW339 (A101)

VEGETATION:

The shrub stratum is strongly dominated by *Garrya elliptica* (wavyleaf silktassel), with *Baccharis pilularis* (coyotebrush) and *Eriophyllum stoechadifolium* (lizard tail) present at low cover in both plots. *Rubus ursinus* (Pacific blackberry) is a moderately constant low to moderately high cover shrub. The most constant herbaceous stratum taxa (mostly present at low cover) are *Achillea millefolium* (yarrow), *Aira praecox* (yellow hairgrass), *Anaphalis margaritacea* (pearly everlasting), *Polypodium* sp. (polypody fern), *Polystichum munitum* (western sword fern), and *Lupinus* sp. (lupine).

ENVIRONMENT:

The two plots were observed in the vicinity of the Gyon Coastal Bluff; the vegetation may be more widespread in RNSP. It occurs along bluffs and slopes facing the Pacific Ocean. The geologic substrate of both sites was mapped as the Redwood Creek schist (Franciscan complex). Elevations ranged from 40 to 120 feet (12 to 37 meters), slopes were 50% to 65%, and aspects were generally west or northwest. The landform positions were described as “slope” or “low slope.” The environment is likely much like that of the *Baccharis pilularis*/*Polystichum munitum* association.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Mediterranean Scrub & Grassland (2.B.1)

USNVC Division: Californian Scrub (2.B.1.Na)

USNVC Macrogroup: California Coastal Scrub (M044)

USNVC Group: California North Coastal & Mesic Scrub (G662)

USNVC Alliance: *Baccharis pilularis* Shrubland Alliance (A0836)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Not mapped individually

MCV Alliance: *Garrya elliptica* Provisional Shrubland Alliance (Sawyer et al. 2009)

MCV Association: *Garrya elliptica* (Solomeshch)

Table B24. Synthesis table for all vascular plant taxa recorded in *Garrya elliptica* association at Redwood National and State Parks (# plots=2).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Picea sitchensis</i>	Tree	50%	5.0	0-10
<i>Garrya elliptica</i>	Shrub	100%	72.5	60-85
<i>Baccharis pilularis</i>	Shrub	100%	5.0	5-5
<i>Eriophyllum stoechadifolium</i>	Shrub	100%	0.5	few
<i>Gaultheria shallon</i>	Shrub	50%	7.5	0-15
<i>Rubus ursinus</i>	Shrub	50%	2.0	0-4
<i>Vaccinium ovatum</i>	Shrub	50%	2.0	0-4
<i>Myrica californica</i>	Shrub	50%	1.5	0-3
<i>Diplacus aurantiacus</i> subsp. <i>aurantiacus</i>	Shrub	50%	0.1	0-trace
<i>Achillea millefolium</i>	Herb	100%	0.5	few
<i>Aira praecox</i>	Herb	100%	0.5	few
<i>Anaphalis margaritacea</i>	Herb	100%	0.5	few
<i>Polypodium</i> sp.	Herb	100%	0.5	few
<i>Polystichum munitum</i>	Herb	100%	0.5	few
<i>Lupinus</i> sp.	Herb	100%	0.3	trace-few
<i>Maianthemum dilatatum</i>	Herb	50%	1.5	0-3
<i>Angelica hendersonii</i>	Herb	50%	0.3	0-few
<i>Cirsium vulgare</i>	Herb	50%	0.3	0-few
<i>Dudleya farinosa</i>	Herb	50%	0.3	0-few
<i>Epilobium</i> sp.	Herb	50%	0.3	0-few
<i>Galium aparine</i>	Herb	50%	0.3	0-few
<i>Iris douglasiana</i>	Herb	50%	0.3	0-few
<i>Pentagramma triangularis</i>	Herb	50%	0.3	0-few
<i>Poa</i> sp.	Herb	50%	0.3	0-few
<i>Polystichum imbricans</i>	Herb	50%	0.3	0-few
<i>Sanicula crassicaulis</i>	Herb	50%	0.3	0-few
<i>Sonchus oleraceus</i>	Herb	50%	0.3	0-few
<i>Symphyotrichum chilense</i>	Herb	50%	0.3	0-few
<i>Vulpia bromoides</i>	Herb	50%	0.3	0-few
<i>Bromus carinatus</i>	Herb	50%	0.1	0-few
<i>Cerastium arvense</i>	Herb	50%	0.1	0-few
<i>Elymus</i> sp.	Herb	50%	0.1	0-few
<i>Gamochaeta purpurea</i>	Herb	50%	0.1	0-few
<i>Leymus</i> sp.	Herb	50%	0.1	0-few
<i>Plantago subnuda</i>	Herb	50%	0.1	0-few
<i>Sonchus asper</i>	Herb	50%	0.1	0-few

***Ceanothus pumilus*/Festuca idahoensis association**

LOCAL TYPE CONCEPT:

Grasslands of inland areas with *Festuca idahoensis* (Idaho fescue) the most abundant species in the herbaceous stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW030 (203), REDW031 (223), REDW032 (225), REDW033 (226), REDW034 (227), REDW035 (228), REDW036 (229), REDW037 (232), REDW038 (233), REDW039 (236), REDW185 (A32), REDW234 (A80)

VEGETATION:

The herbaceous stratum is strongly, and usually solely, dominated by *Festuca idahoensis* (Idaho fescue). The stratum is fairly species-rich, with a number of mostly low cover species. The most constant taxa are *Perideridia oregana* (Oregon yampah), *Carex concinnoides* (northwestern sedge), *Aspidotis densa* (Indian's dream), *Epilobium minutum* (chaparral willowherb), *Danthonia californica* (California oatgrass), *Hastingsia serpenticola* (Klamath rushlily), *Koeleria macrantha* (prairie junegrass), *Calochortus tolmiei* (hairy star tulip), *Agoseris* sp. (agoseris), *Erigeron* sp. (fleabane), *Eriophyllum lanatum* (common woollysunflower), *Cerastium arvense* (field chickweed), and *Brodiaea elegans* subsp. *elegans* (harvest brodiaea). *Ceanothus pumilus* (dwarf ceanothus) is constant as a low cover short shrub.

ENVIRONMENT:

Most plots assigned to this vegetation occurred in the Little Bald Hills; a single plot was recorded in the watershed of Rock Creek, a tributary to the South Fork of the Smith River. The Little Bald Hills plots were from areas mapped as Josephine ophiolite (serpentinic); the Rock Creek plot was from an area mapped as the Franciscan complex Broken Formation (non-serpentinic). Slopes ranged from 5% to 45%, aspects were various, and elevations ranged from 1,520 to 1,880 feet (468 to 578 meters) above sea level. The landform positions were described as middle to upper slopes.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: Southern Vancouverian Lowland Grassland & Shrubland (M050)

USNVC Group: Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie (G488)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: *Festuca idahoensis* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Ceanothus pumilus*/Festuca idahoensis (Solomeshch)

Table B25. Synthesis table for most constant vascular plant taxa recorded in *Ceanothus pumilus*/*Festuca idahoensis* association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Pinus jeffreyi</i>	Tree	83%	0.3	0-few
<i>Ceanothus pumilus</i>	Shrub	100%	3.9	few-10
<i>Arctostaphylos nevadensis</i>	Shrub	42%	0.4	0-3
<i>Holodiscus discolor</i>	Shrub	25%	0.1	0-few
<i>Frangula californica</i> subsp. <i>californica</i>	Shrub	25%	0.1	0-few
<i>Festuca idahoensis</i>	Herb	100%	37.2	8-51
<i>Perideridia oregana</i>	Herb	100%	3.0	few-6
<i>Carex concinnoides</i>	Herb	100%	2.3	few-5
<i>Aspidotis densa</i>	Herb	100%	1.3	trace-3
<i>Epilobium minutum</i>	Herb	100%	0.7	few-3
<i>Danthonia californica</i>	Herb	92%	3.1	0-6
<i>Hastingsia serpicicola</i>	Herb	92%	1.3	0-3
<i>Koeleria macrantha</i>	Herb	92%	0.8	0-3
<i>Calochortus tolmiei</i>	Herb	92%	0.4	0-few
<i>Agoseris</i> sp.	Herb	83%	0.4	0-few
<i>Erigeron</i> sp.	Herb	75%	0.6	0-3
<i>Eriophyllum lanatum</i>	Herb	75%	0.6	0-3
<i>Cerastium arvense</i>	Herb	75%	0.5	0-3
<i>Brodiaea elegans</i> subsp. <i>elegans</i>	Herb	75%	0.4	0-few
<i>Horkelia sericata</i>	Herb	67%	3.0	0-10
<i>Viola cuneata</i>	Herb	67%	1.0	0-3
<i>Elymus glaucus</i>	Herb	67%	0.8	0-4
<i>Achillea millefolium</i>	Herb	67%	0.5	0-3
<i>Ranunculus occidentalis</i>	Herb	67%	0.3	0-few
<i>Sanicula graveolens</i>	Herb	67%	0.2	0-few
<i>Trifolium longipes</i>	Herb	67%	0.2	0-few
<i>Achnatherum lemmonii</i>	Herb	58%	1.5	0-5
<i>Aira praecox</i>	Herb	50%	0.3	0-few
<i>Collinsia linearis</i>	Herb	42%	0.2	0-few
<i>Lomatium dissectum</i>	Herb	42%	0.2	0-few
<i>Sisyrinchium bellum</i>	Herb	42%	0.1	0-few
<i>Castilleja affinis</i>	Herb	33%	0.1	0-few
<i>Phlox diffusa</i>	Herb	25%	0.8	0-3
<i>Triphysaria pusilla</i>	Herb	25%	0.1	0-few
<i>Bromus laevipes</i>	Herb	25%	0.1	0-few
<i>Luzula parviflora</i>	Herb	25%	0.1	0-few
<i>Polygonum douglasii</i> subsp. <i>spargulariiforme</i>	Herb	25%	0.1	0-few
<i>Calystegia atriplicifolia</i> subsp. <i>buttensis</i>	Herb	25%	0.0	0-trace
<i>Zigadenus micranthus</i>	Herb	25%	0.0	0-trace
<i>Sidalcea malviflora</i>	Herb	17%	0.1	0-few
<i>Eriogonum nudum</i>	Herb	17%	0.1	0-few
<i>Aira caryophylla</i>	Herb	17%	0.0	0-trace
<i>Dodecatheon hendersonii</i>	Herb	17%	0.0	0-trace

Species recorded in plots at 8% constancy and less than 0.4% mean cover include *Juniperus communis*, *Mahonia aquifolium*, *Vaccinium ovatum* (all shrubs), *Poa* sp., *Agrostis* sp., *Calystegia* sp., *Galium ambiguum* subsp. *siskiyouense*, *Galium* sp., *Gilia capitata*, *Luzula comosa*, *Melica geyeri*, *Melica* sp., *Polygonum* sp., *Sedum* sp., *Zigadenus* sp., *Allium* sp., *Iris* sp., *Viola* sp., *Vulpia bromoides*, and *Vulpia microstachys* (all herbs).

***Gaultheria shallon* association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Gaultheria shallon* (salal) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW338 (A100)

VEGETATION:

In the single plot, the shrub stratum is dominated by *Gaultheria shallon* (salal), with *Baccharis pilularis* (coyotebrush) also present at significant cover. The most abundant herbaceous stratum taxa (mostly present at low cover) are *Lupinus* sp. (lupine), *Polypodium glycyrrhiza* (licorice fern), and *Polystichum imbricans* (narrowleaf sword fern).

ENVIRONMENT:

The single plot was observed in the vicinity of the Gyon Coastal Bluff; the vegetation may be more widespread in RNSP. It occurs along bluffs and slopes facing the Pacific Ocean. The geologic substrate was mapped as the Redwood Creek schist (Franciscan complex). The elevation was about 40 feet (12 37 meters), the slope was about 50%, and the aspect was west. The landform positions were described as “low slope.” The environment is likely much like that of the *Baccharis pilularis*/*Polystichum munitum* association.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: Southern Vancouverian Lowland Grassland & Shrubland (M050)

USNVC Group: Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie (G488)

USNVC Alliance: *Festuca rubra* - *Calamagrostis nutkaensis* Coastal Headland Herbaceous Alliance (A3739)

USNVC Association: *Gaultheria shallon* - *Vaccinium ovatum* / *Pteridium aquilinum* Shrubland (CEGL000972)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Mixed Shrubland (in part)

MCV Alliance: *Rubus* (*parviflorus*, *spectabilis*, *ursinus*) Shrubland Alliance (Sawyer et al. 2009)

MCV Association: *Gaultheria shallon* (Solomeshch)

Table B26. Synthesis table for all vascular plant taxa recorded in *Gaultheria shallon* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Picea sitchensis</i>	Tree	100%	0.5	few
<i>Gaultheria shallon</i>	Shrub	100%	60.0	60
<i>Baccharis pilularis</i>	Shrub	100%	20.0	20
<i>Garrya elliptica</i>	Shrub	100%	5.0	5
<i>Eriophyllum stoechadifolium</i>	Shrub	100%	0.5	few
<i>Lupinus</i> sp.	Herb	100%	3.0	3
<i>Polypodium glycyrrhiza</i>	Herb	100%	3.0	3
<i>Polystichum imbricans</i>	Herb	100%	3.0	3
<i>Achillea millefolium</i>	Herb	100%	0.5	few
<i>Dudleya farinosa</i>	Herb	100%	0.5	few
<i>Galium aparine</i>	Herb	100%	0.5	few
<i>Iris douglasiana</i>	Herb	100%	0.5	few
<i>Polystichum munitum</i>	Herb	100%	0.5	few
<i>Heracleum lanatum</i>	Herb	100%	0.1	trace
<i>Maianthemum dilatatum</i>	Herb	100%	0.1	trace

***Rubus parviflorus*/Tellima grandiflora association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Rubus parviflorus* (thimbleberry) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW113 (62001), REDW115 (D97_062003), REDW116 (D98_062004), REDW118 (A2), REDW276 (A147), REDW287 (A157), REDW289 (A159), REDW295 (A165)

VEGETATION:

The shrub stratum is strongly dominated by *Rubus parviflorus* (thimbleberry). *Rubus ursinus* (Pacific blackberry) and *Baccharis pilularis* (coyotebrush) are constant low cover shrubs. The most constant herbaceous stratum species (present at low to moderately high cover) are *Polystichum munitum* (western sword fern), *Marah oreganus* (coast man-root), *Tellima grandiflora* (fringe cups), *Heracleum lanatum* (= *Heracleum maximum*) (common cowparsnip), and *Urtica dioica* (stinging nettle). The overall floristic composition of this vegetation is very similar to that of the *Rubus ursinus*/*Heracleum lanatum* association, and the two types might be interpreted as different dominance phases of a single type.

ENVIRONMENT:

Plots assigned to this vegetation were recorded from the vicinity of High Bluff (just south of the Klamath River mouth) to Sister Rocks. The vegetation is probably frequent along bluffs and slopes facing the Pacific Ocean, at least in the northern part of RNSP and possibly throughout the parks. All plots were observed within 0.25 mile (0.32 km) of the Pacific Ocean. Geologic substrates were mapped as the Crescent City mélange unit of the Franciscan complex or as a Quaternary landslide. Slopes were 25% to 60%, aspects were generally west (northwest to southwest), and elevations ranged from 40 to 520 feet (12 to 160 meters) above sea level. The landform positions were described as slopes (lower to upper) of coastal bluffs. The environmental setting appears to be nearly identical to that of the *Rubus ursinus*/*Heracleum lanatum* association.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: Southern Vancouverian Lowland Grassland & Shrubland (M050)

USNVC Group: Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie (G488)

USNVC Alliance: *Festuca rubra* - *Calamagrostis nutkaensis* Coastal Headland Herbaceous Alliance (A3739)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Rubus* Shrubland (in part)

MCV Alliance: *Rubus* (*parviflorus*, *spectabilis*, *ursinus*) Shrubland Alliance (Sawyer et al. 2009)
 MCV Association: *Rubus ursinus*/*Tellima grandiflora* (Solomeshch)

Table B27. Synthesis table for most constant vascular plant taxa recorded in *Rubus parviflorus*/*Tellima grandiflora* association at Redwood National and State Parks (# plots=8).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus parviflorus</i>	Shrub	100%	83.0	40-99
<i>Rubus ursinus</i>	Shrub	100%	4.3	few-10
<i>Baccharis pilularis</i>	Shrub	63%	3.4	0-25
<i>Sambucus racemosa</i>	Shrub	50%	1.4	0-10
<i>Frangula purshiana</i>	Shrub	25%	0.1	0-few
<i>Lonicera involucrata</i>	Shrub	13%	0.6	0-5
<i>Toxicodendron diversilobum</i>	Shrub	13%	0.6	0-5
<i>Rosa californica</i>	Shrub	13%	0.1	0-few
<i>Rubus spectabilis</i>	Shrub	13%	0.1	0-few
<i>Polystichum munitum</i>	Herb	100%	11.2	0.5-30
<i>Marah oreganus</i>	Herb	100%	9.3	4-15
<i>Tellima grandiflora</i>	Herb	100%	1.7	few-5
<i>Heracleum lanatum</i>	Herb	100%	1.3	few-4
<i>Urtica dioica</i>	Herb	75%	2.6	0-7
<i>Vicia nigricans</i> subsp. <i>gigantea</i>	Herb	50%	0.7	0-4
<i>Galium aparine</i>	Herb	50%	0.6	0-3
<i>Holcus lanatus</i>	Herb	50%	0.2	0-few
<i>Stachys ajugoides</i>	Herb	38%	0.5	0-3
<i>Carex</i> sp.	Herb	38%	0.2	0-few
<i>Achillea millefolium</i>	Herb	38%	0.1	0-few
<i>Claytonia sibirica</i>	Herb	38%	0.1	0-few
<i>Moehringia</i> sp.	Herb	25%	0.4	0-3
<i>Petasites frigidus</i>	Herb	25%	0.4	0-3
<i>Sanicula crassicaulis</i>	Herb	25%	0.4	0-3
<i>Pteridium aquilinum</i>	Herb	25%	0.4	0-3
<i>Agrostis</i> sp.	Herb	25%	0.1	0-few
<i>Galium triflorum</i>	Herb	25%	0.1	0-few
<i>Scrophularia californica</i>	Herb	25%	0.1	0-few
<i>Stellaria</i> sp.	Herb	25%	0.1	0-few
<i>Dactylis glomerata</i>	Herb	25%	0.1	0-few
<i>Epilobium</i> sp.	Herb	25%	0.1	0-few
<i>Athyrium filix-femina</i>	Herb	13%	0.9	0-7
<i>Elymus glaucus</i>	Herb	13%	0.6	0-5
<i>Calamagrostis</i> sp.	Herb	13%	0.1	0-few
<i>Cardamine oligosperma</i>	Herb	13%	0.1	0-few
<i>Cirsium vulgare</i>	Herb	13%	0.1	0-few
<i>Conium maculatum</i>	Herb	13%	0.1	0-few
<i>Dryopteris arguta</i>	Herb	13%	0.1	0-few
<i>Epilobium angustifolium</i> subsp. <i>angustifolium</i>	Herb	13%	0.1	0-few
<i>Epilobium ciliatum</i>	Herb	13%	0.1	0-few
<i>Equisetum telmateia</i>	Herb	13%	0.1	0-few
<i>Lathyrus</i> sp.	Herb	13%	0.1	0-few

Species recorded in plots at 13% constancy and less than 0.1% mean cover include *Bellis perennis*, *Bromus carinatus*, *Bromus vulgaris*, *Cardamine californica*, *Elymus* sp., *Leucanthemum vulgare*, *Poa pratensis*, and *Vicia sativa* subsp. *nigra* (all herbs).

***Rubus ursinus*/Heracleum lanatum association**

LOCAL TYPE CONCEPT:

Shrublands in the vicinity of the ocean coast with *Rubus ursinus* (Pacific blackberry) the most abundant species in the shrub stratum and usually strongly dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW062 (262), REDW117 (A1), REDW278 (A148), REDW279 (A149), REDW288 (A158), REDW294 (A164), REDW299 (A168)

VEGETATION:

The shrub stratum is strongly dominated by *Rubus ursinus* (Pacific blackberry). *Baccharis pilularis* (coyotebrush) is a moderately constant low cover shrub. The most constant herbaceous stratum taxa (mostly present at low cover) are *Heracleum lanatum* (= *Heracleum maximum*) (common cowparsnip), *Marah oreganus* (coast man-root), *Polystichum munitum* (western sword fern), *Galium aparine* (cleavers), *Holcus lanatus* (velvetgrass), *Pteridium aquilinum* (bracken fern), *Agrostis* sp. (coast bentgrass), *Elymus glaucus* (blue wildrye), *Bromus carinatus* (California brome), and *Sonchus asper* (prickly sow thistle). The overall floristic composition of this vegetation is very similar to that of the *Rubus parviflorus*/*Tellima grandiflora* association, and the two types might be interpreted as different dominance phases of a single type.

ENVIRONMENT:

Plots assigned to this vegetation were recorded from the vicinity of High Bluff (just south of the Klamath River mouth) to Sister Rocks. The vegetation is probably frequent along bluffs and slopes facing the Pacific Ocean, at least in the northern part of RNSP and possibly throughout the parks. All plots were observed within 0.25 mile (0.32 km) of the Pacific Ocean. Geologic substrates were mapped as the Crescent City mélange unit of the Franciscan complex. Slopes were 15% to 45%, aspects were generally west (northwest to southwest), and elevations ranged from 40 to 520 feet (12 to 160 meters) above sea level. The landform positions were described as slopes (usually middle slopes) of coastal bluffs. The environmental setting appears to be nearly identical to that of the *Rubus parviflorus*/*Tellima grandiflora* association.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: Southern Vancouverian Lowland Grassland & Shrubland (M050)

USNVC Group: Southern Vancouverian Shrub & Herbaceous Bald, Bluff & Prairie (G488)

USNVC Alliance: *Festuca rubra* - *Calamagrostis nutkaensis* Coastal Headland Herbaceous Alliance (A3739)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Rubus* Shrubland (in part)
 MCV Alliance: *Rubus* (*parviflorus*, *spectabilis*, *ursinus*) Shrubland Alliance (Sawyer et al. 2009)
 MCV Association: *Rubus ursinus*/*Heracleum lanatum* (Solomeshch)

Table B28. Synthesis table for most constant vascular plant taxa recorded in *Rubus ursinus*/*Heracleum lanatum* association at Redwood National and State Parks (# plots=7).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	100%	82.1	50-95
<i>Baccharis pilularis</i>	Shrub	71%	0.7	0-3
<i>Eriophyllum stoechadifolium</i>	Shrub	29%	1.2	0-8
<i>Frangula purshiana</i>	Shrub	29%	0.1	0-few
<i>Ribes</i> sp.	Shrub	29%	0.1	0-few
<i>Rubus armeniicus</i>	Shrub	29%	0.1	0-few
<i>Rubus parviflorus</i>	Shrub	14%	0.4	0-3
<i>Heracleum lanatum</i>	Herb	100%	2.0	0.5-5
<i>Marah oreganus</i>	Herb	86%	7.1	0-25
<i>Polystichum munitum</i>	Herb	86%	2.8	0-7
<i>Galium aparine</i>	Herb	86%	1.8	0-5
<i>Holcus lanatus</i>	Herb	86%	0.7	0-3
<i>Pteridium aquilinum</i>	Herb	71%	1.2	0-4
<i>Agrostis</i> sp.	Herb	57%	1.2	0-7
<i>Elymus glaucus</i>	Herb	57%	0.8	0-4
<i>Bromus carinatus</i>	Herb	57%	0.6	0-3
<i>Sonchus asper</i>	Herb	57%	0.2	0-few
<i>Symphotrichum chilense</i>	Herb	43%	4.1	0-25
<i>Achillea millefolium</i>	Herb	43%	0.6	0-3
<i>Scrophularia californica</i>	Herb	43%	0.6	0-3
<i>Tellima grandiflora</i>	Herb	43%	0.6	0-3
<i>Erechtites minima</i>	Herb	43%	0.2	0-few
<i>Stellaria</i> sp.	Herb	43%	0.2	0-few
<i>Cirsium vulgare</i>	Herb	43%	0.2	0-few
<i>Angelica hendersonii</i>	Herb	29%	1.1	0-5
<i>Dactylis glomerata</i>	Herb	29%	0.6	0-4
<i>Iris douglasiana</i>	Herb	29%	0.6	0-4
<i>Epilobium</i> sp.	Herb	29%	0.5	0-3
<i>Stachys ajugoides</i>	Herb	29%	0.5	0-3
<i>Urtica dioica</i>	Herb	29%	0.5	0-3
<i>Epilobium ciliatum</i>	Herb	29%	0.1	0-few
<i>Vicia sativa</i> subsp. <i>nigra</i>	Herb	29%	0.1	0-few
<i>Artemisia suksdorfii</i>	Herb	14%	1.1	0-8
<i>Calamagrostis</i> sp.	Herb	14%	0.7	0-5
<i>Anagallis arvensis</i>	Herb	14%	0.4	0-3
<i>Claytonia sibirica</i>	Herb	14%	0.4	0-3
<i>Vicia nigricans</i> subsp. <i>gigantea</i>	Herb	14%	0.4	0-3
<i>Vicia</i> sp.	Herb	14%	0.4	0-3

Species recorded in plots at 14% constancy and less than 0.2% mean cover include *Gaultheria shallon*, *Sambucus racemosa* (both shrubs), *Anaphalis margaritacea*, *Athyrium filix-femina*, *Cirsium arvense*, *Digitalis purpurea*, *Elymus* sp., *Equisetum telmateia*, *Geranium dissectum*, *Lathyrus* sp., *Leucanthemum vulgare*, *Lupinus* sp., *Moehringia* sp., *Pentagramma triangularis*, *Sanicula crassicaulis*, *Sanicula* sp., *Senecio* sp., *Stellaria media*, *Vicia villosa*, *Bromus hordeaceus*, *Daucus carota*, *Gnaphalium* sp., *Plantago lanceolata*, and *Raphanus raphanistrum* (all herbs).

Agrostis (gigantea, stolonifera)-Festuca arundinacea association

LOCAL TYPE CONCEPT:

Ungrazed or lightly grazed grasslands with *Agrostis gigantea* (redtop) and/or *Agrostis stolonifera* (creeping bentgrass) together or individually dominant or co-dominant with other graminoid species in the herbaceous stratum and disturbance tolerant species absent or present in insignificant amounts.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW134 (B69_070105), REDW153 (B28_071112), REDW318 (A187)

VEGETATION:

The herbaceous stratum cover is dominated by some mix of the grass species *Agrostis gigantea* (redtop) and/or *Agrostis stolonifera* (creeping bentgrass), individually or together. Other grasses which may be important to co-dominant include *Holcus lanatus* (velvetgrass), *Anthoxanthum odoratum* (sweet vernalgrass), *Festuca arundinacea* (= *Schedonorus arundinaceus*) (tall fescue), *Festuca rubra* (red fescue), *Dactylis glomerata* (orchard grass), and/or *Poa pratensis* (Kentucky bluegrass). The most constant forb species are *Hypochaeris radicata* (rough cat's-ear), *Plantago lanceolata* (English plantain), and *Rumex acetosella* (sheep sorrel). Disturbance-tolerant forbs, including *Trifolium repens* (white clover), *Prunella vulgaris* (common self-heal), *Taraxacum officinale* (common dandelion), and *Bellis perennis* (English daisy) have insignificant (generally, less than 5%) combined cover.

ENVIRONMENT:

Plots that were assigned to this vegetation were recorded from various locations, and the vegetation probably occurs throughout RNSP in small patches. It occurs on invaded natural grasslands and areas previously planted with grasses, and other open, relatively level sites that are infrequently or never mowed. Slopes were level to slight, and elevations ranged from 50 to 640 feet (15 to 197 meters) above sea level. The landform positions were often Quaternary marine or stream terraces.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: Southern Vancouverian Lowland Ruderal Grassland & Shrubland (G648)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Agrostis gigantea*-*Agrostis stolonifera* Grassland (in part)

MCV Alliance: *Agrostis (gigantea, stolonifera)*-*Festuca arundinacea* Semi-Natural Herbaceous Stands (Sawyer et al. 2009)

MCV Association: *Agrostis (gigantea, stolonifera)*-*Festuca arundinacea* (Solomeshch)

Table B29. Synthesis table for all vascular plant taxa recorded in *Agrostis (gigantea, stolonifera)*-*Festuca arundinacea* association at Redwood National and State Parks (# plots=3).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus armeniacus</i>	Shrub	33%	0.2	0-few
<i>Rubus ursinus</i>	Shrub	33%	2.3	0-7
<i>Rosa</i> sp.	Shrub	33%	1.0	0-3
<i>Rosa gymnocarpa</i>	Shrub	33%	0.2	0-few
<i>Agrostis</i> sp.	Herb	100%	40.0	25-60
<i>Holcus lanatus</i>	Herb	100%	15.2	few-40
<i>Anthoxanthum odoratum</i>	Herb	67%	10.2	0-30
<i>Hypochaeris radicata</i>	Herb	67%	4.3	0-10
<i>Festuca arundinacea</i>	Herb	67%	3.5	0-10
<i>Rumex acetosella</i>	Herb	67%	2.0	0-3
<i>Dactylis glomerata</i>	Herb	67%	2.0	0-3
<i>Plantago lanceolata</i>	Herb	67%	1.5	0-4
<i>Festuca rubra</i>	Herb	33%	11.7	0-35
<i>Pteridium aquilinum</i>	Herb	33%	6.7	0-20
<i>Poa pratensis</i>	Herb	33%	5.0	0-15
<i>Leontodon taraxacoides</i>	Herb	33%	1.7	0-5
<i>Lolium perenne</i>	Herb	33%	1.7	0-5
<i>Phalaris arundinacea</i>	Herb	33%	1.3	0-4
<i>Prunella vulgaris</i>	Herb	33%	1.0	0-3
<i>Lolium</i> sp.	Herb	33%	1.0	0-3
<i>Achillea millefolium</i>	Herb	33%	1.0	0-3
<i>Elymus</i> sp.	Herb	33%	1.0	0-3
<i>Rumex obtusifolius</i>	Herb	33%	0.2	0-few
<i>Bromus carinatus</i>	Herb	33%	0.2	0-few
<i>Leucanthemum vulgare</i>	Herb	33%	0.2	0-few
<i>Trifolium dubium</i>	Herb	33%	0.2	0-few
<i>Carex</i> sp.	Herb	33%	0.2	0-few
<i>Brodiaea</i> sp.	Herb	33%	0.2	0-few
<i>Daucus carota</i>	Herb	33%	0.2	0-few
<i>Iris douglasiana</i>	Herb	33%	0.2	0-few
<i>Luzula comosa</i>	Herb	33%	0.2	0-few
<i>Alopecurus</i> sp.	Herb	33%	0.2	0-few
<i>Bromus hordeaceus</i>	Herb	33%	0.2	0-few
<i>Danthonia californica</i>	Herb	33%	0.2	0-few
<i>Poa annua</i>	Herb	33%	0.2	0-few
<i>Ranunculus occidentalis</i>	Herb	33%	0.2	0-few
<i>Trifolium</i> sp.	Herb	33%	0.2	0-few
<i>Viola</i> sp.	Herb	33%	0.2	0-few

Agrostis (gigantea, stolonifera)-Trifolium repens-Prunella vulgaris association

LOCAL TYPE CONCEPT:

Grazed, trampled, or mowed grasslands with *Agrostis gigantea* (redtop) and/or *Agrostis stolonifera* (creeping bentgrass) together or individually dominant in the herbaceous stratum and disturbance tolerant species present in significant amounts.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW044 (244), REDW261 (A124), REDW274 (A143), REDW275 (A144), REDW319 (A188)

VEGETATION:

The herbaceous stratum cover is dominated by some mix of the grass species *Agrostis gigantea* (redtop) and/or *Agrostis stolonifera* (creeping bentgrass), individually or together. Constant and occasionally co-dominant species include *Holcus lanatus* (velvetgrass), *Hypochaeris radicata* (rough cat's-ear), and *Trifolium repens* (white clover). Constant species of low to moderate cover are *Plantago lanceolata* (English plantain), *Prunella vulgaris* (common self-heal), *Anthoxanthum odoratum* (sweet vernalgrass), *Lolium* sp. (ryegrass), *Rumex acetosella* (sheep sorrel), *Dactylis glomerata* (orchard grass), *Taraxacum officinale* (common dandelion), *Bellis perennis* (English daisy), *Ranunculus repens* (creeping buttercup), *Festuca arundinacea* (= *Schedonorus arundinaceus*) (tall fescue), and *Geranium molle* (dove's foot geranium). Disturbance-tolerant forbs, including *Trifolium repens* (white clover), *Prunella vulgaris* (common self-heal), *Taraxacum officinale* (common dandelion), and *Bellis perennis* (English daisy) have significant (generally, more than 5%) combined cover.

ENVIRONMENT:

Plots that were assigned to this vegetation were recorded from various locations, and the vegetation occurs throughout RNSP in small patches. It occurs on disturbed areas, usually previously planted with grasses, such as lawns around campgrounds and facilities and roadsides, where trampling or mowing is frequent. Slopes were level to slight, and elevations ranged from 30 to 620 feet (9 to 191 meters) above sea level. The landform positions were often Quaternary marine or stream terraces.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: Southern Vancouverian Lowland Ruderal Grassland & Shrubland (G648)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Agrostis gigantea*-*Agrostis stolonifera* Grassland (in part)

MCV Alliance: *Agrostis (gigantea, stolonifera)*-*Festuca arundinacea* Semi-Natural Herbaceous Stands (Sawyer et al. 2009)

MCV Association: *Agrostis (gigantea, stolonifera)*-*Trifolium repens*-*Prunella vulgaris* association (Solomeshch)

Table B30. Synthesis table for all vascular plant taxa recorded in *Agrostis (gigantea, stolonifera)*-*Trifolium repens*-*Prunella vulgaris* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus armeniacus</i>	Shrub	44%	0.1	0-few
<i>Rubus ursinus</i>	Shrub	33%	2.5	0-15
<i>Agrostis</i> sp.	Herb	100%	29.3	20-40
<i>Hypochaeris radicata</i>	Herb	100%	12.1	10-25
<i>Holcus lanatus</i>	Herb	100%	11.8	3-25
<i>Trifolium repens</i>	Herb	100%	6.4	3-30
<i>Plantago lanceolata</i>	Herb	100%	3.4	few-10
<i>Prunella vulgaris</i>	Herb	100%	3.1	4-5
<i>Anthoxanthum odoratum</i>	Herb	80%	7.7	0-15
<i>Lolium</i> sp.	Herb	80%	4.6	0-15
<i>Rumex acetosella</i>	Herb	80%	1.7	0-5
<i>Dactylis glomerata</i>	Herb	80%	1.7	0-7
<i>Taraxacum officinale</i>	Herb	80%	1.1	0-5
<i>Bellis perennis</i>	Herb	80%	0.2	0-few
<i>Ranunculus repens</i>	Herb	60%	6.7	0-15
<i>Festuca arundinacea</i>	Herb	60%	1.7	0-4
<i>Geranium molle</i>	Herb	60%	0.4	0-3
<i>Lotus corniculatus</i>	Herb	40%	1.9	0-4
<i>Poa</i> sp.	Herb	40%	0.9	0-4
<i>Rumex obtusifolius</i>	Herb	40%	0.5	0-3
<i>Bromus carinatus</i>	Herb	40%	0.2	0-few
<i>Leucanthemum vulgare</i>	Herb	40%	0.1	0-few
<i>Trifolium dubium</i>	Herb	40%	0.1	0-few
<i>Plantago major</i>	Herb	40%	0.1	0-few
<i>Festuca rubra</i>	Herb	20%	8.3	0-40
<i>Vulpia bromoides</i>	Herb	20%	1.7	0-15
<i>Leontodon taraxacoides</i>	Herb	20%	1.0	0-4
<i>Raphanus raphanistrum</i>	Herb	20%	0.9	0-8
<i>Convolvulus arvensis</i>	Herb	20%	0.4	0-4
<i>Veronica</i> sp.	Herb	20%	0.4	0-3
<i>Cirsium vulgare</i>	Herb	20%	0.1	0-few
<i>Daucus carota</i>	Herb	20%	0.1	0-few
<i>Galium</i> sp.	Herb	20%	0.1	0-few
<i>Mentha pulegium</i>	Herb	20%	0.1	0-few
<i>Crepis</i> sp.	Herb	20%	0.1	0-few
<i>Equisetum arvense</i>	Herb	20%	0.1	0-few
<i>Medicago lupulina</i>	Herb	20%	0.1	0-few
<i>Trifolium pratense</i>	Herb	20%	0.1	0-few

***Arrhenatherum elatius-Cynosurus echinatus* association**

LOCAL TYPE CONCEPT:

Grasslands of inland areas with *Arrhenatherum elatius* (tall oatgrass) present in significant amounts and usually dominant or co-dominant in the herbaceous stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW077 (TR17), REDW094 (60901), REDW095 (60902), REDW097 (C71_061002), REDW102 (C38_061301), REDW103 (C39_061302), REDW104 (C40_061303), REDW149 (C20_071021)

VEGETATION:

The herbaceous stratum is dominated by the grass species *Arrhenatherum elatius* (tall oatgrass). The graminoid taxa *Agrostis gigantea* (redtop), *Agrostis stolonifera* (creeping bentgrass), *Carex* sp. (sedges), *Cynosurus echinatus* (bristly dogstail grass), and/or *Anthoxanthum odoratum* (sweet vernalgrass) may co-dominate. Constant low cover graminoids include *Aira caryophyllea* (silver hairgrass), *Holcus lanatus* (velvetgrass), *Luzula comosa* (Pacific woodrush), *Dactylis glomerata* (orchard grass), and *Bromus hordeaceus* (soft chess). The most constant forb taxa are *Plantago lanceolata* (English plantain), *Hypochaeris radicata* (rough cat's-ear), *Rumex acetosella* (sheep sorrel), *Lotus micranthus* (hill lotus), *Ranunculus occidentalis* (western buttercup), *Achillea millefolium* (yarrow), *Trifolium dubium* (suckling clover), *Potentilla* sp. (cinquefoil), and *Linum bienne* (pale flax).

ENVIRONMENT:

Plots assigned to this vegetation occurred in the Bald Hills area, in the vicinity of Schoolhouse Peak and Coyote Peak (upper parts of the Coyote Creek and Copper Creek drainages) and in the upper drainage of Harry Weir Creek, on geologic substrates mapped as the Coyote Creek Formation or other units of the Franciscan complex. Slopes ranged from 5% to 15%, aspects were various, and elevations ranged from 1,760 to 3,040 feet (542 to 935 meters) above sea level. The landform positions were described as middle to upper slopes. This vegetation is often associated with the *Quercus garryana/Festuca californica* association, and the two types are compositionally similar.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: Southern Vancouverian Lowland Ruderal Grassland & Shrubland (G648)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Arrhenatherum elatius-Cynosurus echinatus* Grassland

MCV Alliance: *Cynosurus echinatus* Semi-natural Herbaceous Stands (Sawyer et al. 2009)
MCV Association: *Arrhenatherum elatius*-*Cynosurus echinatus* (Solomeshch) (= *Cynosurus echinatus*-*Arrhenatherum elatius*/*Dichelostemma capitatum* (Sawyer et al. 2009))

Table B31. Synthesis table for most constant vascular plant taxa recorded in *Arrhenatherum elatius*-*Cynosurus echinatus* association at Redwood National and State Parks (# plots=8).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	50%	2.7	0-15
<i>Rubus armeniacus</i>	Shrub	38%	0.6	0-4
<i>Arrhenatherum elatius</i>	Herb	100%	23.0	4-30
<i>Plantago lanceolata</i>	Herb	100%	3.8	few-15
<i>Hypochaeris radicata</i>	Herb	100%	3.7	few-5
<i>Aira caryophylla</i>	Herb	100%	1.9	few-4
<i>Rumex acetosella</i>	Herb	88%	8.3	0-25
<i>Agrostis</i> sp.	Herb	88%	6.5	0-35
<i>Carex</i> sp.	Herb	88%	3.8	0-25
<i>Holcus lanatus</i>	Herb	88%	2.8	0-7
<i>Lotus micranthus</i>	Herb	88%	0.7	0-3
<i>Cynosurus echinatus</i>	Herb	75%	11.1	0-30
<i>Luzula comosa</i>	Herb	75%	2.1	0-4
<i>Dactylis glomerata</i>	Herb	75%	2.0	0-10
<i>Ranunculus occidentalis</i>	Herb	75%	1.4	0-4
<i>Achillea millefolium</i>	Herb	75%	1.0	0-3
<i>Anthoxanthum odoratum</i>	Herb	63%	10.7	0-30
<i>Trifolium dubium</i>	Herb	63%	2.7	0-20
<i>Bromus hordeaceus</i>	Herb	63%	2.4	0-7
<i>Potentilla</i> sp.	Herb	63%	0.7	0-4
<i>Linum bienne</i>	Herb	63%	0.3	0-few
<i>Pteridium aquilinum</i>	Herb	50%	4.9	0-15
<i>Poa pratensis</i>	Herb	50%	4.5	0-25
<i>Danthonia californica</i>	Herb	50%	2.3	0-10
<i>Brodiaea</i> sp.	Herb	50%	0.6	0-3
<i>Elymus</i> sp.	Herb	50%	0.6	0-3
<i>Vulpia bromoides</i>	Herb	50%	0.5	0-3
<i>Bromus vulgaris</i>	Herb	50%	0.5	0-3
<i>Lupinus nanus</i>	Herb	50%	0.3	0-few
<i>Cerastium glomeratum</i>	Herb	50%	0.2	0-few
<i>Marah oreganus</i>	Herb	38%	0.5	0-4
<i>Sherardia arvensis</i>	Herb	38%	0.5	0-3
<i>Lolium perenne</i>	Herb	38%	0.4	0-3
<i>Dichelostemma capitatum</i>	Herb	38%	0.2	0-few
<i>Taraxacum officinale</i>	Herb	38%	0.1	0-few
<i>Trifolium subterraneum</i>	Herb	38%	0.1	0-few
<i>Hypericum perforatum</i>	Herb	38%	0.1	0-few
<i>Poa</i> sp.	Herb	25%	3.8	0-20

Species recorded in plots at $\leq 25\%$ constancy and less than 0.5% mean cover include *Pseudotsuga menziesii*, *Quercus garryana* (both trees), *Rosa gymnocarpa*, *Rubus parviflorus*, *Symphoricarpos* sp., *Baccharis pilularis*, *Rosa* sp. (all shrubs), *Madia* sp., *Vicia sativa* subsp. *nigra*, *Bromus carinatus*, *Chlorogalum pomeridianum*, *Dichelostemma ida-maia*, *Festuca idahoensis*, *Geranium dissectum*, *Hypochaeris glabra*, *Triteleia hyacinthina*, *Triteleia laxa*, *Cirsium vulgare*, *Lotus unifoliolatus* var. *unifoliolatus*, *Viola* sp., *Festuca* sp., *Anthoxanthum aristatum*, *Trifolium repens*, *Avena barbata*, *Festuca californica*, *Brodiaea elegans* subsp. *elegans*, *Cerastium* sp., *Chlorogalum* sp., *Elymus glaucus*, *Fragaria vesca*, *Galium aparine*, *Galium divaricatum*, *Galium parisiense*, *Geranium molle*, *Geranium* sp., *Juncus* sp., *Lathyrus nevadensis* subsp. *nevadensis*, *Lathyrus* sp., *Lathyrus vestitus*, *Lilium columbianum*, *Lomatium* sp., *Lupinus rivularis*, *Phalaris* sp., *Prunella vulgaris*, *Stellaria media*, *Trifolium microdon*, *Trifolium* sp., *Triphysaria pusilla*, *Veronica* sp., *Agoseris* sp., *Briza minor*, *Calochortus* sp., *Cirsium* sp., *Epilobium brachycarpum*, *Galium* sp., *Iris* sp., *Lotus* sp., *Rumex crispus*, *Sisyrinchium bellum*, *Sonchus asper*, *Taeniatherum caput-medusae*, and *Trifolium albopurpureum* (all herbs).

***Holcus lanatus*-*Anthoxanthum odoratum* association**

LOCAL TYPE CONCEPT:

Grasslands of inland areas with *Holcus lanatus* (velvetgrass) dominant or co-dominant in the herbaceous stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW059 (258), REDW075 (275), REDW114 (D96_062002), REDW297 (A167), REDW320 (A189)

VEGETATION:

The herbaceous stratum cover is dominated by some mix of the grass species *Holcus lanatus* (velvetgrass), *Dactylis glomerata* (orchard grass), and/or *Anthoxanthum odoratum* (sweet vernalgrass). *Bromus carinatus* (California brome) and *Poa pratensis* (Kentucky bluegrass) are fairly constant low cover grass species. The most constant forb species are *Cirsium vulgare* (bull thistle), *Marah oreganus* (coast man-root), *Achillea millefolium* (yarrow), *Plantago lanceolata* (English plantain), *Polystichum munitum* (western sword fern), and *Rumex acetosella* (sheep sorrel). *Rubus ursinus* (Pacific blackberry) forms a constant low cover low shrub stratum.

ENVIRONMENT:

Plots assigned to this vegetation occurred along coastal bluffs from just south of the Klamath River north to just south of Crescent City. All plots were within 0.6 mile (1 km) of the Pacific Ocean. The vegetation is likely more widely distributed in RNSP, but limited to the coastal area. Geologic substrates of four sites were mapped as the Crescent City mélange unit of the Franciscan complex; substrate of one site was the Battery Formation. Slopes were from near level to 40%, aspects were generally west to southwest, and elevations ranged from 30 to 720 feet (9 to 222 meters) above sea level. The landform positions were primarily middle to upper slopes of coastal bluffs, with one site on foredunes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate Grassland & Shrubland (2.B.2)

USNVC Division: Western North American Grassland & Shrubland (2.B.2.Na)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: Southern Vancouverian Lowland Ruderal Grassland & Shrubland (G648)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Holcus lanatus*-*Anthoxanthum odoratum*
Mixed Grassland

MCV Alliance: *Holcus lanatus*-*Anthoxanthum odoratum* Semi-natural Herbaceous Stands (Sawyer et al. 2009)

MCV Association: *Rubus ursinus*/*Anthoxanthum odoratum* (Solomeshch)

Table B32. Synthesis table for most constant vascular plant taxa recorded in *Holcus lanatus*-*Anthoxanthum odoratum* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	100%	13.8	7-20
<i>Frangula purshiana</i>	Shrub	60%	1.2	0-3
<i>Rosa</i> sp.	Shrub	40%	0.2	0-few
<i>Rubus parviflorus</i>	Shrub	20%	1.0	0-5
<i>Rosa californica</i>	Shrub	20%	0.6	0-3
<i>Rubus armeniacus</i>	Shrub	20%	0.6	0-3
<i>Holcus lanatus</i>	Herb	100%	36.0	15-60
<i>Dactylis glomerata</i>	Herb	100%	22.0	5-45
<i>Cirsium vulgare</i>	Herb	100%	0.5	few
<i>Anthoxanthum odoratum</i>	Herb	80%	7.7	0-30
<i>Marah oreganus</i>	Herb	80%	4.3	0-20
<i>Bromus carinatus</i>	Herb	80%	4.2	0-10
<i>Achillea millefolium</i>	Herb	80%	1.9	0-3
<i>Plantago lanceolata</i>	Herb	80%	1.7	0-5
<i>Poa pratensis</i>	Herb	80%	1.1	0-4
<i>Polystichum munitum</i>	Herb	80%	0.9	0-3
<i>Rumex acetosella</i>	Herb	80%	0.8	0-3
<i>Heracleum lanatum</i>	Herb	60%	2.8	0-5
<i>Pteridium aquilinum</i>	Herb	60%	2.2	0-4
<i>Festuca arundinacea</i>	Herb	60%	1.8	0-8
<i>Elymus glaucus</i>	Herb	60%	1.5	0-4
<i>Galium aparine</i>	Herb	60%	0.8	0-3
<i>Agrostis</i> sp.	Herb	60%	0.3	0-few
<i>Lupinus</i> sp.	Herb	60%	0.3	0-few
<i>Stachys ajugoides</i>	Herb	40%	1.2	0-3
<i>Epilobium</i> sp.	Herb	40%	0.7	0-3
<i>Leucanthemum vulgare</i>	Herb	40%	0.7	0-3
<i>Stellaria</i> sp.	Herb	40%	0.7	0-3
<i>Angelica hendersonii</i>	Herb	40%	0.2	0-few
<i>Carex</i> sp.	Herb	40%	0.2	0-few
<i>Daucus carota</i>	Herb	40%	0.2	0-few
<i>Erechtites minima</i>	Herb	40%	0.2	0-few
<i>Raphanus sativus</i>	Herb	40%	0.2	0-few
<i>Symphotrichum chilense</i>	Herb	40%	0.2	0-few
<i>Poa</i> sp.	Herb	20%	2.0	0-10
<i>Raphanus raphanistrum</i>	Herb	20%	2.0	0-10
<i>Ranunculus repens</i>	Herb	20%	1.0	0-5
<i>Urtica dioica</i>	Herb	20%	1.0	0-5
<i>Equisetum telmateia</i>	Herb	20%	0.6	0-3
<i>Lolium</i> sp.	Herb	20%	0.6	0-3

Species recorded in plots at 20% constancy and less than 0.2% mean cover include *Baccharis pilularis* (shrub), *Aira caryophyllaea*, *Athyrium filix-femina*, *Digitalis purpurea*, *Epilobium ciliatum*, *Fragaria chiloensis*, *Hypochaeris radicata*, *Iris douglasiana*, *Lupinus rivularis*, *Oxalis* sp., *Rumex crispus*, *Rumex obtusifolius*, *Sanicula crassicaulis*, *Sonchus asper*, *Sonchus oleraceus*, *Taraxacum officinale*, *Trifolium dubium*, *Trifolium repens*, *Vicia sativa* subsp. *nigra*, *Geranium dissectum*, and *Torilis arvensis* (all herbs).

***Dudleya farinosa-Erigeron glaucus* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation in the vicinity of the ocean coast with *Dudleya farinosa* (bluff lettuce) dominant or co-dominant, evidently occurring in small patches.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW159 (A18), REDW292 (A162), REDW326 (A88), REDW327 (A89), REDW328 (A90), REDW329 (A91), REDW330 (A92), REDW331 (A93), REDW332 (A94), REDW333 (A95), REDW334 (A96), REDW335 (A99)

VEGETATION:

The herbaceous stratum cover is dominated by *Dudleya farinosa* (bluff lettuce), which is present typically at 5-25% cover. Other relatively constant, usually low cover, taxa are *Lupinus* sp. (lupine), *Aira praecox* (yellow hairgrass), *Sonchus oleraceus* (common sowthistle), *Vulpia bromoides* (brome fescue), *Poa* sp. (bluegrass), *Achillea millefolium* (yarrow), *Galium aparine* (cleavers), *Bromus carinatus* (California brome), *Daucus pusillus* (rattlesnake weed), and *Erigeron glaucus* (seaside daisy).

ENVIRONMENT:

Plots assigned to this vegetation were recorded from coastal bluffs from the Gyon Coastal Bluff north to the mouth of the Klamath River, and the vegetation is probably frequent on cliffs and rocky slopes along the Pacific Ocean throughout RNSP. All plots were observed within 0.25 mile (0.32 km) of the Pacific Ocean. Geologic substrates were mapped as the Crescent City mélange unit or the Redwood Creek schist (both of the Franciscan complex). Slopes were 45% to 80%, aspects were generally west (northwest to southwest), and elevations ranged from 30 to 120 feet (9 to 37 meters) above sea level. The landform positions were described as slopes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: Pacific Coastal Cliff & Bluff Vegetation (M058)

USNVC Group: North Pacific Coastal Scrub & Herb Cliff & Bluff (G554)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Herbaceous (in part)

MCV Alliance: None recognized by Sawyer et al. (2009)

MCV Association: *Dudleya farinosa* - *Erigeron glaucus* (Solomeshch)

Table B33. Synthesis table for most constant vascular plant taxa recorded in *Dudleya farinosa*-*Erigeron glaucus* association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Baccharis pilularis</i>	Shrub	58%	1.1	0-4
<i>Eriophyllum stoechadifolium</i>	Shrub	42%	0.7	0-4
<i>Gaultheria shallon</i>	Shrub	8%	0.0	0-few
<i>Dudleya farinosa</i>	Herb	100%	12.8	4-26
<i>Lupinus</i> sp.	Herb	92%	2.5	0-5
<i>Aira praecox</i>	Herb	92%	2.3	0-5
<i>Sonchus oleraceus</i>	Herb	92%	0.7	0-3
<i>Vulpia bromoides</i>	Herb	83%	3.6	0-10
<i>Poa</i> sp.	Herb	83%	2.3	0-5
<i>Achillea millefolium</i>	Herb	83%	2.0	0-4
<i>Galium aparine</i>	Herb	75%	0.4	0-few
<i>Bromus carinatus</i>	Herb	67%	1.0	0-4
<i>Daucus pusillus</i>	Herb	67%	0.5	0-3
<i>Erigeron glaucus</i>	Herb	67%	0.3	0-few
<i>Anagallis arvensis</i>	Herb	58%	1.4	0-4
<i>Fragaria chiloensis</i>	Herb	58%	0.9	0-3
<i>Plantago maritima</i>	Herb	58%	0.9	0-3
<i>Madia sativa</i>	Herb	58%	0.7	0-3
<i>Leymus</i> sp.	Herb	50%	0.7	0-3
<i>Polypodium</i> sp.	Herb	50%	0.3	0-0.5
<i>Hypochaeris radicata</i>	Herb	50%	0.2	0-few
<i>Carpobrotus chilensis</i>	Herb	42%	0.8	0-5
<i>Parapholis incurva</i>	Herb	42%	0.6	0-3
<i>Pseudognaphalium stramineum</i>	Herb	42%	0.2	0-few
<i>Cerastium arvense</i>	Herb	25%	0.4	0-4
<i>Plantago elongata</i>	Herb	25%	0.1	0-few
<i>Sagina maxima</i> subsp. <i>crassicaulis</i>	Herb	25%	0.1	0-few
<i>Plantago lanceolata</i>	Herb	17%	0.8	0-10
<i>Angelica hendersonii</i>	Herb	17%	0.3	0-4
<i>Alopecurus</i> sp.	Herb	17%	0.3	0-3
<i>Bromus hordeaceus</i>	Herb	17%	0.1	0-few
<i>Plantago subnuda</i>	Herb	17%	0.1	0-few
<i>Trifolium</i> sp.	Herb	17%	0.1	0-few
<i>Crassula</i> sp.	Herb	17%	0.1	0-few
<i>Vulpia myuros</i>	Herb	8%	1.3	0-15
<i>Bromus diandrus</i>	Herb	8%	0.8	0-10
<i>Sedum</i> sp.	Herb	8%	0.8	0-10
<i>Cynosurus echinatus</i>	Herb	8%	0.3	0-4
<i>Aira caryophyllea</i>	Herb	8%	0.3	0-3
<i>Madia</i> sp.	Herb	8%	0.3	0-3

Species recorded in plots at 8% constancy and less than 0.1% mean cover include *Gaultheria shallon* (shrub), *Bromus* sp., *Castilleja* sp., *Elymus* sp., *Equisetum telmateia*, *Festuca rubra*, *Gamochaeta ustulata*, *Lotus micranthus*, *Pentagramma triangularis*, *Polystichum imbricans*, *Pteridium aquilinum*, *Rumex crispus*, *Sonchus asper*, *Sonchus* sp., and *Sagina* sp., (all herbs).

***Sedum spathulifolium*-*Tellima grandiflora* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation in small patches in rocky settings in the vicinity of the ocean coast with *Sedum* spp. (stonecrop) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW290 (A160)

VEGETATION:

Sedum sp. (stonecrop) is the most abundant species in the herbaceous stratum of the single plot. The next highest cover species are *Aira praecox* (yellow hairgrass), *Dactylis glomerata* (orchard grass), *Festuca rubra* (red fescue), *Rubus ursinus* (Pacific blackberry), and *Tellima grandiflora* (fringe cups).

ENVIRONMENT:

The single plot assigned to this vegetation was recorded from a rock on the Pacific Ocean beach just south from the mouth of the Klamath River. The vegetation is likely to be more widespread in RNSP on cliffs and rocky slopes along the Pacific Ocean. The nearest mapped bedrock unit to the site (likely source of the substrate) is the Crescent City mélange unit of the Franciscan complex. The slope was recorded as 85%, and the elevation is less than 40 feet (12 meters) above sea level.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: Pacific Coastal Cliff & Bluff Vegetation (M058)

USNVC Group: North Pacific Coastal Scrub & Herb Cliff & Bluff (G554)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Herbaceous (in part)

MCV Alliance: *Sedum spathulifolium* Provisional Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Sedum spathulifolium*-*Tellima grandiflora* (Solomeshch)

Table B34. Synthesis table for all vascular plant taxa recorded in *Sedum spathulifolium*-*Tellima grandiflora* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	100%	3.0	3
<i>Sedum</i> sp.	Herb	100%	12.0	12
<i>Aira praecox</i>	Herb	100%	3.0	3
<i>Dactylis glomerata</i>	Herb	100%	3.0	3
<i>Festuca rubra</i>	Herb	100%	3.0	3
<i>Tellima grandiflora</i>	Herb	100%	3.0	3
<i>Briza maxima</i>	Herb	100%	0.5	few
<i>Cardamine oligosperma</i>	Herb	100%	0.5	few
<i>Cerastium arvense</i>	Herb	100%	0.5	few
<i>Galium aparine</i>	Herb	100%	0.5	few
<i>Pentagramma triangularis</i>	Herb	100%	0.5	few
<i>Polypodium scolieri</i>	Herb	100%	0.5	few
<i>Sonchus oleraceus</i>	Herb	100%	0.5	few
<i>Vulpia bromoides</i>	Herb	100%	0.5	few

Dune Herbaceous Vegetation association

LOCAL TYPE CONCEPT:

Herbaceous vegetation of coastal dunes with native forbs dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW137 (A12), REDW138 (A13), REDW142 (B31_070205), REDW143 (A14), REDW144 (A15), REDW343 (A103), REDW345 (A105), REDW347 (A107), REDW348 (A108), REDW349 (A109)

VEGETATION:

The herbaceous stratum cover is comprised of a mixture of relatively small set of species. The most constant are *Glehnia littoralis* (American silvertop), *Cakile maritima* (European sea rocket), *Abronia latifolia* (coastal sand verbena), *Artemisia pycnocephala* (beach wormwood), *Calystegia soldanella* (seashore false bindweed), *Leymus mollis* (American dunegrass), and *Ambrosia chamissonis* (beach bur). A number of species may be strongly dominant or co-dominant locally; these include *Glehnia littoralis*, *Abronia latifolia*, *Calystegia soldanella*, *Leymus mollis*, *Ambrosia chamissonis*, and *Tanacetum camphoratum* (camphor tansy).

This vegetation was described as four different associations by Solomeshch, with some not well replicated by plots. All plots are floristically similar, and, since the four units are treated as a single association by Sawyer et al. (2009) and were mapped similarly as a single unit, their description as a single unit is applied here.

ENVIRONMENT:

Plots that were assigned to this vegetation were recorded from the immediate vicinity of Pacific Ocean beaches at Gyon Bluff and in Prairie Creek Redwoods State Park at the mouth of Fern Canyon. The vegetation may occur elsewhere along the coast in RNSP. It occurs on sand dunes. Geologic substrates of plot sites are mapped as Quaternary beach sands. Slopes were level to slight, and elevation was recorded as 6 to 20 feet (2 to 6 meters) above sea level. The landforms were recorded as dunes.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: Pacific Coastal Beach & Dune Vegetation (M081)

USNVC Group: North Pacific Maritime Coastal Scrub & Herb Beach & Dune (G498)

USNVC Alliance: *Poa macrantha* - *Leymus mollis* - *Festuca rubra* Sand Dune Herbaceous Alliance (A2066)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Dune Herbaceous
 MCV Alliance: *Abronia latifolia*- *Ambrosia chamissonis* Herbaceous Alliance (Sawyer et al. 2009)
 MCV Association: *Abronia latifolia*- *Leymus mollis* (Sawyer et al. 2009); *Tanacetum camphoratum*,
Ambrosia chamissonis, *Calystegia soldanella*-*Glehnia littoralis*, *Abronia latifolia*-*Erigeron glaucus*
 (Solomeshch)

Table B35. Synthesis table for all vascular plant taxa recorded in Dune Herbaceous Vegetation association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Baccharis pilularis</i>	Shrub	10%	0.1	0-few
<i>Eriophyllum stoechadifolium</i>	Shrub	10%	0.1	0-few
<i>Glehnia littoralis</i>	Herb	100%	4.0	few-13
<i>Cakile maritima</i>	Herb	90%	0.9	0-3
<i>Abronia latifolia</i>	Herb	80%	9.0	0-50
<i>Calystegia soldanella</i>	Herb	50%	8.2	0-26
<i>Artemisia pycnocephala</i>	Herb	50%	0.9	0-4
<i>Leymus mollis</i>	Herb	50%	0.5	0-3
<i>Ambrosia chamissonis</i>	Herb	40%	5.1	0-50
<i>Lathyrus littoralis</i>	Herb	30%	1.1	0-10
<i>Ammophila arenaria</i>	Herb	30%	0.1	0-few
<i>Tanacetum camphoratum</i>	Herb	20%	3.1	0-30
<i>Fragaria chiloensis</i>	Herb	20%	0.4	0-3
<i>Polygonum paronychia</i>	Herb	20%	0.1	0-few
<i>Camissonia cheiranthifolia</i> subsp. <i>cheiranthifolia</i>	Herb	10%	0.3	0-3
<i>Agrostis</i> sp.	Herb	10%	0.1	0-few
<i>Anaphalis margaritacea</i>	Herb	10%	0.1	0-few
<i>Angelica hendersonii</i>	Herb	10%	0.1	0-few
<i>Carpobrotus chilensis</i>	Herb	10%	0.1	0-few
<i>Erigeron glaucus</i>	Herb	10%	0.1	0-few
<i>Festuca</i> sp.	Herb	10%	0.1	0-few
<i>Poa macrantha</i>	Herb	10%	0.1	0-few
<i>Rumex salicifolius</i> var. <i>crassus</i>	Herb	10%	0.1	0-few
<i>Symphotrichum chilense</i>	Herb	10%	0.1	0-few
<i>Achillea millefolium</i>	Herb	10%	<0.1	0-trace

***Leymus mollis* association**

LOCAL TYPE CONCEPT:

Grasslands of coastal dunes with *Leymus mollis* (American dunegrass) dominant or co-dominant in the herbaceous stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW344 (A104), REDW346 (A106)

VEGETATION:

The herbaceous stratum cover is dominated by *Leymus mollis* (American dunegrass), which is present typically at 10-25% cover. Other relatively constant, usually low cover, species are *Calystegia soldanella* (seashore false bindweed), *Glehnia littoralis* (American silvertop), *Artemisia pycnocephala* (beach wormwood), and *Cakile maritima* (European sea rocket).

ENVIRONMENT:

The two plots that were assigned to this vegetation were recorded from the immediate vicinity of Pacific Ocean beaches at Gyon Bluff. The vegetation may occur elsewhere along the coast in RNSP. It occurs on sand dunes. Geologic substrates of plot sites are mapped as Quaternary beach sands. Slopes were level to slight, and elevation was recorded as 6 feet (2 meters) above sea level. The landforms were recorded as dunes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: Pacific Coastal Beach & Dune Vegetation (M081)

USNVC Group: North Pacific Maritime Coastal Scrub & Herb Beach & Dune (G498)

USNVC Alliance: *Poa macrantha* - *Leymus mollis* - *Festuca rubra* Sand Dune Herbaceous Alliance (A2066)

USNVC Association: *Leymus mollis* ssp. *mollis* - *Abronia latifolia* Herbaceous Vegetation (CEGL001796)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: *Leymus mollis* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Leymus mollis* (Solomeshch) (= *Leymus mollis*-*Abronia latifolia*-(*Cakile* sp.) (Sawyer et al. 2009))

Table B36. Synthesis table for all vascular plant taxa recorded in *Leymus mollis* association at Redwood National and State Parks (# plots=2).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Leymus mollis</i>	Herb	100%	18.0	10-26
<i>Calystegia soldanella</i>	Herb	100%	10.3	few-20
<i>Glehnia littoralis</i>	Herb	100%	1.8	few-3
<i>Artemisia pycnocephala</i>	Herb	100%	0.5	few
<i>Cakile maritima</i>	Herb	100%	0.5	few
<i>Abronia latifolia</i>	Herb	50%	1.5	0-3
<i>Lathyrus littoralis</i>	Herb	50%	0.3	0-few
<i>Tanacetum camphoratum</i>	Herb	50%	0.3	0-few

***Ammophila arenaria* association**

LOCAL TYPE CONCEPT:

Grasslands of coastal dunes with *Ammophila arenaria* (European beachgrass) dominant or co-dominant in the herbaceous stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW131 (B57_070101), REDW132 (A10_070103), REDW133 (B56_070104), REDW139 (B62_070203)

VEGETATION:

The herbaceous stratum cover is dominated by *Ammophila arenaria* (European beachgrass), which is present typically at 20-40% cover. The most constant low cover species are *Lupinus littoralis* (seashore lupine), *Hypochaeris radicata* (rough cat's-ear), *Aira caryophyllea* (silver hairgrass), *Fragaria chiloensis* (beach strawberry), *Camissonia cheiranthifolia* subsp. *cheiranthifolia* (beach suncup), *Gamochaeta ustulata* (purple cudweed), *Plantago lanceolata* (English plantain), *Vulpia bromoides* (brome fescue), *Anthoxanthum odoratum* (sweet vernalgrass), *Trifolium wormskioldii* (cows clover), and *Calystegia soldanella* (seashore false bindweed).

ENVIRONMENT:

Plots that were assigned to this vegetation were recorded from the immediate vicinity of Pacific Ocean beaches in Prairie Creek Redwoods State Park from Gold Bluffs to the mouth of Fern Canyon. The vegetation may occur elsewhere along the coast in RNSP. It occurs on stabilized sand dunes in areas in which the non-native grass *Ammophila arenaria* may have been planted or to which it may have spread. Geologic substrates of plot sites are mapped as Quaternary beach sands. Slopes were level to slight, and elevations ranged from 3 to 10 feet (1 to 3 meters) above sea level. The landforms were recorded as dunes.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: North Pacific Maritime Coastal Ruderal Shrub & Grass Dune (G647)

USNVC Alliance: *Ammophila arenaria* Coastal Dunegrass Ruderal Grassland Alliance (A2061)

USNVC Association: *Ammophila arenaria* Ruderal Herbaceous Vegetation (CEGL003006)

GENERALIZED ALLIANCE MAP CLASS (this project): *Ammophila arenaria* Grassland

MCV Alliance: *Ammophila arenaria* Semi-natural Herbaceous Stands (Sawyer et al. 2009)

MCV Association: *Ammophila arenaria* (Solomeshch, Sawyer et al. 2009)

Table B37. Synthesis table for most constant vascular plant taxa recorded in *Ammophila arenaria* association at Redwood National and State Parks (# plots=4).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Picea sitchensis</i>	Tree	50%	0.3	0-few
<i>Baccharis pilularis</i>	Shrub	50%	2.6	0-10
<i>Myrica californica</i>	Shrub	50%	0.3	0-few
<i>Ammophila arenaria</i>	Herb	100%	28.8	20-40
<i>Lupinus littoralis</i>	Herb	100%	12.5	4-40
<i>Hypochaeris radicata</i>	Herb	100%	2.4	few-3
<i>Aira caryophyllea</i>	Herb	100%	2.3	few-5
<i>Fragaria chiloensis</i>	Herb	100%	2.0	few-4
<i>Rumex acetosella</i>	Herb	100%	1.8	few-3
<i>Camissonia cheiranthifolia</i> subsp. <i>cheiranthifolia</i>	Herb	100%	1.1	few-3
<i>Gamochaeta ustulata</i>	Herb	100%	1.1	few-3
<i>Plantago lanceolata</i>	Herb	100%	0.5	few
<i>Vulpia bromoides</i>	Herb	75%	1.6	0-3
<i>Anthoxanthum odoratum</i>	Herb	75%	1.4	0-5
<i>Trifolium wormskioldii</i>	Herb	75%	0.9	0-3
<i>Calystegia soldanella</i>	Herb	75%	0.4	0-few
<i>Holcus lanatus</i>	Herb	50%	2.5	0-10
<i>Lotus corniculatus</i>	Herb	50%	1.5	0-3
<i>Lotus micranthus</i>	Herb	50%	1.5	0-3
<i>Cerastium glomeratum</i>	Herb	50%	0.8	0-3
<i>Lolium perenne</i>	Herb	50%	0.8	0-3
<i>Agrostis</i> sp.	Herb	50%	0.3	0-few
<i>Cardionema ramosissimum</i>	Herb	50%	0.3	0-few
<i>Glehnia littoralis</i>	Herb	50%	0.3	0-few
<i>Polygonum paronychia</i>	Herb	50%	0.3	0-few
<i>Senecio</i> sp.	Herb	50%	0.3	0-few
<i>Trifolium dubium</i>	Herb	50%	0.3	0-few
<i>Abronia latifolia</i>	Herb	50%	0.2	0-few
<i>Gnaphalium</i> sp.	Herb	50%	0.2	0-few
<i>Hypericum perforatum</i>	Herb	50%	0.2	0-few
<i>Leymus mollis</i>	Herb	50%	0.2	0-few
<i>Vulpia myuros</i>	Herb	50%	0.2	0-few
<i>Cynosurus echinatus</i>	Herb	25%	1.3	0-5
<i>Bromus hordeaceus</i>	Herb	25%	1.0	0-4
<i>Achillea millefolium</i>	Herb	25%	0.8	0-3
<i>Bromus carinatus</i>	Herb	25%	0.8	0-3
<i>Bromus diandrus</i>	Herb	25%	0.8	0-3
<i>Poa pratensis</i>	Herb	25%	0.8	0-3

Species recorded in plots at 25% constancy and less than 0.2% mean cover include *Alnus rubra* (tree), *Gaultheria shallon*, *Holodiscus discolor* (shrubs), *Ambrosia chamissonis*, *Anaphalis margaritacea*, *Cakile maritima*, *Chenopodium ambrosioides*, *Chenopodium* sp., *Daucus pusillus*, *Erigeron* sp., *Galium aparine*, *Luzula comosa*, *Mentha pulegium*, *Rubus ursinus*, *Sanicula crassicaulis*, *Sherardia arvensis*, *Sonchus oleraceus*, *Stellaria media*, *Trifolium arvense*, *Vaccinium ovatum*, *Vicia sativa* subsp. *nigra*, *Castilleja* sp., *Geranium molle*, *Linum bienne*, *Rumex crispus*, *Silene gallica*, and *Veronica* sp. (all herbs).

***Cakile maritima* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of coastal dunes and beaches with *Cakile maritima* (European sea rocket) dominant or co-dominant in the herbaceous stratum.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW064 (264), REDW065 (265), REDW066 (266), REDW067 (267), REDW068 (268), REDW072 (272), REDW073 (273), REDW074 (274), REDW135 (B61_070201), REDW136 (A11)

VEGETATION:

The herbaceous stratum cover is low (usually from less than 1% to 15%), and has relatively low species richness. *Cakile maritima* (European sea rocket) is the most constant species and usually is the species with highest cover. The next most constant species include *Abronia latifolia* (coastal sand verberna), *Leymus mollis* (American dunegrass), and *Ambrosia chamissonis* (beach bur).

ENVIRONMENT:

The ten plots that were assigned to this vegetation were recorded from two sites in the immediate vicinity of Pacific Ocean beaches, including just south of Crescent City and at the mouth of Fern Canyon in Prairie Creek Redwoods State Park. The vegetation is likely to occur throughout RNSP along the ocean in suitable habitat: sandy beaches and low sand dunes. Geologic substrates of plot sites are mapped as Quaternary beach sands. Slopes were level to slight, and the recorded elevation range was from 3 to 20 feet (1 to 6 meters) above sea level. The landform positions were dunes or foredunes.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Temperate & Boreal Grassland & Shrubland (2.B)

USNVC Formation: Temperate to Polar Scrub & Herb Coastal Vegetation (2.B.4)

USNVC Division: Pacific North American Coast Scrub & Herb Vegetation (2.B.4.Nb)

USNVC Macrogroup: North Pacific Coastal Ruderal Grassland & Shrubland (M511)

USNVC Group: North Pacific Maritime Coastal Ruderal Shrub & Grass Dune (G647)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Dune Herbaceous

MCV Alliance: *Cakile (edentula, maritima)* Semi-natural Herbaceous Stands (Sawyer et al. 2009)

MCV Association: *Cakile maritima* (Solomeshch)

Table B38. Synthesis table for all vascular plant taxa recorded in *Cakile maritima* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Salix hookeriana</i>	Shrub	10%	<0.1	0-trace
<i>Salix</i> sp.	Shrub	10%	<0.1	0-trace
<i>Cakile maritima</i>	Herb	100%	7.1	4-15
<i>Abronia latifolia</i>	Herb	60%	0.1	0-few
<i>Leymus mollis</i>	Herb	40%	0.2	0-few
<i>Ambrosia chamissonis</i>	Herb	40%	0.1	0-few
<i>Chenopodium ambrosioides</i>	Herb	30%	0.4	0-3
<i>Abronia umbellata</i>	Herb	30%	0.1	0-few
<i>Rumex salicifolius</i>	Herb	30%	0.0	0-trace
<i>Ammophila arenaria</i>	Herb	20%	0.5	0-4
<i>Hypochaeris radicata</i>	Herb	20%	0.5	0-4
<i>Cakile edentula</i>	Herb	20%	0.1	0-few
<i>Camissonia cheiranthifolia</i> subsp. <i>cheiranthifolia</i>	Herb	20%	0.1	0-few
<i>Argentina anserina</i>	Herb	20%	0.1	0-few
<i>Plantago lanceolata</i>	Herb	20%	0.1	0-few
<i>Agrostis</i> sp.	Herb	10%	0.1	0-few
<i>Atriplex</i> sp.	Herb	10%	0.1	0-few
<i>Fragaria chiloensis</i>	Herb	10%	0.1	0-few
<i>Mentha pulegium</i>	Herb	10%	0.1	0-few
<i>Rumex acetosella</i>	Herb	10%	0.1	0-few
<i>Glehnia littoralis</i>	Herb	10%	<0.1	0-trace
<i>Juncus breweri</i>	Herb	10%	<0.1	0-trace
<i>Lathyrus</i> sp.	Herb	10%	<0.1	0-trace
<i>Melilotus</i> sp.	Herb	10%	<0.1	0-trace
<i>Polygonum</i> sp.	Herb	10%	<0.1	0-trace
<i>Scirpus</i> sp.	Herb	10%	<0.1	0-trace
<i>Trifolium wormskioldii</i>	Herb	10%	<0.1	0-trace

***Heterotheca oregona*-*Saponaria officinalis* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation (occasionally with a sparse shrub layer) of rocky riparian bars with *Heterotheca oregona* (Oregon goldenaster) present in significant amounts and usually dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW001 (201), REDW007 (208), REDW008 (209), REDW009 (210), REDW011 (212), REDW013 (214), REDW014 (215), REDW016 (217), REDW043 (243), REDW122 (A4), REDW123 (A5), REDW124 (A6), REDW125 (A7), REDW126 (A8), REDW127 (A9), REDW128 (A10)

VEGETATION:

A wide variety of mostly weedy native and alien herbaceous species are present, with most species occurring at low cover. *Heterotheca oregona* (Oregon goldenaster) is the most constant and, often, the highest cover species, and is fairly diagnostic of this vegetation. The next most constant species include *Festuca arundinacea* (= *Schedonorus arundinaceus*) (tall fescue), *Melilotus alba* (sweetclover), *Saponaria officinalis* (bouncing bet), *Lupinus rivularis* (riverbank lupine), *Plantago lanceolata* (English plantain), *Festuca idahoensis* (Idaho fescue), *Lotus unifoliolatus* var. *unifoliolatus* (American bird's foot trefoil), and *Elymus glaucus* subsp. *jepsonii* (Jepson's blue wildrye). A shrub stratum, mostly comprised of *Salix* spp. (willows) usually is present, but is typically at low cover. Other frequent, but usually scattered, shrubs include *Cytisus scoparius* (Scotch broom), *Genista monspessulana* (French broom), and *Physocarpus capitatus* (Pacific ninebark). Overall plant cover typically is 5-30%. Species richness is relatively high. Compared to the *Hirschfeldia incana*-*Chenopodium botrys* association, the ratio of perennial species to biennial and annual species is higher.

ENVIRONMENT:

All plots assigned to this vegetation are from along the Smith River in Jedediah Smith State Park. The vegetation is evidently frequent along cobbly seasonally flooded riparian bars along that stream. Geologic substrates are mapped as channel deposits. Elevations ranged from 80 to 120 feet (25 to 37 meters) above sea level. The landform positions are described as river bar. This vegetation co-occurs with the *Salix* Shrubland, but evidently occupies less protected sites on bars (e.g., nearer the channel center).

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Wet Shrubland (G322)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Heterotheca oregona* Herbaceous

MCV Alliance: None recognized by Sawyer et al. (2009)

MCV Association: *Heterotheca oregona*-*Saponaria officinalis* (Solomeshch)

Table B39. Synthesis table for most constant vascular plant taxa recorded in *Heterotheca oregona*-*Saponaria officinalis* association at Redwood National and State Parks (# plots=16).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	50%	0.4	0-3
<i>Pseudotsuga menziesii</i>	Tree	25%	0.1	0-few
<i>Salix</i> sp.	Shrub	81%	6.8	0-98
<i>Cytisus scoparius</i>	Shrub	81%	0.3	0-few
<i>Genista monspessulana</i>	Shrub	63%	0.3	0-few
<i>Physocarpus capitatus</i>	Shrub	56%	0.4	0-3
<i>Baccharis pilularis</i>	Shrub	44%	0.2	0-few
<i>Rubus armeniacus</i>	Shrub	31%	0.3	0-3
<i>Heterotheca oregona</i>	Herb	100%	8.9	trace-25
<i>Festuca arundinacea</i>	Herb	94%	1.5	0-4
<i>Melilotus alba</i>	Herb	88%	2.2	0-7
<i>Saponaria officinalis</i>	Herb	88%	0.9	0-4
<i>Lupinus rivularis</i>	Herb	81%	2.7	0-12
<i>Plantago lanceolata</i>	Herb	81%	0.9	0-3
<i>Festuca idahoensis</i>	Herb	69%	2.0	0-7
<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	Herb	63%	0.6	0-3
<i>Elymus glaucus</i> subsp. <i>jepsonii</i>	Herb	63%	0.5	0-3
<i>Danthonia californica</i>	Herb	44%	0.4	0-3
<i>Hypericum perforatum</i>	Herb	44%	0.3	0-3
<i>Aira caryophylla</i>	Herb	44%	0.2	0-few
<i>Bromus diandrus</i>	Herb	38%	0.5	0-3
<i>Trifolium willdenowii</i>	Herb	38%	0.3	0-3
<i>Bromus hordeaceus</i>	Herb	38%	0.3	0-3
<i>Cynosurus echinatus</i>	Herb	38%	0.2	0-few
<i>Bromus carinatus</i>	Herb	31%	0.3	0-3
<i>Anthoxanthum odoratum</i>	Herb	31%	0.3	0-3
<i>Silene gallica</i>	Herb	31%	0.2	0-few
<i>Rumex acetosella</i>	Herb	31%	0.2	0-few
<i>Agrostis</i> sp.	Herb	31%	0.1	0-few
<i>Briza maxima</i>	Herb	25%	0.3	0-3
<i>Achillea millefolium</i>	Herb	25%	0.3	0-3
<i>Avena barbata</i>	Herb	25%	0.1	0-few
<i>Vulpia bromoides</i>	Herb	25%	0.1	0-few
<i>Daucus carota</i>	Herb	25%	0.1	0-few
<i>Cortaderia jubata</i>	Herb	25%	0.1	0-few

Species recorded in plots at <20% constancy (all less than 0.4% mean cover) include *Malus sylvestris*, *Umbellularia californica*, *Chamaecyparis lawsoniana*, *Acer macrophyllum*, *Populus balsamifera* subsp. *trichocarpa*, *Fraxinus latifolia* (all trees), *Holodiscus discolor*, *Amelanchier alnifolia*, *Toxicodendron diversilobum* (all shrubs), *Trifolium microcephalum*, *Anaphalis margaritacea*, *Prunella vulgaris*, *Dactylis glomerata*, *Chenopodium* sp., *Rumex obtusifolius*, *Claytonia* sp., *Vulpia myuros*, *Sanguisorba minor* subsp. *muricata*, *Lotus micranthus*, *Hypochaeris radicata*, *Eriogonum* sp., *Eriogonum nudum*, *Epilobium* sp., *Silene californica*, *Rumex salicifolius* var. *salicifolius*, *Madia* sp., *Cynosurus cristatus*, *Bromus sterilis*, *Zigadenus* sp., *Petrorhagia dubia*, *Lupinus* sp., *Lupinus bicolor*, *Erigeron* sp., *Sanguisorba officinalis*, *Polygonum* sp., *Melilotus indica*, *Lolium perenne*, *Leucanthemum vulgare*, *Lathyrus latifolius*, *Koeleria macrantha*, *Hirschfeldia incana*, *Gilia capitata*, *Eschscholzia californica*, *Erigeron foliosus* var. *hartwegii*, *Elymus* sp., *Cyperus* sp., *Brassica nigra*, *Ageratina occidentalis*, *Phacelia* sp., *Mimulus* sp., *Medicago lupulina*, *Juncus bufonius*, *Holcus lanatus*, *Eriophyllum lanatum*, *Deschampsia elongata*, and *Bromus rubens* (all herbs).

***Salix lasiolepis*-*Salix lucida* association**

LOCAL TYPE CONCEPT:

Shrublands of riparian bars with *Salix* spp. (willows) dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW002 (202), REDW003 (204), REDW004 (205), REDW005 (206), REDW010 (211), REDW012 (213), REDW015 (216), REDW040 (240), REDW041 (241), REDW042 (242)

VEGETATION:

The composition of this vegetation is very similar to that of the *Heterotheca oregona* Herbaceous Vegetation and might be characterized as a more shrub-dominated version of that vegetation. *Salix* sp. (willows) dominate a shrub layer that ranges from 10 to 85% cover. Other shrub species are inconstant and at very low cover, when present. The herbaceous stratum cover is low (typically 0-20%, and is comprised of a wide variety of mostly weedy native and alien herbaceous species. is the most constant and often, the highest cover species, and its presence is somewhat diagnostic of this vegetation. The next most constant species include *Saponaria officinalis* (bouncing bet), *Festuca arundinacea* (= *Schedonorus arundinaceus*) (tall fescue), *Melilotus alba* (sweetclover), *Heterotheca oregona* (Oregon goldenaster), and *Elymus glaucus* subsp. *jepsonii* (Jepson's blue wildrye).

ENVIRONMENT:

All plots assigned to this vegetation are from along the Smith River in Jedediah Smith State Park. The vegetation is evidently frequent along cobbly seasonally flooded riparian bars along that stream. Geologic substrates are mapped as channel deposits. Elevations ranged from 80 to 160 feet (25 to 49 meters) above sea level. The landform positions are described as river bar. This vegetation co-occurs with the *Heterotheca oregona* Herbaceous Vegetation, but evidently occupies more protected sites on bars.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Wet Shrubland (G322)

USNVC Alliance: *Salix hookeriana* - *Salix sitchensis* - *Spiraea douglasii* Flooded Shrubland Alliance (A3835)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Salix* Shrubland

MCV Alliance: *Salix lasiolepis* Shrubland Alliance (Sawyer et al. 2009)

MCV Association: *Salix lasiolepis*-*Salix lucida* (Solomeshch, Sawyer et al. (2009))

Table B40. Synthesis table for all vascular plant taxa recorded in *Salix lasiolepis*-*Salix lucida* association at Redwood National and State Parks (# plots=10).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	40%	1.0	0-3
<i>Fraxinus latifolia</i>	Tree	20%	0.1	0-few
<i>Acer macrophyllum</i>	Tree	20%	0.1	0-few
<i>Salix</i> sp.	Shrub	100%	65.4	5-85
<i>Genista monspessulana</i>	Shrub	30%	0.2	0-few
<i>Rubus armeniacus</i>	Shrub	30%	0.2	0-few
<i>Physocarpus capitatus</i>	Shrub	20%	0.4	0-3
<i>Lonicera involucrata</i>	Shrub	20%	0.1	0-few
<i>Baccharis pilularis</i>	Shrub	10%	0.1	0-few
<i>Rosa</i> sp.	Shrub	10%	0.1	0-few
<i>Rubus parviflorus</i> var. <i>parviflorus</i>	Shrub	10%	0.1	0-few
<i>Rubus ursinus</i>	Shrub	10%	0.1	0-few
<i>Toxicodendron diversilobum</i>	Shrub	10%	0.1	0-few
<i>Saponaria officinalis</i>	Herb	80%	1.4	0-3
<i>Festuca arundinacea</i>	Herb	70%	0.5	0-3
<i>Melilotus alba</i>	Herb	70%	0.3	0-few
<i>Heterotheca oregona</i>	Herb	60%	0.7	0-4
<i>Elymus glaucus</i> subsp. <i>jepsonii</i>	Herb	60%	0.2	0-few
<i>Carex</i> sp.	Herb	40%	0.2	0-few
<i>Festuca idahoensis</i>	Herb	30%	0.2	0-few
<i>Lupinus rivularis</i>	Herb	30%	0.2	0-few
<i>Plantago lanceolata</i>	Herb	30%	0.2	0-few
<i>Epipactis gigantea</i>	Herb	30%	0.1	0-few
<i>Hypericum perforatum</i>	Herb	30%	0.1	0-few
<i>Phalaris arundinacea</i>	Herb	30%	0.1	0-few
<i>Agrostis</i> sp.	Herb	30%	0.1	0-few
<i>Ageratina occidentalis</i>	Herb	20%	0.1	0-few
<i>Lathyrus latifolius</i>	Herb	20%	0.1	0-few
<i>Lotus unifoliolatus</i> var. <i>unifoliolatus</i>	Herb	20%	<0.1	0-trace
<i>Agrostis stolonifera</i>	Herb	10%	0.1	0-few
<i>Anaphalis margaritacea</i>	Herb	10%	0.1	0-few
<i>Aquilegia formosa</i>	Herb	10%	0.1	0-few
<i>Calamagrostis</i> sp.	Herb	10%	0.1	0-few
<i>Elymus</i> sp.	Herb	10%	0.1	0-few
<i>Equisetum arvense</i>	Herb	10%	0.1	0-few
<i>Helenium bigelovii</i>	Herb	10%	0.1	0-few
<i>Juncus</i> sp.	Herb	10%	0.1	0-few
<i>Petasites frigidus</i>	Herb	10%	0.1	0-few
<i>Rumex salicifolius</i>	Herb	10%	0.1	0-few
<i>Sanguisorba minor</i> subsp. <i>muricata</i>	Herb	10%	0.1	0-few
<i>Trisetum</i> sp.	Herb	10%	0.1	0-few
<i>Bromus diandrus</i>	Herb	10%	<0.1	0-trace
<i>Bromus orcuttianus</i>	Herb	10%	<0.1	0-trace
<i>Dactylis glomerata</i>	Herb	10%	<0.1	0-trace
<i>Equisetum</i> sp.	Herb	10%	<0.1	0-trace
<i>Mimulus cardinalis</i>	Herb	10%	<0.1	0-trace

***Carex obnupta* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Carex obnupta* (slough sedge) dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW024 (231), REDW071 (271), REDW140 (B33_070204), REDW141 (B64_070205), REDW196 (A43), REDW201 (A48), REDW251 (A114), REDW253 (A115), REDW255 (A117), REDW282 (A152), REDW312 (A181), REDW316 (A185)

VEGETATION:

Carex obnupta (slough sedge) is strongly dominant in all plots. *Oenanthe sarmentosa* (Pacific water parsley) often occurs, usually at low cover, and is the only moderately constant species. A variety of other species, mostly strongly hydrophytic, are present at low cover.

ENVIRONMENT:

Plots assigned to this vegetation occurred throughout RNSP, and the vegetation is probably a widespread small patch wetland type in seasonally flooded wetlands, including swales and other depressions and along pond edges. The geologic substrate at the sites is mapped as Josephine ophiolite, the Battery Formation, alluvium, and beach sand. Elevations ranged from 3 to 2,080 feet (1 to 640 meters) above sea level. The landform positions were described as pond, swale, depression, wetland edge, river terrace, and ocean terrace.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Freshwater Wet Meadow & Marsh (G517)

USNVC Alliance: *Carex obnupta* Herbaceous Alliance (A3832)

USNVC Association: *Carex obnupta* Herbaceous Vegetation (CEGL003313)

GENERALIZED ALLIANCE MAP CLASS (this project): *Carex obnupta* Grassland

MCV Alliance: *Carex obnupta* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Carex obnupta* (Solomeshch,Sawyer et al. (2009))

Table B41. Synthesis table for all vascular plant taxa recorded in *Carex obnupta* association at Redwood National and State Parks (# plots=12).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	8%	0.3	0-3
<i>Salix</i> sp.	Shrub	8%	0.0	0-few
<i>Carex obnupta</i>	Herb	100%	88.0	70-99
<i>Oenanthe sarmentosa</i>	Herb	67%	2.6	0-15
<i>Phalaris arundinacea</i>	Herb	25%	2.2	0-25
<i>Lysichiton americanus</i>	Herb	25%	1.8	0-20
<i>Athyrium filix-femina</i>	Herb	25%	0.1	0-few
<i>Glyceria occidentalis</i>	Herb	25%	0.1	0-few
<i>Argentina anserina</i>	Herb	25%	0.1	0-few
<i>Nuphar lutea</i> subsp. <i>polysepala</i>	Herb	17%	1.9	0-20
<i>Agrostis stolonifera</i>	Herb	17%	0.1	0-few
<i>Callitriche</i> sp.	Herb	17%	0.1	0-few
<i>Ranunculus repens</i>	Herb	17%	0.1	0-few
<i>Veronica americana</i>	Herb	17%	0.1	0-few
<i>Eleocharis palustris</i>	Herb	17%	0.1	0-few
<i>Scirpus microcarpus</i>	Herb	17%	0.1	0-few
<i>Comarum palustre</i>	Herb	8%	0.3	0-3
<i>Juncus</i> sp.	Herb	8%	0.3	0-3
<i>Cardamine</i> sp.	Herb	8%	<0.1	0-few
<i>Carex</i> sp.	Herb	8%	<0.1	0-few
<i>Carex vesicaria</i> var. <i>vesicaria</i>	Herb	8%	<0.1	0-few
<i>Epilobium</i> sp.	Herb	8%	<0.1	0-few
<i>Equisetum arvense</i>	Herb	8%	<0.1	0-few
<i>Galium</i> sp.	Herb	8%	<0.1	0-few
<i>Glyceria</i> sp.	Herb	8%	<0.1	0-few
<i>Holcus lanatus</i>	Herb	8%	<0.1	0-few
<i>Lathyrus</i> sp.	Herb	8%	<0.1	0-few
<i>Mentha</i> sp.	Herb	8%	<0.1	0-few
<i>Polystichum munitum</i>	Herb	8%	<0.1	0-few
<i>Rorippa</i> sp.	Herb	8%	<0.1	0-few
<i>Veronica</i> sp.	Herb	8%	<0.1	0-few
<i>Deschampsia cespitosa</i>	Herb	8%	<0.1	0-trace
<i>Lotus corniculatus</i>	Herb	8%	<0.1	0-trace
<i>Mimulus guttatus</i>	Herb	8%	<0.1	0-trace
<i>Vicia</i> sp.	Herb	8%	<0.1	0-trace

***Carex obnupta-Deschampsia cespitosa* association**

LOCAL TYPE CONCEPT:

Grasslands dominated by mesic upland grass species and with *Carex obnupta* (slough sedge) and other wetland species also present in significant amounts to co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW152 (B27_071111)

VEGETATION:

In the single plot, *Anthoxanthum odoratum* (sweet vernalgrass), *Carex obnupta* (slough sedge), and *Ranunculus repens* (creeping buttercup) co-dominate. Other species present at significant cover include *Rubus ursinus* (Pacific blackberry), *Lotus corniculatus* (bird's foot trefoil), *Plantago lanceolata* (English plantain), *Pteridium aquilinum* (brackenfern), and *Deschampsia cespitosa* (tufted hairgrass) occur at low cover. This type appears to have relatively high species richness, with a mix of upland and wetland species present.

ENVIRONMENT:

The single plot assigned to this vegetation is from along Elk Prairie. The vegetation may occur elsewhere in RNSP in seasonally flooded wetlands, including swales and other depressions. The geologic substrate was mapped as Quaternary terrace. The elevation was approximately 150 feet (46 meters) above sea level. The landform position was described as river terraces.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Freshwater Wet Meadow & Marsh (G517)

USNVC Alliance: *Carex obnupta* Herbaceous Alliance (A3832)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Carex obnupta-Deschampsia cespitosa*
Grassland

MCV Alliance: *Deschampsia cespitosa* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Carex obnupta-Deschampsia cespitosa* (Solomeshch) (= *Deschampsia cespitosa*-*Anthoxanthum odoratum* (Sawyer et al. 2009))

Table B42. Synthesis table for all vascular plant taxa recorded in *Carex obnupta-Deschampsia cespitosa* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Rubus ursinus</i>	Shrub	100%	15.0	5-25
<i>Rosa</i> sp.	Shrub	100%	4.0	1-5
<i>Rubus armeniacus</i>	Shrub	100%	0.5	few
<i>Rosa gymnocarpa</i>	Shrub	100%	0.5	few
<i>Symphoricarpos</i> sp.	Shrub	100%	0.5	few
<i>Anthoxanthum odoratum</i>	Herb	100%	30.0	25-50
<i>Ranunculus repens</i>	Herb	100%	30.0	25-50
<i>Carex obnupta</i>	Herb	100%	30.0	25-50
<i>Lotus corniculatus</i>	Herb	100%	10.0	5-25
<i>Plantago lanceolata</i>	Herb	100%	5.0	1-10
<i>Pteridium aquilinum</i>	Herb	100%	5.0	1-10
<i>Carex</i> sp.	Herb	100%	5.0	1-10
<i>Deschampsia cespitosa</i>	Herb	100%	5.0	1-10
<i>Agrostis</i> sp.	Herb	100%	4.0	1-5
<i>Holcus lanatus</i>	Herb	100%	4.0	1-5
<i>Juncus</i> sp.	Herb	100%	3.0	1-5
<i>Rumex salicifolius</i>	Herb	100%	3.0	1-5
<i>Hypochaeris radicata</i>	Herb	100%	0.5	few
<i>Prunella vulgaris</i>	Herb	100%	0.5	few
<i>Rumex acetosella</i>	Herb	100%	0.5	few
<i>Dactylis glomerata</i>	Herb	100%	0.5	few
<i>Taraxacum officinale</i>	Herb	100%	0.5	few
<i>Poa</i> sp.	Herb	100%	0.5	few
<i>Lolium perenne</i>	Herb	100%	0.5	few
<i>Veronica</i> sp.	Herb	100%	0.5	few
<i>Brodiaea</i> sp.	Herb	100%	0.5	few
<i>Cirsium vulgare</i>	Herb	100%	0.5	few
<i>Galium</i> sp.	Herb	100%	0.5	few
<i>Iris douglasiana</i>	Herb	100%	0.5	few
<i>Luzula comosa</i>	Herb	100%	0.5	few
<i>Mentha pulegium</i>	Herb	100%	0.5	few
<i>Epilobium</i> sp.	Herb	100%	0.5	few
<i>Hordeum brachyantherum</i>	Herb	100%	0.5	few
<i>Oenanthe sarmentosa</i>	Herb	100%	0.5	few
<i>Sisyrinchium bellum</i>	Herb	100%	0.5	few
<i>Solidago</i> sp.	Herb	100%	0.5	few
<i>Stachys arvensis</i>	Herb	100%	0.5	few
<i>Stellaria</i> sp.	Herb	100%	0.5	few
<i>Triteleia hyacinthina</i>	Herb	100%	0.5	few
<i>Rumex obtusifolius</i>	Herb	100%	0.1	trace
<i>Botrychium multifidum</i>	Herb	100%	0.1	trace

***Carex vesicaria*-*Deschampsia caespitosa* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Carex vesicaria* (blister sedge) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW023 (230), REDW197 (A44), REDW198 (A45), REDW199 (A46), REDW200 (A47)

VEGETATION:

Carex vesicaria var. *vesicaria* (blister sedge) is dominant in all plots. *Deschampsia cespitosa* (tufted hairgrass) is constant and sometimes co-dominant. Other species (usually strongly hydrophytic) were inconstant, and species richness appears to be low.

ENVIRONMENT:

The five plots assigned to this vegetation are from the Little Bald Hills, one along the Little Bald Hills trail and one at Bummer Lake in the Mill Creek acquisition area. The vegetation may occur elsewhere at RNSP in seasonally flooded wetlands, including swales and other depressions. The geologic substrate at the sites is mapped as Josephine ophiolite. Elevations range from 1,000 to 2,080 feet (308 to 640 meters) above sea level. The landform position for one plot was described as the central part of a wetland.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Freshwater Wet Meadow & Marsh (G517)

USNVC Alliance: *Danthonia californica* - *Carex lenticularis* - *Deschampsia caespitosa* Coastal & Lowland Herbaceous Alliance (A3820)

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: *Carex (utriculata, vesicaria)* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Carex vesicaria*-*Deschampsia caespitosa* (Solomeshch)

Table B43. Synthesis table for all vascular plant taxa recorded in *Carex vesicaria-Deschampsia cespitosa* association at Redwood National and State Parks (# plots=5).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Carex vesicaria</i> var. <i>vesicaria</i>	Herb	100%	36.0	10-65
<i>Deschampsia cespitosa</i>	Herb	100%	16.9	few-30
<i>Agrostis</i> sp.	Herb	20%	0.6	0-3
<i>Carex obnupta</i>	Herb	20%	0.1	0-few
<i>Juncus xiphioides</i>	Herb	20%	0.1	0-few
<i>Schoenoplectus subterminalis</i>	Herb	20%	0.1	0-few

***Glyceria occidentalis* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Glyceria occidentalis* (western mannagrass) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW250 (A112), REDW258 (A121), REDW259 (A122)

VEGETATION:

At the single site, *Glyceria occidentalis* (western mannagrass) is dominant. *Holcus lanatus* (velvetgrass), *Oenanthe sarmentosa* (Pacific water parsley), *Agrostis stolonifera* (creeping bentgrass), *Scirpus microcarpus* (panicled bulrush), *Ranunculus repens* (creeping buttercup), and *Veronica americana* (American speedwell) also are present at significant cover. A variety of other species, mostly strongly hydrophytic, are present at low cover.

ENVIRONMENT:

The three plots assigned to this vegetation are from a single site along lower Redwood Creek. The vegetation may occur elsewhere in RNSP in seasonally flooded wetlands. The geologic substrate was mapped as alluvium. Elevations ranged from 26 to 40 feet (8 to 12 meters) above sea level. The landform position was described as river terraces.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Vancouverian Lowland Wet Shrubland, Wet Meadow & Marsh (M073)

USNVC Group: Vancouverian Freshwater Wet Meadow & Marsh (G517)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: *Glyceria occidentalis* Provisional Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Glyceria occidentalis* (Solomeshch)

Table B44. Synthesis table for all vascular plant taxa recorded in *Glyceria occidentalis* association at Redwood National and State Parks (# plots=3).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	33%	<0.1	0-trace
<i>Glyceria occidentalis</i>	Herb	100%	58.3	55-60
<i>Holcus lanatus</i>	Herb	100%	23.3	20-30
<i>Oenanthe sarmentosa</i>	Herb	100%	12.7	3-20
<i>Agrostis stolonifera</i>	Herb	100%	10.0	5-15
<i>Scirpus microcarpus</i>	Herb	100%	7.0	4-10
<i>Ranunculus repens</i>	Herb	100%	5.3	3-10
<i>Veronica americana</i>	Herb	100%	1.3	1-3
<i>Juncus</i> sp.	Herb	67%	2.5	0-7
<i>Epilobium</i> sp.	Herb	67%	0.3	0-few
<i>Galium</i> sp.	Herb	67%	0.3	0-few
<i>Lysichiton americanus</i>	Herb	33%	1.0	0-3
<i>Alopecurus aequalis</i>	Herb	33%	0.2	0-few
<i>Anthoxanthum odoratum</i>	Herb	33%	0.2	0-few
<i>Argentina anserina</i>	Herb	33%	0.2	0-few
<i>Senecio</i> sp.	Herb	33%	0.2	0-few
<i>Bidens cernua</i>	Herb	33%	<0.1	0-trace
<i>Cirsium</i> sp.	Herb	33%	<0.1	0-trace

***Hirschfeldia incana*-*Chenopodium botrys* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation dominated by alien forbs on riparian bars of Redwood Creek and other streams.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW046 (246), REDW047 (247), REDW048 (248), REDW350 (A135), REDW351 (A136), REDW352 (A138), REDW353 (A141), REDW354 (A142)

VEGETATION:

A wide variety of mostly weedy and alien herbaceous species are present, with most species occurring at low cover. The most constant taxa are *Melilotus alba* (sweetclover), *Hirschfeldia incana* (shortpod mustard), *Chenopodium ambrosioides* (Mexican tea), *Chenopodium botrys* (Jerusalem oak goosefoot), *Plantago lanceolata* (English plantain), *Cyperus eragrostis* (panicled bulrush), *Hypochaeris radicata* (rough cat's-ear), *Collomia heterophylla* (variableleaf collomia), *Holcus lanatus* (velvetgrass), *Rumex acetosella* (sheep sorrel), *Epilobium* sp. (willowherb), *Daucus carota* (Queen Anne's lace), *Leucanthemum vulgare* (oxeye daisy), *Festuca arundinacea* (= *Schedonorus arundinaceus*) (tall fescue), *Mentha pulegium* (pennyroyal), *Cirsium vulgare* (bull thistle), *Lapsana communis* (common nipplewort), *Anagallis arvensis* (scarlet pimpernel), and *Polygonum arenastrum* (oval-leaf knotweed). *Alnus rubra* (red alder) and *Salix* spp. (willows) may be present at low cover as scattered shrubs or occasional trees. Overall plant cover typically is 5-30%. Species richness is relatively high. Compared to the *Heterotheca oregona*-*Saponaria officinalis* association, the ratio of biennial and annual species to perennial species is higher.

ENVIRONMENT:

All plots assigned to this vegetation are from along Redwood Creek. The vegetation is evidently frequent along seasonally flooded riparian bars along that creek and possibly others within RNSP. Geologic substrates are mapped as alluvium or channel deposits. Elevations ranged from 40 to 120 feet (12 to 37 meters) above sea level. The landform positions are described as river bar or creek bar.

TRANSLATION ("CROSSWALK") TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Western North American Ruderal Wet Shrubland, Meadow & Marsh (M301)

USNVC Group: Western North American Ruderal Wet Shrubland, Meadow & Marsh (G524)

USNVC Alliance: None recognized

USNVC Association: None recognized

GENERALIZED ALLIANCE MAP CLASS (this project): *Hirschfeldia incana* Herbaceous

MCV Alliance: None recognized by Sawyer et al. (2009)

MCV Association: *Hirschfeldia incana*-*Chenopodium botrys* (Solomeshch)

Table B45. Synthesis table for most constant vascular plant taxa recorded in *Hirschfeldia incana*-*Chenopodium botrys* association at Redwood National and State Parks (# plots=8).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Alnus rubra</i>	Tree	75%	0.4	0-few
<i>Salix</i> sp.	Shrub	75%	0.4	0-1
<i>Melilotus alba</i>	Herb	100%	10.1	3-25
<i>Hirschfeldia incana</i>	Herb	100%	5.8	few-15
<i>Chenopodium ambrosioides</i>	Herb	100%	2.4	few-6
<i>Chenopodium botrys</i>	Herb	100%	2.0	few-4
<i>Plantago lanceolata</i>	Herb	100%	0.5	few
<i>Cyperus eragrostis</i>	Herb	88%	0.4	0-few
<i>Hypochaeris radicata</i>	Herb	88%	0.4	0-few
<i>Collomia heterophylla</i>	Herb	88%	0.4	0-few
<i>Holcus lanatus</i>	Herb	88%	0.4	0-few
<i>Rumex acetosella</i>	Herb	88%	0.4	0-few
<i>Epilobium</i> sp.	Herb	88%	0.3	0-few
<i>Daucus carota</i>	Herb	75%	0.4	0-few
<i>Leucanthemum vulgare</i>	Herb	75%	0.4	0-few
<i>Festuca arundinacea</i>	Herb	75%	0.4	0-few
<i>Mentha pulegium</i>	Herb	75%	0.4	0-few
<i>Cirsium vulgare</i>	Herb	75%	0.3	0-few
<i>Lapsana communis</i>	Herb	75%	0.3	0-few
<i>Anagallis arvensis</i>	Herb	75%	0.3	0-few
<i>Polygonum arenastrum</i>	Herb	75%	0.3	0-few
<i>Agrostis stolonifera</i>	Herb	63%	0.6	0-3
<i>Rumex crispus</i>	Herb	63%	0.3	0-few
<i>Rumex obtusifolius</i>	Herb	63%	0.3	0-few
<i>Solanum americanum</i>	Herb	63%	0.3	0-few
<i>Cichorium intybus</i>	Herb	63%	0.3	0-few
<i>Dactylis glomerata</i>	Herb	63%	0.3	0-few
<i>Erechtites minima</i>	Herb	63%	0.3	0-few
<i>Prunella vulgaris</i>	Herb	63%	0.3	0-few
<i>Lythrum hyssopifolia</i>	Herb	63%	0.2	0-few
<i>Rorippa</i> sp.	Herb	63%	0.2	0-few
<i>Elymus glaucus</i> subsp. <i>jepsonii</i>	Herb	50%	0.3	0-1
<i>Spergularia</i> sp.	Herb	50%	0.3	0-few
<i>Stachys ajugoides</i>	Herb	50%	0.3	0-few

Species recorded in plots at $\leq 50\%$ constancy and less than 0.3% mean cover) include *Rubus armeniacus*, *Rubus ursinus*, *Baccharis pilularis*, *Genista monspessulana*, *Rosa* sp. (all shrubs), *Conyza canadensis*, *Deschampsia elongata*, *Gnaphalium* sp., *Hypericum perforatum*, *Lotus corniculatus*, *Medicago lupulina*, *Polygonum hydropiperoides*, *Sonchus asper*, *Juncus bufonius*, *Kickxia elatine*, *Agrostis* sp., *Equisetum arvense*, *Artemisia douglasiana*, *Cardamine oligosperma*, *Cerastium glomeratum*, *Lupinus* sp., *Mimulus* sp., *Polypogon* sp., *Senecio vulgaris*, *Anthemis cotula*, *Dipsacus fullonum*, *Madia exigua*, *Silene* sp., *Taraxacum officinale*, *Carex* sp., *Cerastium arvense*, *Cynosurus echinatus*, *Juncus* sp., *Lactuca saligna*, *Veronica americana*, *Barbarea orthoceras*, *Lolium perenne* subsp. *multiflorum*, *Lotus* sp., *Mimulus guttatus*, *Sonchus arvensis*, *Sonchus oleraceus*, *Aralia californica*, *Pseudognaphalium canescens* subsp. *canescens*, *Trifolium microcephalum*, *Agrostis gigantea*, *Anaphalis margaritacea*, *Anthoxanthum odoratum*, *Briza minor*, *Cardamine* sp., *Chamaesyce glyptosperma*, *Cortaderia jubata*, *Crepis* sp., *Echinochloa crus-galli*, *Euchiton japonicus*, *Galium* sp., *Glyceria striata*, *Lotus micranthus*, *Lotus unifoliolatus* var. *unifoliolatus*, *Navarretia squarrosa*, *Phalaris minor*, *Poa pratensis*, *Polypogon monspeliensis*, *Rumex salicifolius*, *Sagina* sp., *Trifolium repens*, *Trisetum* sp., *Achillea millefolium*, *Anethum graveolens*, *Chamaesyce prostrata*, *Erodium cicutarium*, *Gastridium ventricosum*, *Hierochloa occidentalis*, *Hypochaeris glabra*, *Linum bienne*, *Phacelia* sp., *Plantago major*, *Polygonum persicaria*, *Sonchus* sp., *Stellaria media*, *Trifolium fucatum*, *Trifolium* sp., *Urtica dioica*, *Vicia sativa* subsp. *nigra*, and *Vulpia bromoides* (all herbs).

***Phalaris arundinacea* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Phalaris arundinacea* (reed canarygrass) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW315 (A184)

VEGETATION:

At the single site, *Phalaris arundinacea* (reed canarygrass) is dominant. *Carex obnupta* (slough sedge) is present at moderately high cover. *Nuphar lutea* **subsp. *polysepala*** (yellow pond-lily), *Typha latifolia* (broadleaf cattail), and *Salix* sp. (willow) occur at low cover. Species richness typically is low.

ENVIRONMENT:

The single plot assigned to this vegetation was at the Lagoon Pond (north of the Klamath River). The vegetation probably occurs throughout RNSP in wet meadows or swales that are temporarily to seasonally flooded. The geologic substrate was mapped as alluvium. The elevation is about 30 feet (9 meters) above sea level.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Western North American Ruderal Wet Shrubland, Meadow & Marsh (M301)

USNVC Group: Western North American Ruderal Wet Shrubland, Meadow & Marsh (G524)

USNVC Alliance: *Phalaris arundinacea* Native & Semi-native Herbaceous Alliance (A3846)

USNVC Association: *Phalaris arundinacea* Western Herbaceous Vegetation (CEGL001474)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: None recognized by Sawyer et al. (2009)

MCV Association: *Phalaris arundinacea* (Solomeshch)

Table B46. Synthesis table for all vascular plant taxa recorded in *Phalaris arundinacea* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Salix</i> sp.	Shrub	100%	0.5	few
<i>Phalaris arundinacea</i>	Herb	100%	80.0	80
<i>Carex obnupta</i>	Herb	100%	25.0	25
<i>Nuphar lutea</i> subsp. <i>polysepala</i>	Herb	100%	3.0	3
<i>Typha latifolia</i>	Herb	100%	0.5	few

***Scirpus microcarpus* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Scirpus microcarpus* (panicled bulrush) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW069 (269), REDW254 (A116), REDW256 (A119), REDW257 (A120)

VEGETATION:

At both sites, *Scirpus microcarpus* (panicled bulrush) is dominant. *Ranunculus repens* (creeping buttercup), *Oenanthe sarmentosa* (Pacific water parsley), and *Holcus lanatus* (velvetgrass) are present at low to moderately high cover. A variety of other species, mostly strongly hydrophytic, are present at low cover.

ENVIRONMENT:

The four plots assigned to this vegetation are from two sites: just south of Crescent City and along lower Redwood Creek. The vegetation probably occurs throughout RNSP in seasonally flooded wetlands. Geologic substrates were mapped as alluvium and the Battery Formation. Elevations ranged from 3 to 40 feet (1 to 12 meters) above sea level. The landform positions were described as ocean terrace and river terrace.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Arid West Interior Freshwater Emergent Marsh (M888)

USNVC Group: Arid West Interior Freshwater Emergent Marsh (G531)

USNVC Alliance: *Schoenoplectus americanus* - *Schoenoplectus acutus* - *Scirpus microcarpus* Herbaceous Emergent Alliance (A3895)

USNVC Association: *Scirpus microcarpus* Herbaceous Vegetation (CEGL003322)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Grassland (in part)

MCV Alliance: *Scirpus microcarpus* Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Scirpus microcarpus* (Solomeshch, Sawyer et al. (2009))

Table B47. Synthesis table for all vascular plant taxa recorded in *Scirpus microcarpus* association at Redwood National and State Parks (# plots=4).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Scirpus microcarpus</i>	Herb	100%	76.3	65-95
<i>Ranunculus repens</i>	Herb	100%	17.3	4-30
<i>Oenanthe sarmentosa</i>	Herb	100%	5.8	3-10
<i>Holcus lanatus</i>	Herb	100%	5.6	few-15
<i>Agrostis stolonifera</i>	Herb	75%	11.3	0-15
<i>Glyceria occidentalis</i>	Herb	75%	5.1	0-10
<i>Juncus</i> sp.	Herb	75%	4.6	0-15
<i>Rumex conglomeratus</i>	Herb	75%	0.4	0-18
<i>Veronica americana</i>	Herb	50%	0.3	0-few
<i>Alopecurus aequalis</i>	Herb	25%	0.1	0-few
<i>Argentina anserina</i>	Herb	25%	0.1	0-few
<i>Athyrium filix-femina</i>	Herb	25%	0.1	0-few
<i>Caltha</i> sp.	Herb	25%	0.1	0-few
<i>Galium</i> sp.	Herb	25%	0.1	0-few
<i>Lotus corniculatus</i>	Herb	25%	0.1	0-few
<i>Mentha pulegium</i>	Herb	25%	0.1	0-few
<i>Rumex</i> sp.	Herb	25%	0.1	0-few

***Typha latifolia* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands with *Typha latifolia* (broadleaf cattail) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW070 (270), REDW260 (A123), REDW322 (A113)

VEGETATION:

At both sites, *Typha latifolia* (broadleaf cattail) is dominant, and *Oenanthe sarmentosa* (Pacific water parsley) is also present at significant cover. A variety of other species, mostly strongly hydrophytic, are present at low cover.

ENVIRONMENT:

The three plots assigned to this vegetation are from two sites: just south of Crescent City and along lower Redwood Creek. The vegetation probably occurs throughout RNSP in shallow seasonally flooded to semipermanently flooded fresh to brackish waters that are still or have normally sluggish flow. Geologic substrates were mapped as alluvium and the Battery Formation. Elevations ranged from 3 to 40 feet (1 to 12 meters) above sea level. The landform positions were described as ocean terrace and river terrace.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Grassland & Shrubland (2)

USNVC Subclass: Shrub & Herb Wetland (2.C)

USNVC Formation: Temperate to Polar Freshwater Marsh, Wet Meadow & Shrubland (2.C.4)

USNVC Division: Western North American Freshwater Shrubland, Wet Meadow & Marsh (2.C.4.Nb)

USNVC Macrogroup: Arid West Interior Freshwater Emergent Marsh (M888)

USNVC Group: Arid West Interior Freshwater Emergent Marsh (G531)

USNVC Alliance: *Typha domingensis* - *Typha latifolia* - *Typha angustifolia* Western Herbaceous Emergent Alliance (A3896)

USNVC Association *Typha* (*latifolia*, *angustifolia*) Western Herbaceous Vegetation (CEGL002010)

GENERALIZED ALLIANCE MAP CLASS (this project): *Typha latifolia* Herbaceous

MCV Alliance: *Typha* (*angustifolia*, *domingensis*, *latifolia*) Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Typha latifolia* (Solomeshch, Sawyer et al. (2009))

Table B48. Synthesis table for all vascular plant taxa recorded in *Typha latifolia* association at Redwood National and State Parks (# plots=3).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Typha latifolia</i>	Herb	100%	68.3	55-80
<i>Oenanthе sarmentosa</i>	Herb	100%	16.3	3-26
<i>Glyceria occidentalis</i>	Herb	67%	4.3	0-10
<i>Agrostis stolonifera</i>	Herb	67%	3.5	0-10
<i>Holcus lanatus</i>	Herb	67%	2.7	0-5
<i>Scirpus microcarpus</i>	Herb	67%	2.7	0-5
<i>Ranunculus repens</i>	Herb	67%	2.5	0-7
<i>Juncus</i> sp.	Herb	67%	2.2	0-6
<i>Veronica americana</i>	Herb	67%	1.5	0-4
<i>Galium</i> sp.	Herb	67%	0.3	0-few
<i>Sparganium</i> sp.	Herb	33%	8.3	0-25
<i>Eleocharis palustris</i>	Herb	33%	1.7	0-5
<i>Carex obnupta</i>	Herb	33%	1.3	0-4
<i>Glyceria</i> sp.	Herb	33%	1.3	0-4
<i>Mimulus</i> sp.	Herb	33%	1.0	0-3
<i>Agrostis</i> sp.	Herb	33%	0.2	0-few
<i>Argentina anserina</i>	Herb	33%	0.2	0-few
<i>Equisetum arvense</i>	Herb	33%	0.2	0-few
<i>Lysichiton americanus</i>	Herb	33%	0.2	0-few
<i>Polygonum hydropiperoides</i>	Herb	33%	0.2	0-few
<i>Anthoxanthum odoratum</i>	Herb	33%	<0.1	0-trace
<i>Senecio</i> sp.	Herb	33%	<0.1	0-trace

***Nuphar lutea* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands and shallow water with *Nuphar lutea* subsp. *polysepala* (yellow pond-lily) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW314 (A183)

VEGETATION:

At the single site, *Nuphar lutea* subsp. *polysepala* (yellow pond-lily) is dominant. *Potamogeton natans* (floating pondweed) also is present. Species richness typically is low.

ENVIRONMENT:

The single plot assigned to this vegetation was at the Lagoon Pond (north of the Klamath River). The vegetation probably occurs throughout RNSP in shallow semipermanently to permanently flooded fresh waters that are still or have normally sluggish flow. The geologic substrates was mapped as alluvium. The elevation is about 30 feet (9 meters) above sea level.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Aquatic Vegetation (5)

USNVC Subclass: Freshwater Aquatic Vegetation (5.B)

USNVC Formation: Temperate & Boreal Freshwater Aquatic Vegetation (5.B.2)

USNVC Division: North American Freshwater Aquatic Vegetation (5.B.2.Na)

USNVC Macrogroup: Western North American Freshwater Aquatic Vegetation (M109)

USNVC Group: Western North American Temperate Freshwater Aquatic Bed (G544)

USNVC Alliance: *Nuphar polysepala* Western Aquatic Herbaceous Alliance (A3926)

USNVC Association: *Nuphar polysepala* Herbaceous Vegetation (CEGL002001)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Aquatic Herbaceous (in part)

MCV Alliance: *Nuphar lutea* Provisional Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Nuphar lutea* (Solomeshch)

Table B49. Synthesis table for all vascular plant taxa recorded in *Nuphar lutea* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Nuphar lutea</i> subsp. <i>polysepala</i>	Herb	50%	55.0	55
<i>Potamogeton natans</i>	Herb	50%	15.0	15

***Potamogeton natans* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of shallow water with *Potamogeton natans* (floating pondweed) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW217 (A63)

VEGETATION:

At the single site, *Potamogeton natans* (floating pondweed) is present at 95% cover, with no associated species.

ENVIRONMENT:

The single plot assigned to this vegetation was in a pond near the Gold Beach kiosk. The vegetation probably occurs throughout RNSP in shallow, permanently flooded fresh waters that are still or have normally sluggish flow. The geologic substrate was mapped as alluvium. Elevation was recorded as 3 feet (1 meter) above sea level.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Aquatic Vegetation (5)

USNVC Subclass: Freshwater Aquatic Vegetation (5.B)

USNVC Formation: Temperate & Boreal Freshwater Aquatic Vegetation (5.B.2)

USNVC Division: North American Freshwater Aquatic Vegetation (5.B.2.Na)

USNVC Macrogroup: Western North American Freshwater Aquatic Vegetation (M109)

USNVC Group: Western North American Temperate Freshwater Aquatic Bed (G544)

USNVC Alliance: *Potamogeton natans* - *Polygonum amphibium* Floating Aquatic Alliance (A3927)

USNVC Association: *Potamogeton natans* Herbaceous Vegetation (CEGL002925)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Aquatic Herbaceous (in part)

MCV Alliance: *Stuckenia (pectinata)*-*Potamogeton* spp. Provisional Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Potamogeton natans* (Solomeshch)

Table B50. Synthesis table for all vascular plant taxa recorded in *Potamogeton natans* association at Redwood National and State Parks (# plots=1).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Potamogeton natans</i>	Herb	100%	95.0	95

***Scirpus subterminalis* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands and shallow water with *Scirpus subterminalis* (= *Schoenoplectus subterminalis*) (swaying bulrush) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW202 (A49), REDW203 (A50)

VEGETATION:

At the single site, *Scirpus subterminalis* (= *Schoenoplectus subterminalis*) (swaying bulrush) is dominant. *Nuphar lutea* subsp. *polysepala* (yellow pond-lily) and *Carex vesicaria* var. *vesicaria* (blister sedge) also are present. Species richness appears to be low.

ENVIRONMENT:

The two plots assigned to this vegetation were from a single site at Bummer Lake in the Mill Creek acquisition area. The vegetation may occur elsewhere at RNSP in seasonally flooded to semipermanently flooded shallow fresh waters. The geologic substrate at the site is mapped as Josephine ophiolite. The elevation is 2,080 feet (640 meters) above sea level.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Aquatic Vegetation (5)

USNVC Subclass: Freshwater Aquatic Vegetation (5.B)

USNVC Formation: Temperate & Boreal Freshwater Aquatic Vegetation (5.B.2)

USNVC Division: North American Freshwater Aquatic Vegetation (5.B.2.Na)

USNVC Macrogroup: Western North American Freshwater Aquatic Vegetation (M109)

USNVC Group: Western North American Temperate Freshwater Aquatic Bed (G544)

USNVC Alliance: *Schoenoplectus subterminalis* Aquatic Herbaceous Alliance (A3929)

USNVC Association: *Schoenoplectus subterminalis* Herbaceous Vegetation (CEGL003309)

GENERALIZED ALLIANCE MAP CLASS (this project): Other Aquatic Herbaceous (in part)

MCV Alliance: None recognized by Sawyer et al. (2009)

MCV Association: *Scirpus subterminalis* association (Solomeshch)

Table B51. Synthesis table for all vascular plant taxa recorded in *Schoenoplectus subterminalis* association at Redwood National and State Parks (# plots=2).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Scirpus subterminalis</i>	Herb	100%	60.0	60
<i>Nuphar lutea</i> subsp. <i>polysepala</i>	Herb	100%	17.5	15-20
<i>Carex vesicaria</i> var. <i>vesicaria</i>	Herb	100%	5.0	5

***Sparganium emersum* association**

LOCAL TYPE CONCEPT:

Herbaceous vegetation of wetlands or shallow water with *Sparganium* sp. (bur-reed) dominant or co-dominant.

PLOTS INCLUDED IN CONCEPT, BY NPS-PLOTS CODE (FIELD CODE):

REDW252 (A118), REDW317 (A186)

VEGETATION:

Sparganium **sp.** (bur-reed) is dominant. Other species of aquatic or wetland settings are often present, usually at low cover.

ENVIRONMENT:

The two plots assigned to this vegetation were at the Lagoon Pond (north of the Klamath River) and along lower Redwood Creek. The vegetation probably occurs throughout RNSP in shallow, semipermanently to permanently flooded fresh waters that are still or have normally sluggish flow. Geologic substrates were mapped as alluvium. Elevations ranged from 30 to 40 feet (9 to 12 meters) above sea level. The landform positions were described as lagoon and river terrace.

TRANSLATION (“CROSSWALK”) TO OTHER CLASSIFICATIONS:

USNVC Class: Aquatic Vegetation (5)

USNVC Subclass: Freshwater Aquatic Vegetation (5.B)

USNVC Formation: Temperate & Boreal Freshwater Aquatic Vegetation (5.B.2)

USNVC Division: North American Freshwater Aquatic Vegetation (5.B.2.Na)

USNVC Macrogroup: Western North American Freshwater Aquatic Vegetation (M109)

USNVC Group: Western North American Temperate Freshwater Aquatic Bed (G544)

USNVC Alliance: *Hippuris vulgaris* - *Ruppia* spp. - *Sparganium* spp. Rooted Floating Aquatic Alliance (A3893)

USNVC Association: *Sparganium angustifolium* Herbaceous Vegetation (CEGL001990)

GENERALIZED ALLIANCE MAP CLASS (this project): *Sparganium* (*angustifolium*) Herbaceous

MCV Alliance: *Sparganium* (*angustifolium*) Herbaceous Alliance (Sawyer et al. 2009)

MCV Association: *Sparganium emersum* (Solomeshch)

Table B52. Synthesis table for all vascular plant taxa recorded in *Sparganium emersum* association at Redwood National and State Parks (# plots=2).

SPECIES LATIN NAME	PRIMARY STRATUM	CONSTANCY	MEAN COVER (%)	RANGE COVER (%)
<i>Sparganium angustifolium</i>	Herb	50%	27.5	0-55
<i>Sparganium</i> sp.	Herb	50%	12.5	0-25
<i>Glyceria occidentalis</i>	Herb	50%	7.5	0-15
<i>Potamogeton</i> sp.	Herb	50%	2.5	0-5
<i>Caltha</i> sp.	Herb	50%	0.3	0-few
<i>Eleocharis palustris</i>	Herb	50%	0.3	0-few
<i>Mentha pulegium</i>	Herb	50%	0.3	0-few
<i>Oenanthe sarmentosa</i>	Herb	50%	0.3	0-few

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National Park Service
U.S. Department of the Interior



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