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**Pacific Northwest Region**

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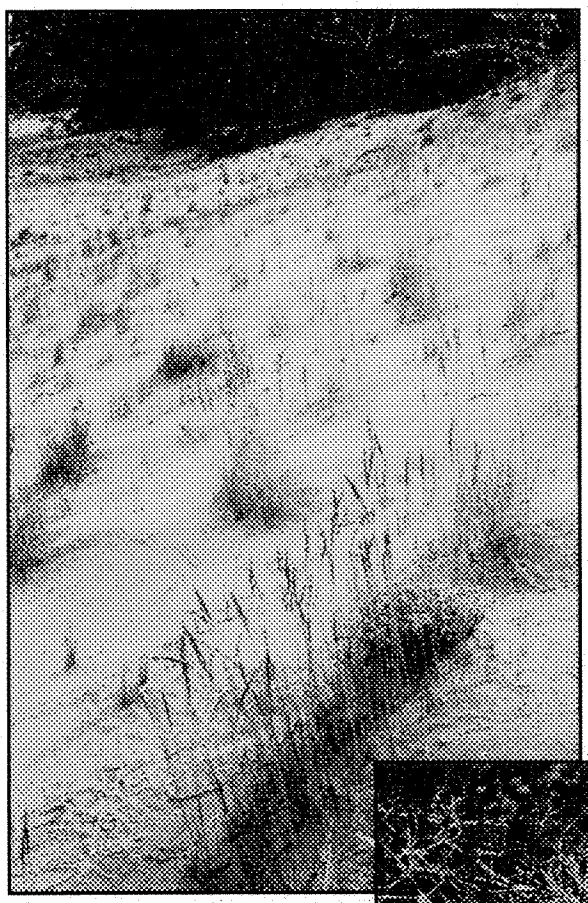
# Plant Associations of the Oregon Dunes National Recreation Area



Red fescue association and shore pine/bearberry association.

# PLANT ASSOCIATIONS OF THE OREGON DUNES NATIONAL RECREATION AREA

## SIUSLAW NATIONAL FOREST, OREGON

Minimal differences in movement of sand can influence vegetation: at right, the seashore bluegrass association on slightly shifting sand at the foot of a dune slip face; at left, the red fescue association on relatively stable sand, slowly being buried by the slip face.

by

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and
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Photographs by John Christy

Cover photos: Shore pine/bearberry association and red fescue association.

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## SUMMARY

This book is a guide to the plant associations of the Oregon Dunes National Recreation Area. It includes general descriptions of the physical and biological setting of the Recreation Area: its climate, geology, landscape, soils, wildlife, and ecological processes. Analysis of quantitative field data identified 52 plant associations occurring in the Recreation Area, and others surely escaped our detection. Vegetation is classified according to the National Vegetation Classification System (Federal Geographic Data Committee 1996; Anderson et al. 1998; Grossman et al. 1998). Ordination of stand data, and delineation of successional pathways indicate that the vegetation is arranged along gradients of moisture, stand structure, soil development, and successional age. Keys identifying each association are followed by descriptions of each association. Descriptions of each association include acronym, ecoclass code (Hall 1998), environment, vegetation and ecology, succession, distribution and history, management issues, and previous studies. Appendices summarize vegetation data, and list vascular plants known or reported from the Recreation Area.

## PREVIOUS WORK

The Oregon Dunes National Recreation Area is well known for its towering dunes, reputedly the largest of their kind in the world, and a seemingly endless expanse of shifting sand. People come from all over the world to see, study, and play in this spectacular landscape. Some people have even tried to farm it.

Many scientists have worked in the Recreation Area, creating a wealth of information which helped in the compilation of this guide. Munger (1910, 1967) conducted the first survey of forest types on the Recreation Area, two years after it was acquired by the Forest Service. House (1914a, 1914b, 1918), Peck (1919) and Cooper (1936) were the first to describe vegetation in and near the Recreation Area. Egler (1934), while assisting Cooper in the field, gathered data and wrote the first account of vegetation ecology in the Recreation Area. Cooper's (1958) monograph of the structural features, history and ecology of the dunes remains the definitive reference for any work on the Recreation Area. Kumler (1963, 1969) was the first to describe the forest associations of the Recreation Area in any detail. Wiedemann (1966, 1984, 1993), Wiedemann et al. (1969), and Wiedemann and Pickart (1996) produced a series of comprehensive overviews of dune ecology in the Recreation Area and elsewhere along the Pacific coast. Leuthner (1969) studied the lichen flora of dunes in the Florence area, including two sites in the Recreation Area at Cleawox Lake and Carter Lake. Pinto et al. (1972) provided descriptions, including useful site-specific information, in a planning document for the newly-created Recreation Area. Lund (1973) wrote a brief description of dune landforms, based on the earlier work of Cooper (1958). Newman (1974, 1983) studied dynamics of deflation plains between Carter Lake and Tahkenitch Creek. Wilde (1982), while working in the Sutton Creek dune sheet just north of the Recreation Area, documented changes caused by the advent of European beachgrass -- processes also occurring within the boundaries of the Recreation Area. Quaye (1982) described several Sitka spruce associations from headlands north of the Recreation Area. Hemstrom and Logan (1986) focused most of their work on forests farther inland, but provided descriptions for some of the forest associations on the Recreation Area. Pilz et al. (1996) and Hosford et al. (1997) are investigating the productivity of commercially-valuable matsutake mushrooms in different habitats on the Recreation Area, and monitoring the response of matsutake to different harvest regimes. McCune et al. (1997) reported several rare lichens from the Recreation Area, collected at Eel Creek and Carter Lake.

## LOCATION

The Recreation Area, a district of the Siuslaw National Forest, is located on the central coast of Oregon. It spans 40 miles of the Coos Bay dune sheet, from Coos Bay in the south to Florence in the north, between approximately 43°30' N and 44°N latitude. The Recreation Area averages about 1.5 miles in width, extending up to 3 miles inland (Fig. 1). It encompasses some 31,500 acres of dunes, forest and wetlands, spanning the western portions of Lane, Douglas and Coos counties. Elevation ranges from sea level to about 600 feet.

## CLIMATE

The climate of the Recreation Area is both maritime and Mediterranean, being influenced by the Pacific Ocean. Temperatures are moderate year-round. Most precipitation occurs in winter months, followed by summer drought (Fig. 2). Mild winter temperatures permit a growing season throughout most of the year (Patching 1987; Haagen 1989). Between October and April, low-pressure weather systems generated in the Gulf of Alaska bring extended and occasionally violent cyclonic storms to the coast. These winter storms bring heavy rains, accounting for 80 percent of the year's total precipitation, and strong south to southwesterly winds. High-pressure atmospheric conditions may develop in winter, producing periods of cold, clear weather and frost. Snow is rare on the Recreation Area, but not uncommon in the adjacent Coast Range above 2,500 feet elevation. By mid-June, a high pressure system with north to northwesterly winds develops off the coast, deflecting storms to the north and maintaining clear skies. Summer precipitation is negligible, and may not occur for weeks at a time. On hot days, marine fogs occur along the immediate coast, causing cool temperatures up to a mile or two inland. The high pressure system breaks down in September, bringing an end to summer drought.

Along this area of the Pacific coast, precipitation increases gradually with increasing latitude, and temperatures become cooler (Cooper 1958; Wiedemann et al. 1969; Loy 1976). However, the moderating maritime influence diminishes abruptly only a few miles inland, and the cooling coastal fogs of summer penetrate the Coast Range only along the larger rivers. Weather stations at North Bend and Canary, the latter five miles southeast of Florence, show relatively little variation in seasonal average temperature, but both maximum and minimum temperatures become more extreme at Canary (Table 1).

Table 1. Average seasonal temperatures (°F) at North Bend and Canary.

| | Ave. winter | Ave. winter minimum | Ave. summer | Ave. summer maximum |
|---|---|---|---|---|
| North Bend | 46 | 40 | 59 | 65 |
| Canary | 45 | 38 | 60 | 76 |

While precipitation increases with latitude, it also increases with elevation in the Coast Range. Precipitation on the Recreation Area averages 65-70 inches per year, but it may reach 100 inches 10-20 miles inland. In November 1983, Florence received 15.95 inches of rain, while a ridge 10 miles inland received 22.02 inches in the same period (Hemstrom and Logan 1986). Cooper (1958) reported only 47 clear days in one year, the balance with fog on 58 days, rain on 68, cloud and fog on 78 and cloud on 115.

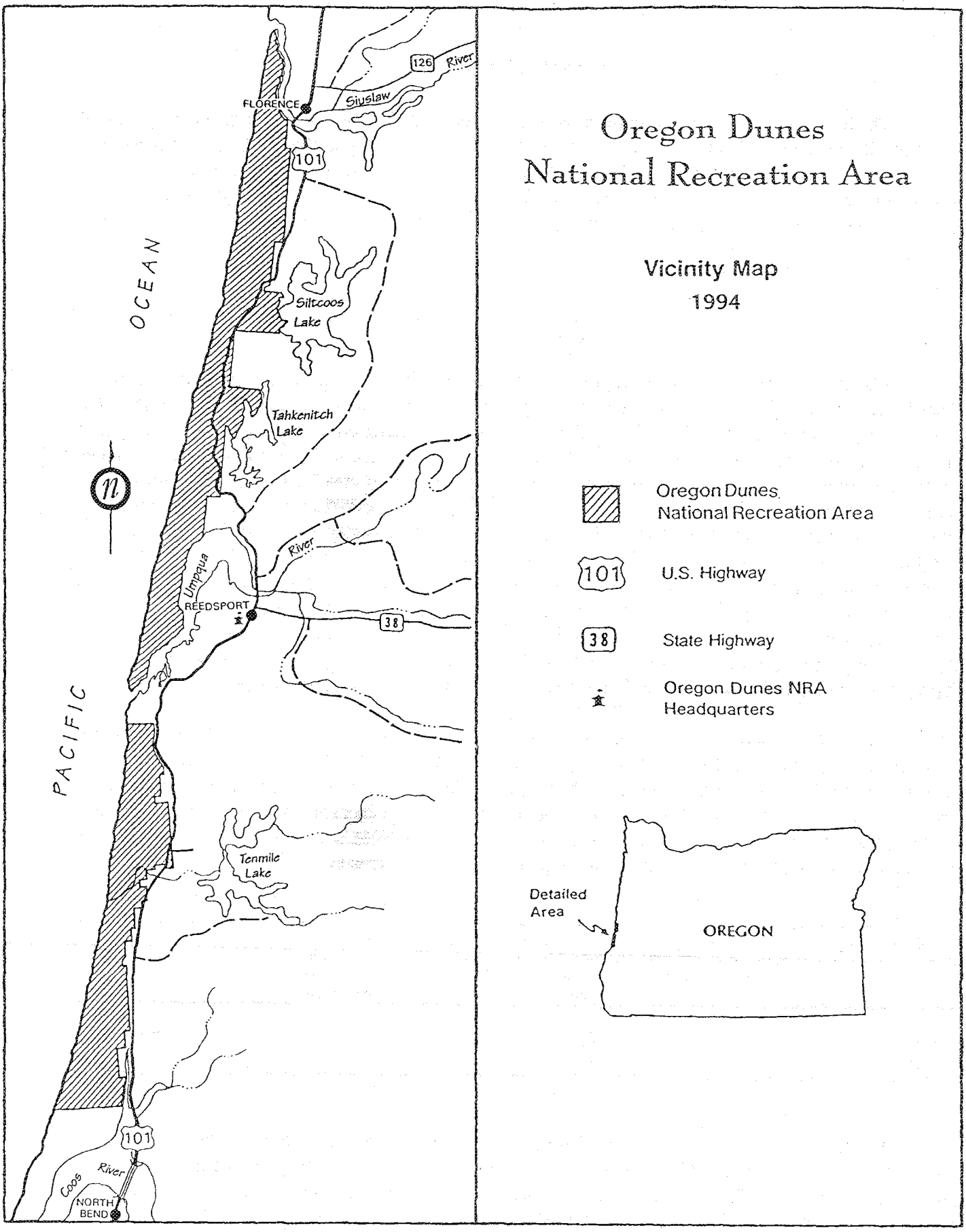


Fig. 1. Location map, Oregon Dunes National Recreation Area.

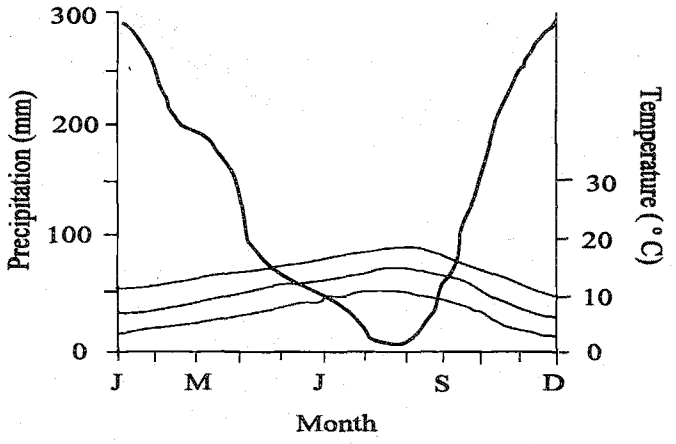


Fig. 2. Temperature and precipitation records for North Bend, at the southern end of the Oregon Dunes National Recreation Area (after Loy 1976).

## GEOLOGY

The geology of the northwest coast of North America was reviewed by Wiedemann (1984, 1993) and Wiedemann et al. (1969). The Recreation Area is underlain by sedimentary bedrock of the Coaledo Formation that originated as offshore marine deposits in the early Eocene, 53 million years ago. These sediments are part of a geosyncline associated with building of the Cascade Range. They are composed of clay, shale and siltstone originating from feldspar and quartz sands, and tuffaceous silts and clays. Toward the end of the Miocene, 7 million years ago, uplifting began to form the Coast Range. Subsequent erosion of the thick sedimentary beds was rapid, resulting in today's low, rounded mountains. The easily eroded rock permitted the development of wave-cut terraces on which present-day sand dunes have developed.

Sea level in the Recreation Area has risen and fallen repeatedly over geologic time, caused by changes in ocean volume associated with cycles of glaciation (Wiedemann 1984, 1993). Repeated subsidence and uplifting of the land mass, resulting from large subduction earthquakes, has also affected sea level (Darienzo and Peterson 1990; Plafker 1990; Komar and Shih 1993; Thilenius 1995). During the late Pliocene and early Pleistocene, about 1 million years ago, a deep submergence created wave-cut terraces as high as 1,400 feet above present sea level. Subsequent uplift lowered the shoreline to 300 feet below present sea level, and it was during this period that rivers and streams cut trenches across the continental shelf. Resubmergence then drowned the river mouths, creating the wide estuaries and salt marshes seen today at the mouths of the Siuslaw and Umpqua Rivers, and in Coos Bay. The last major lowering of the shoreline, to 500 feet below present sea level, occurred during the Wisconsin glacial maximum, about 20,000 years ago. A subsequent resubmergence began about 6000 years ago.

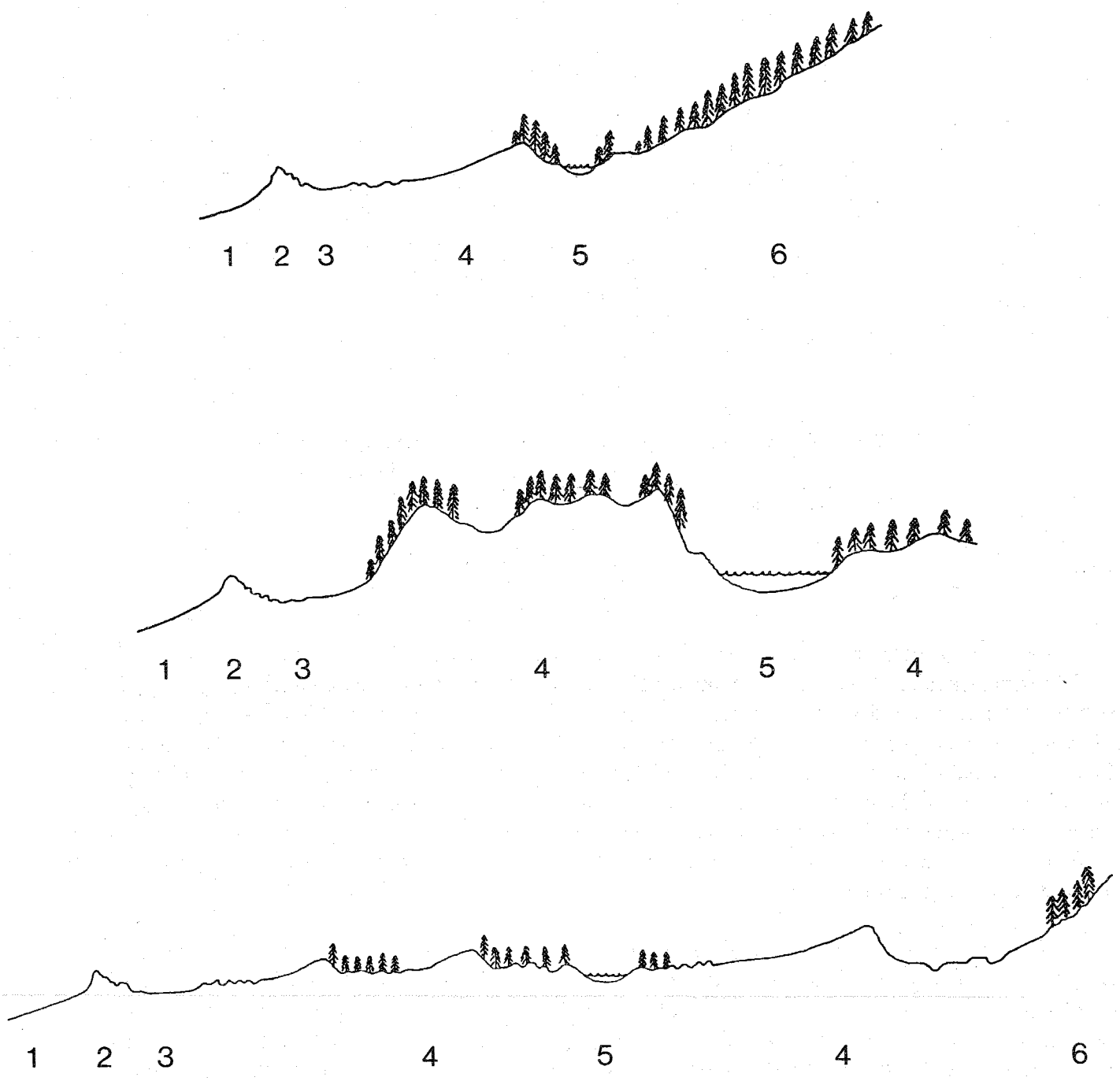


Fig. 3. Three dune profiles, Oregon Dunes National Recreation Area (after Pinto et al. 1972). 1 – Beach; 2 – Foredune; 3 – Deflation plain; 4 – Transverse dunes and tree islands; 5 – Lakes; 6 – Coast Range foothills.

# LANDFORMS AND VEGETATION

The sandy landscape of the Recreation Area is a product of past geologic events and the ıteractions of wind, water, sand supply, vegetation, fire and human activity. Dune formations and rocesses were reviewed by Cooper (1958), Wiedemann (1984, 1990, 1993), Wiedemann and Pickart .996) and Wiedemann et al. (1969). The enormous amount of sand dominating the Recreation Area riginated from the sediment load transported to the coast by major rivers draining the interior of the :gion, as well as ongoing erosion along the immediate coastline. Sand is transported along the coast y nearshore and longshore currents. In summer, longshore currents move sand southward, and deposit ıuch of it on beaches. In winter, these same currents, as well as storm-generated wave activity, move ınd northward, eroding beach deposits. The annual net movement of sand is northward.

Unconsolidated sand dominates about 70 percent of the Recreation Area. The remaining 30 ercent has loam soils of the foothills of the Coast Range, underlain by ancient sandstone. Of the sandy ortions, about 20 percent is bare of vegetation. The balance is covered by a broad array of vegetation, ınging from sparse stands of dune grass or herbs, to tall forests of Sitka spruce, Douglas fir and Port rford cedar, some 300-600 years old, with dense shrub layers of evergreen huckleberry, western ıododendron and wax myrtle up to 15 feet tall. Wind, water, vegetation and topography interact with ınd to form several distinctive landforms that occupy different positions in the landscape. These ındforms, progressing inland from beaches, include foredunes, deflation plains, and interior dunes some 00 feet tall, the last ranging a mile or two inland (Fig. 3).

Plants on the dunes have adapted to living in nutrient-poor, droughty soils and areas subject to igh winds, abrading sand and salt spray. Many exhibit a mat-forming habit, reducing exposure to winds nd salt spray, while others develop waxy cuticles, fleshy stems or silvery hairs that resist desiccation nd store water in specialized tissues. Most dune plants have extensive root systems that cope with hifting sands, and maximize water uptake (Alpert 1991).

**eaches.** Beaches on the Recreation Area typically lack any vegetation except on the landward edge, here beaches grade into foredunes. Surf, wind, sand, and salt are pervasive disturbance factors. Except or an incipient European beachgrass association that forms on hummocks, the occasional herbaceous lants seen on the beach do not form a discernable association. Common species include sea rocket, ellow sandverbena, beach pea, seashore lupine, and sea purslane (Appendix 3 lists common and cientific names). Detritus washed up on beaches usually includes eelgrass, marine algae, dead animals nd wood. These materials, mediated by a specialized fauna and flora of decomposers, provide organic ıaterial and nutrients to beaches and foredunes. Driftwood, often of large diameter, piles up on beaches, nd is often carried into estuaries and deflation plains by large storm surges, where it may remain for ecades. The logs provide habitat for plants and animals, sometimes being the only suitable substrate ı an otherwise saline or waterlogged environment, and serve as a long-term source of organic material nd nutrients. Leuthner (1969) found driftwood logs to host more lichen species than any other substrate ı the dunes, and several species recorded were restricted to these logs.

**oredunes.** Foredunes are tall ridges created by sand-trapping plants, primarily European beachgrass, olerant of continual burial by wind-blown sand. Foredunes may reach heights of 25-35 feet, and basal vidths of over 320 feet. European beachgrass efficiently traps windblown sand, intercepting most of he sand moving inland from beaches. Nutrients may be elevated in foredunes, because of the input of rganic material and salts blown in from beaches.

In the Recreation Area, foredunes did not appear in their present form until after 1935, when the introduced European beachgrass began to spread throughout the region (Wilde 1982; Buell 1992; Wiedemann and Pickart 1996). Prior to this time, the original foredunes had a lower profile, formed by native sand-trapping plants, primarily American dunegrass, yellow sandverbena, seashore bluegrass and beach silver-top. These native species can be effective in building foredunes, as evidenced by the extensive system of old parallel dune ridges north and south of the mouth of the Columbia River. However, foredunes such as these may never have been well-developed along the central coast of Oregon, because of seasonal erosion (Wiedemann and Pickart 1996). Since the advent of European beachgrass, the original foredunes of the Pacific coast have disappeared from most areas and have become a rare landform. Even individual species of original foredune vegetation are now becoming rare. The best remnants of this landform occur at the Lanphere-Christensen Dunes Preserve near Humboldt Bay, in northern California.

**Deflation plains.** Behind the foredunes are deflation plains, where wind has eroded the sand to the water table, forming a wet surface resistant to further erosion. Many of today's deflation plains are artifacts of the establishment and spread of European beachgrass, and the subsequent creation of large foredunes (Pinto et al. 1972; Wilde 1982). The new foredunes intercepted sand blowing inland from beaches, and sand behind the foredunes subsequently became the source of resupply for interior dunes. Wind has excavated deflation plains that have increased in width continuously over the last 50 years, in some places doubling since 1950 (Pinto et al. 1972). Expansion of deflation plains occurs along their eastern edge, and in some places they are now over half a mile wide. Deflation also occurs further inland in troughs among dunes.

Deflation plains are typically flooded with fresh or brackish water for much of the winter, drying out to a greater or lesser extent in summer. Dried-up depressions are often stained with iron. A variety of moisture and salinity gradients are present throughout the year, dictated by depth of sand and distance from estuaries (Newman 1974, 1983). These gradients have a profound effect on the distribution of plant associations containing the highest diversity of species recorded from the Recreation Area. These include the salt rush and the sickle-leaved rush-salt rush associations. Wetter sites support extensive marshes of slough sedge, Nevada rush and Hooker willow. Drier sandy flats and hummocks support stands of European beachgrass and salt rush. These drier sites are invaded rapidly by dense stands of evergreen huckleberry, salal, shore pine and Sitka spruce. Such stands are often severely pruned by wind-blown sand and salt spray, and usually become impenetrable.

Some deflation plains were present long before the advent of European beachgrass. House described the vegetation of deflation plains in 1914. Goose Pasture, a deflation plain formed around 1813 (Cooper 1958), has changed from a meadow to a Sitka spruce forest in about 60 years. It also exhibits successional stages ranging from mature spruce trees at its western end, to progressively younger stands of pine woods and wetlands at its eastern end. This site represents what many of the deflation plains on the Recreation Area will look like in the future. A similar pattern appears to be developing on deflation plains north of Tenmile Creek.

**Interior dunes.** Farther inland, a variety of actively moving dunes respond to wind patterns and local topography. They are largely bare of vegetation. Prevailing seasonal winds form two distinctive types of dunes. **Summer transverse dunes** form regular "washboard" patterns east of the deflation plains. They are oriented in a southwest-to-northeast direction, perpendicular to prevailing summer winds. They range from 3-20 feet high, are spaced about 110 feet apart, and are often leveled by winter winds. **Winter transverse dunes** form enormous parallel ridges near the eastern edge of the dune sheet

Described as "oblique dunes" by many authors, Hunter et al. (1983) found that this type of dune rarely became oblique, and the name is best forgotten. These dunes are oriented in a somewhat northwest-to-southeast direction, perpendicular to winter winds. They range from 80-200 feet high, and are spaced 500-1800 feet apart. Some are over a mile long, and move northeasterly about 12 feet per year (Wiedemann 1984). Their eastern faces merge with the **retention ridge**, or precipitation ridge, forming a **slip face** along the eastern edge of the dune sheet. Here, a wall of sand up to 75 feet high can bury existing forest vegetation, and moves inland about 5 feet per year (Wiedemann 1984). Leaning and dying trees, their trunks buried deep in sand, are common along the retention ridge. **Parabola dunes** are formed by vigorous wind erosion that excavates and funnels sand through a trough, forming a U-shaped dune at the distal end, where slip faces similar to retention ridges can bury existing forest. In troughs between dunes, long-buried forests and their ancient soils may be exhumed by the wind.

When vegetation is disturbed to expose bare sand, wind erosion can quickly destroy a stabilized dune. Undermining adjacent vegetation may cause **blowouts**. Remnant mounds of forest, called **tree islands**, are created by such activity. The vegetation on these sites is often deformed by wind into grotesque or aerodynamic shapes. The windward side of tree islands, as well as forest at the edge of the dune sheet, all show familiar "wind pruning" of shrubs and "flagging" of trees. Incipient tree islands can be seen west of Tahkenitch Campground, where peninsular lobes of forest are eroding around their edges, and may someday be cut off from the forest. Tree islands are covered by mixed stands of shore pine, Sitka spruce, Port Orford cedar or Douglas fir, with a dense understory of salal and evergreen huckleberry. Stands typically contain a mix of age classes, including scattered Sitka spruce and Douglas fir up to 650 years old, the oldest trees known from the Recreation Area. The woody parts of trees and shrubs in the interior of these islands are often coated with sand, transported from the surrounding dunes by storm winds, and deposited as a sandy precipitation that becomes cemented to wet stems and branches.

**Coast Range foothills.** The eastern part of the Recreation Area includes hills rising to 600 feet. A few of these are ancient dunes, but most are underlain by sandstone, and form the western terminus of the Coast Range. These are the "mountain front" of Pinto et al. (1972). Much of the forest is dominated by second-growth Sitka spruce and western hemlock. Forest stands in the foothills are floristically distinct from those on sand dunes, because of the better-quality soil with higher moisture-holding capacity. Perennial streams and red alder occur in valleys between the hills.

**Rivers and streams.** The Recreation Area is bounded by the Siuslaw River on the north, Coos Bay on the south, and is bisected in the middle by the Umpqua River. Tahkenitch, Threemile and Tenmile Creeks, and Siltcoos River are the only other streams crossing the dune sheet. All are tidal in their lower reaches. A limited number of wetlands are associated with these streams, including those with the best-developed mucky peat soils. In the foothills along the eastern edge of the Recreation Area, permanent streams form the headwaters of lakes and ponds blocked by the dune sheet. Beaver activity is ubiquitous in these streams, where Hooker and Sitka willow are the primary food source. Bottomlands along the streams are the primary sites for red alder on the Recreation Area.

**Lakes and ponds.** Freshwater ponds and lakes occur throughout the length and breadth of the Recreation Area. Dune-blocked lakes and lakes occurring within the dune sheet were formed by two different processes. Dune-blocked lakes occur along the eastern edge of the dune sheet, and were formed when shifting sands blocked streams draining the Coast Range. Downcut stream valleys were flooded, creating the large lakes east of Highway 101, such as Siltcoos, Woahink, Tahkenitch, and Tenmile Lakes (Cooper 1958). These lakes are usually steep-sided and relatively deep, and water levels may drop as

much as 6-8 feet during the summer. They also have outlet streams large enough to cut across the dune sheet. Many smaller lakes west of Highway 101, such as Cleawox, Carter, Elbow, Threemile and Saunders, were formed in the same manner as the larger lakes. Some of these are connected to each other by streams that flow along the margin of the dune sheet, but all drainage is underground beneath the dune sheet. Most lakes have active beaver populations.

Lakes and ponds occurring within the dune sheet occur in deflated areas where the water table is intercepted. They are typically shallow and subject to seasonal changes in water levels. The best examples occur on ancient deflation plains at the south end of the Recreation Area, between Beale and Horsfall Lakes. These lakes are unique because of their large size and extensive aquatic bed and emergent plant associations, dominated by pond lily, floating-leaved pondweed, water-shield and hardstem bulrush. Several lakes contain water clubrush, an uncommon plant species, and extensive populations of the insectivorous bladderwort. The lakes host large concentrations of waterfowl during the migration season. Cooper (1958) described the drying of these lakes in the 1920's and 1930's. At that time they all contained numerous dead trunks and stumps of shore pine, possible evidence of subsidence and immersion after a subduction earthquake. Groundwater pumping in the wellfield in the Horsfall area may be lowering the water table, threatening the long-term viability of these lakes (Wiedemann 1984).

**Salt marsh.** Salt marsh is limited on the Recreation Area because little estuarine habitat is present within the administrative boundaries. The best example occurs along the North Slough of Coos Bay, where regular tidal inundation has created broad mud flats laced by tidal streams. Much of the hydrology there has been altered by channelization of North Slough, and construction of the railroad.

Distinctive salt marsh species on the Recreation Area include Lyngby sedge, saltgrass, pickleweed and three-square bulrush. The mouths of both the Siuslaw and Umpqua Rivers are subject to sand burial and dredging, and salt marsh in these areas is very small. Tahkenitch Creek, Tenmile Creek, and Siltcoos River all have small estuaries in which some limited salt marsh development has occurred. These are embayments confined by foredunes, with shifting mouths that are often choked with sand. Such choking limits intrusion of salt water at certain times of the year, causing salinity levels to fluctuate more than in larger estuaries open to regular tidal activity. Storm surges can bring seawater and driftwood far into these marshes. The mouths of Tahkenitch and Tenmile Creeks have shifted north or south over the years in response to currents and the creation of foredunes. Air photos show traces of old floodplain features, such as meandering and ponding, along the lower ends of these creeks, but well above the estuary areas. Large logs on these floodplains also show that they were occasionally overrun by storm surges, presumably before foredunes had built up to their present dimensions. Threemile Creek is too small to support any salt marsh.

## SOILS

Soils of the Recreation Area include sands, sandy loams, and silt loams. The shifting and stabilized dunes are composed of excessively-drained and poorly-drained sands. Ancient marine terraces are composed of well-drained and poorly-drained loams and sands. The foothills of the Coast Range, mostly east of Highway 101, are composed of well-drained silt loams. Technical properties of the soils were described by Patching (1987) and Haagen (1989).

**Sand dunes.** The soils of the sand dunes are extremely poor, lacking both nutrients and organic matter. On most of the sparsely-vegetated dunes, permeability is very rapid. High rainfall leaches most nutrients to levels so low they cannot be effectively measured, and pH is about neutral. Beach and foredune sands may contain elevated levels of nitrate, potassium, calcium, magnesium and sodium, originating from drift deposited on beaches, including seagrass, marine algae, dead animals and wood. These nutrients are scarce on sands farther inland, and are directly proportional to the amount of plant biomass and organic matter on a given site (Clark 1986; Duebendorfer 1992).

Older forests on stabilized dunes and tree islands are underlain by 4-15 inches of gray or grayish brown fine sand or sandy loam, underlain by yellow or brownish sand with very little organic material. Because unstable sandy soils move downslope readily, soil depth varies greatly on the dunes. Under shrubs or in openings on slopes, it may be only 1 inch deep, or altogether absent. Pockets 4-6 inches deep develop at the foot of slopes, or in concavities in midslope. Iron-cemented lenses or nodules may be present below the surface. These soils are highly to moderately permeable, low in nutrients and humus, and have a pH of 5.1-6.0. The Waldport, Netarts and Bullards series, classed respectively as Typic Tropopsamments, Entic Haplorthods and Typic Haplorthods, are the primary soil units. A few remnant dunes surviving from the Pleistocene are distinguished by their reddish-colored soils and iron concretions.

Poorly-drained areas in the dunes develop several different soil profiles, depending on age. Deflation plains develop a brown or dark grayish brown sandy soil 4-7 inches deep, underlain by up to 60 inches of mottled grayish brown sand. Waldport and Heceta series, the latter Typic Psammaquents, are the primary units. Older hydric formations on floodplains and marine terraces develop dark, anoxic reddish brown organic soils 60 or more inches deep, sometimes with iron-cemented hardpan in the underlying gray sand. These soils are moderately permeable. These soils are very acid, with a pH of 4.5-5.0. Brallier mucky peat, a Typic Tropohemist, is the primary unit.

**Marine terraces.** Marine terraces, occurring at the south end of the Recreation Area, are composed of Pleistocene beach and offshore deposits, with sand, clay, gravel, peat layers and woody remains, underlain by marine sandstone of Pliocene age (Allen and Baldwin 1944; Griggs 1945; Baldwin 1981). Soils are composed of 5-10 inches of dark grayish brown sandy loam, underlain by 20-40 inches of reddish brown sandy loam with a yellowish brown iron-cemented hardpan. Permeability is moderate to very low. Frequent mapping units are Bandon sandy loam and Blacklock fine sandy loam. These soils are Typic Tropaquods, notorious for poor drainage and infertility. They develop 9-12 inches of black or dark gray fine sandy loam, underlain by mottled, brown or yellowish brown, iron-cemented hardpan to depths of 40-75 inches. Blacklock soils are nutrient-poor, poorly drained, and have a pH of 5.0 (Jenny et al. 1969). Vegetation may be conspicuously stunted in areas with seasonal standing water.

**Coast Range foothills.** The most productive soils on the Recreation Area are deep silt loams that occur mostly east of Highway 101, in the foothills of the Coast Range. The soils formed in colluvium derived from sedimentary bedrock, and have greater moisture-holding capacity than those found on sand dunes. Soils are dark brown or reddish brown silt loam 10-26 inches deep, underlain by silt loam and silty clay loam 14-26 inches thick, sometimes with fractured siltstone. Salander and Templeton are the primary series, classified as Typic Dystrandepts and Andic Humitropepts, respectively.

## HYDROLOGY

Although dune sands have poor moisture-holding capacity, they are underlain by large groundwater reserves that maintain a high water table throughout much of the Recreation Area. The aquifers range from 115-230 feet thick, bound on the east by the basal bedrock of the Coast Range, and extending westward under the ocean (Brown and Newcomb 1963; Wiedemann 1984). The groundwater drains into lakes, streams, North Slough and the ocean. Winter precipitation elevates the water table and inundates some deflation plains to a depth of 3 feet. The seasonal rise in water table also causes vernal pools to form in forested sites on old deflation plains, most notably in the shore pine\slough sedge association. These pools are teeming with invertebrates and are temporary sources of food and breeding grounds for amphibians and migrating waterfowl.

Although the water of the dune aquifers is of good quality, with a somewhat acidic pH of 5.7-6.2, iron makes it less potable in some areas (Brown and Newcomb 1963; Wiedemann 1984). The cities of Florence, North Bend and Coos Bay obtain most of their water supplies from dune aquifers, collected by well fields scattered over the dune sheet. Groundwater pumping on the North Spit of Coos Bay has raised concerns about year-round depression of the water table, dewatering valuable wildlife habitat and possibly altering plant succession at these sites (Wiedemann 1984). The issue is currently under investigation.

Because sands are so permeable, surface runoff occurs only on the silt loams of the Coast Range foothills along the eastern edge of the Recreation Area, and no streams originate in the dune sheet. On stabilized dunes with mature forest cover, steep-walled gullies give the illusion of stream channels, but are merely points where two old dune slip faces join together. Water rarely accumulates at these sites, unless they intersect the elevated winter water table.

Brackish water occurs in the estuaries of Coos Bay, and at the outlets of the few streams crossing the dune sheet. It also occurs to a limited extent in deflation plains adjacent to estuaries. Lakes occurring at the eastern edge of the dune sheet have subterranean outflows beneath the dunes, and probably feed directly to the water table. Cleawox Lake drains in this manner, and irrigates Goose Pasture on the deflation plain about a mile west of the lake (Cooper 1958; Wiedemann 1984).

## DISTURBANCE PROCESSES

The major agents of disturbance on the Recreation Area have been shoreline displacement, wind, salt, fire, and human activities. These forces have mediated the supply, movement, chemistry, and exposure of sand, and have, in turn, influenced development of vegetation on the dunes. The instability of sand, however, is the major factor controlling plant succession on the Recreation Area.

**Shoreline displacement.** Cyclical changes in sea level, associated with glaciation and tectonic events, were credited by Cooper (1958), Wiedemann (1984, 1993) and Wiedemann and Pickart (1996) to have triggered cyclical dune activity. Subsidence or uplift of 6-9 feet associated with earthquakes would destroy existing dune formations and vegetation, and initiate new successional pathways, particularly in wetlands (Plafker 1990; Thilenius 1995). Estimated birth dates for certain dune types coincide with radiocarbon and thermoluminescence dates obtained on the Recreation Area and elsewhere, and support the general notion that major earthquakes occur at 300-1000 year intervals. The most recent events seem to have occurred about 300, 1,050, 1,650 and 2,400 years ago.

**Wind.** Wind drives the seasonal movement of large dunes, causing burial of forest vegetation along the eastern edge of the dune sheet, and exhumation of previously-buried forest in interdunal troughs. Storm winds fell many trees in exposed areas, and windfall is conspicuous in stands containing senescing shore pine. Wind-driven sand and salt abrade and stunt vegetation, and can kill buds and leaves of both conifers and shrubs. In exposed areas, removal of vegetation can leave the underlying sand vulnerable to wind erosion, leading to formation of blowouts or complete destruction of stabilized dunes. McLaughlin and Brown (1942) described the extensive erosion of stabilized dunes on the Clatsop Plains caused by livestock trails cutting through the turf to expose sand to the wind.

**Fire.** Fire probably played a secondary role as an agent of disturbance in the Recreation Area. Most ignition sources were likely aboriginal, as lightning is uncommon along the immediate coast. Shifting dune sands frequently expose buried soils, and these often contain charcoal. Charcoal is visible in shore pine forest south of Threemile Lake, and in 300-400 year-old stands of Port Orford cedar near Hauser and in the Horsfall area. The only fire scars on standing trees were seen on Port Orford cedar at Horsfall.

Most forest fires in the Coast Range are thought to have been intense and infrequent, occurring in a 150-350 year fire return interval (Teensma et al. 1991). Fire frequency increased dramatically in the Coast Range after 1845, when white settlers began clearing land (Morris 1934), but it is largely unknown whether these fires extended onto the Recreation Area. Morris (1934) and Teensma et al. (1991) recorded large fires in the vicinity of the Recreation Area in 1846, 1849 and 1868. Around Florence, abundant charcoal and even-aged stands of shore pine date from stand-replacing fires between 1835-1865 (Cooper 1958).

The fragmented nature of forest and tree islands, with sand surfaces in between, may be a result of past burns, but is more likely due to wind erosion. The complex pattern of vegetation and sand would have caused discontinuous burning, creating variable patch sizes and age classes. Some tree islands appear to have escaped fire for up to 650 years. Although many stands of shore pine originated during primary succession on shifting sand, or were planted, others date from stand-replacement fires, and even-aged stands are typical on the dunes. The high incidence of rare lichen species along the immediate coast, in contrast to their relative dearth farther inland, may in part be due to the low incidence of fire.

**Insects and pathogens.** Forest insects reported to occur on the Recreation Area include the pitch nodule moth, engraver beetles and root weevils. Pathogens known or thought to occur in the area include gall rust, canker and needle cast on shore pine, and needle rust on Sitka spruce (Pinto et al. 1972). Port Orford cedar root disease has recently been identified from the Recreation Area. Except for Port Orford cedar root disease, none of these fungi appear to be limiting stand growth in any significant way. Control measures for Port Orford cedar root disease should exclude motorized recreation from the vicinity of known stands. Pine plantations near Lagoon Campground, cited by Pinto et al. (1972) as a center of infestation by root weevils, appear to be healthy.

**Agriculture and grazing.** Although people have lived on the central coast of Oregon for at least 10,000 years, the area was sparsely settled by Native Americans and Europeans until the 1870's, when grazing and farming became more prevalent. The effects of livestock grazing and cultivation, as well as construction of buildings, jetties, roads, railroads and trails, have all been responsible for rejuvenation of sand movement (McLaughlin and Brown 1942). Early in the century, cattle crossed the dunes from Siltcoos and Woahink Lakes to graze Goose Pasture until it was "cropped short" (Siuslaw National Forest 1912-1916). Munger (1967) recalled that too many cattle grazing on the North Spit around 1910

caused sand to drift into the bay and block the mouth of the Umpqua River. Cooper (1958) noted that cattle had grazed the Recreation Area since at least the 1890's, and were responsible for rejuvenation of sand movement between Tenmile Creek and Coos Bay. Aerial photography shows that homesteads were present at the mouth of Tenmile Creek, the south end of Threemile Lake, and on the Coos Bay spit as late as 1936. These activities no doubt influenced plant succession in certain areas of the Recreation Area. Cultivation and grazing break up vegetation and expose the sand to wind erosion. Weed species that disrupt natural plant succession are also introduced. Cultivation of cranberries began at Hauser as early as 1885, and a number of smaller lakes near the south end of the Recreation Area contain remains of abandoned berms and wooden dams, evidence of this industry. These activities disrupted hydrology and aquatic vegetation, and the plant associations of these areas may still be recovering from the effects.

**Logging.** Forests on the uplands of the Recreation Area were cut over between 1915 and the 1960's, mostly east of Highway 101. Some stands have been cut two or three times. Near Siltcoos Lake, western red cedar was selectively logged prior to 1940, leaving 200 year-old Sitka spruce stands with altered composition. Most such stands were never thinned, resulting in a dense canopy with sparse shrub and herb layers. Red alder dominates some sites formerly occupied by conifer forest. Old-growth forest is rare on the Recreation Area. Scattered individuals of Sitka spruce and Douglas fir up to 650 years old occur in tree islands. Stands of old-growth Port Orford cedar occur near Hauser and in the Horsfall area at the southern end of the Recreation Area. Old-growth Douglas fir and western hemlock occurs on stabilized dunes between Loon Lake and Carter Lake, although part of this stand was clearcut in the 1960's. Old-growth shore pine, 120-150 years old, occurs on tree islands and in the Horsfall area.

**Changes in hydrology.** The well field in the Horsfall area, at the south end of the Recreation Area, is being studied to monitor changes in groundwater levels, and its potential effects on wetlands. Sustained pumping of groundwater may alter extent and composition of seasonal or perennially-flooded wetlands. If dewatering is sustained over a period of years, shallow lakes may be replaced by dry or seasonally-wet associations typical of deflation plains. Because sand is highly permeable, excessive pumping may also cause pollution of groundwater by infiltration of salt water, sewage, fertilizers and pulp mill wastes.

**Recreation.** Recreational off-road vehicles, horseback riding, and hiking can damage vegetation and wetlands if traffic is concentrated, or occurring in fragile areas. Compaction or displacement of sand can destroy fragile native dune vegetation as well as exotic European beachgrass, and rejuvenate sand movement in stabilized areas. Weed seeds and fungal spores adhering to machines, horses and clothing can be dispersed into previously pristine areas. Particularly vulnerable are the red fescue, seashore bluegrass, shore pine/bearberry, and shore pine/hairy manzanita associations. These associations have delicate root systems or thin, fragile layers of lichens, mosses and bearberry covering the sand.

Off-road vehicles have damaged some plant associations throughout the Recreation Area, and damage to wetlands is evident around Horsfall Lake. Similar activity in the Sand Lake dunes, 80 miles north of the Recreation Area, has destroyed nearly all of the red fescue and shore pine/bearberry associations in the last 30 years since such vehicles became popular (Wiedemann 1984, 1990, 1993).

Brown (1990) documented hiking damage to two dune associations in northern California, including a "dune mat" containing elements of the red fescue, seashore bluegrass, and shore pine/bearberry associations. Under the heaviest of four experimental trampling regimes, he observed a 50 percent decline in cover in both types of vegetation. The shore pine/bearberry association was initially more resilient than the dune mat association, but took longer to recover, and reindeer lichens (*Cladina* and *Cladonia* spp.) disappeared from the plots. Neither vegetation type showed appreciable

ecovery after 1 year. Research in Scotland (Bayfield 1979; Bayfield et al. 1981) indicates that the lichen ayer could take more than 8 years to recover from trampling.

## PLANT SUCCESSION

If disturbance processes were absent from the Recreation Area, a classical sequential successional pathway would begin with aquatic vegetation and culminate in mature forest. Classical successional patterns are sometimes evident in both uplands and wetlands of the Recreation Area, as one association grades into another, with vestiges of preceding types providing clues about antecedent vegetation. However, in most of the area underlain by sand and exposed to wind, instability is the rule. Here, the classical linear pattern of succession is seldom followed, and late seral or climax associations are rare. A cyclical process is common to much of the area, where dune surfaces become stabilized by a series of plant associations, eventually becoming forested, only to return to open sand again because of burial by shifting dunes, or rejuvenation of wind erosion caused by removal of protective vegetation. Rejuvenation of sand movement in previously stabilized areas, or *de novo* infiltration or burial by sand, can trigger invasion by European beachgrass in nearly any association in nearly any locality in the Recreation Area. The putative successional sequence may then start over with European beachgrass, instead of whatever had been growing there previous to the advent of new sand. Complex patterns of vegetation are typical, with vastly different vegetation types occurring side by side.

The idealized successional pathways outlined here for both uplands and wetlands follow a hypothetical linear progression, assuming no intermediate disturbance. We recognize early, mid and late seral stages, as well as climax, as defined by Hall et al. (1995).

Because succession in wetlands is complicated by seasonal and long-term variation in moisture, salinity gradients, and microtopography, successional pathways are not as obvious as in uplands. Changes in sedimentation, elevation, dominance of certain species, and presence of species remaining from previous associations are clues indicating possible successional pathways. Most wetland associations are early seral, and two different pathways are evident on the Recreation Area. The first pathway occurs along streams and lakes, where associations change from aquatic bed to emergent marsh, to shrub swamp, to climax Sitka spruce swamp. The second pathway occurs on deflation plains where brackish associations grade into freshwater associations, culminating in transition to upland associations.

Plant associations of perennially flowing or perennially ponded water (Fig. 4) are flooded or saturated year-round, and organic soils are typical. Floating aquatic plants growing on or below the surface of the water (pond lily and floating-leaved pondweed associations) are replaced by associations of erect, emergent plants (inflated sedge, hardstem bulrush and simplestem bur-reed associations) when water depths become shallower with infilling by sediment and detritus. The slough sedge association develops on saturated, organic soils along streams and lakes, and is later invaded by long-lived stands of Douglas spiraea and Hooker willow that respond to disturbance by vigorous resprouting. These stands are eventually replaced by the climax Sitka spruce-red alder/slough sedge-skunk cabbage association, which may live 300 years or more. Stands of this type are rare on the Recreation Area, and never extensive in area.

Plant associations in brackish water (Fig. 5) are flooded in winter, but dry out in summer, and never develop much organic matter. Succession progresses from low salt marsh (saltgrass-Pacific silverweed and three-square bulrush associations) to high salt marsh (Lyngby sedge-Pacific silverweed,

Baltic rush-Pacific silverweed, and creeping bentgrass associations), typical of estuaries along the northern Pacific coast. Depending upon the availability of fresh water, high salt marsh associations appear to be replaced by either freshwater or upland associations. Succession in freshwater is mediated by water depth and seasonal availability.

Freshwater wetland associations derived from brackish water associations (Fig. 6) are arrayed along an elevational gradient, mediated by influx of sand. These usually occur on deflation plains. Younger stands are dominated by the creeping spikerush-Nevada rush association, and the slough sedge-Pacific silverweed association, which are seasonally flooded but dry out by midsummer, with the water table at or below the ground surface. Slightly higher surfaces are invaded by shrubs, to form the Hooker willow/slough sedge-Pacific silverweed association, and two associations dominated by bog blueberry. The Hooker willow sites are wetter than the bog blueberry sites, and are soon colonized by shore pine, which after 20 to 50 years excludes the willow to form the distinctive, seasonally-flooded shore pine/slough sedge association that may persist for more than 100 years. Continued infilling by sand and other woody species replaces these associations with those typical of upland dunes.

Upland dunes slowly become stabilized by a series of associations dominated by herbs or graminoids (Fig. 7). Pioneers include European beachgrass, American dunegrass, salt rush, seashore lupine, and seashore bluegrass. Diminishing movement of sand allows colonization by red fescue. At this point, shrubs and small trees begin to invade stabilized areas, establishing associations dominated by woody species (Fig. 8). Early stages include the tree lupine/European beachgrass, shore pine/bearberry, shore pine/hairy manzanita, and shore pine/Scot's broom/European beachgrass associations. Mosses, lichens and bearberry form extensive, conspicuous layers covering the bare sand. These stands become well established between 30-60 years, and persist for up to 130 years.

Once the shore pine associations are well established, Sitka spruce, Douglas fir, western hemlock and Port Orford cedar begin to invade, forming associations dominated by these species. The more or less open shrub layer of hairy manzanita is replaced by dense, sometimes impenetrable stands of evergreen huckleberry and western rhododendron. Organic material accumulates to form a dark layer of humic soil over the bare sand.

Older forest stands accumulate thicker layers of humic soil than younger forests, with the thickest deposits occurring at the base of slip faces of old dunes. Shore pine in these stands senesces between 80-130 years, and is not replaced unless gaps in the canopy are created by windfall, disease or fire. Douglas fir and western hemlock cannot tolerate salt spray, and occur only in sheltered stands or remote from beaches. In contrast, Sitka spruce and shore pine are more tolerant of salt, and are frequent invaders of deflation plains where salt-laden winds are common year-round. Species that apparently favor salt spray, because they occur only along the immediate coast, include silk tassel and Scouler's polypody. Very old forests are rare on the Recreation Area, but include associations dominated by Douglas fir, Sitka spruce, western hemlock, and Port Orford cedar between 200 and 500 years old. At any point along this idealized successional pathway from bare sand to climax forest, something may intervene to disrupt the pattern.

## EXOTIC PLANTS

Many non-native species of plants are present in the Recreation Area. While most have invaded naturally, or were introduced unintentionally by people, livestock or machinery, others were planted

widely for dune stabilization and wildlife habitat. McLaughlin and Brown (1942), Green (1965), Munger (1967), Pinto et al. (1972), Meyer and Chester (1977) and unpublished documents on file at the Oregon Dunes National Recreation Area headquarters chronicle planting activity on the Recreation Area since 1908. Exotic species persisting from plantations include European beachgrass, black pine, Scot's broom, tree lupine and bird-foot trefoil. Native shore pine, red fescue and American dunegrass were also planted in a number of places for stabilization or enhancement of wildlife habitat.

Widespread planting of exotic, nitrogen-fixing species, especially Scot's broom, tree lupine and birds-foot trefoil, has had profound effects on nitrogen-poor dune soils. Pickart et al. (1990) found that bush lupine elevated levels of ammonium in the sand, and increased soil moisture through shading. These changes fostered invasion of exotic annual grasses and other weeds that, in turn, increased levels of organic matter and nitrate in the soil. Scot's broom produces a similar effect on soils. While these are precisely the objectives of dune stabilization programs, the effects disrupt native plant associations.

Five types of sites on the Recreation Area, each driven by disturbance processes, appear to be especially vulnerable to invasion by exotic species:

**Sites with active sand deposition.** Sites with active deposition of sand are favored habitat for European beachgrass. This species is most abundant on foredunes, portions of deflation plains, and lee slopes of moving dunes. European beachgrass is responsible for the buildup of large foredunes and creation of broad deflation plains, which have cut off the supply of beach sand to dunes further inland. Its competitive superiority and sand-trapping ability have enabled it to infiltrate and destroy nearly all stands of native vegetation on open, partially-stabilized dunes (Wiedemann 1984, 1990, 1993; Boyd 1992; Wiedemann and Pickart 1996). It invades and replaces American dunegrass and seashore bluegrass associations, and to a lesser extent the red fescue association, making these the rarest native plant associations in the Recreation Area. Several native plant species present in these associations, including pink and yellow sandverbena, large-headed sedge, American dunegrass and beach silver-top are also becoming rare because of invasion by European beachgrass.

European beachgrass, first planted on the Recreation Area to stabilize shifting sand on the North Spit around 1910, began to spread naturally by 1930, and after 1935 it was planted widely (McLaughlin 1939; Arnst 1942; McLaughlin and Brown 1942; Munger 1967; Meyer and Chester 1977). By 1970, it had spread the entire length and breadth of the dune sheet. In northern California dunes, 50 years of aerial photography showed that the grass had increased its cover 574 percent, spreading at an average rate of 2.5 acres per year between 1939 and 1962, and 12 acres per year between 1962 and 1989 (Buell 1992).

**Early stages of stabilization by shrubs.** Sand dunes with relatively little movement of sand begin to develop stands of shrubs and small trees. This is favored habitat for Scots' broom, and to a lesser extent, tree lupine. Scot's broom ranges from just behind foredunes to interior dunes, while tree lupine is largely restricted to areas just behind foredunes. On the Recreation Area, tree lupine grows where European beachgrass has already displaced native vegetation. While Scot's broom can flourish in established stands of European beachgrass, it also invades native associations, particularly the shore pine/bearberry and shore pine/hairy manzanita associations. Invasion by Scots' broom replaces the shrub layer, and initiates changes that affect soil chemistry and subsequent plant succession. Shading and increased soil nitrate under these shrubs allows invasive annual grasses and other weeds to thrive (Pickart et al. 1990).

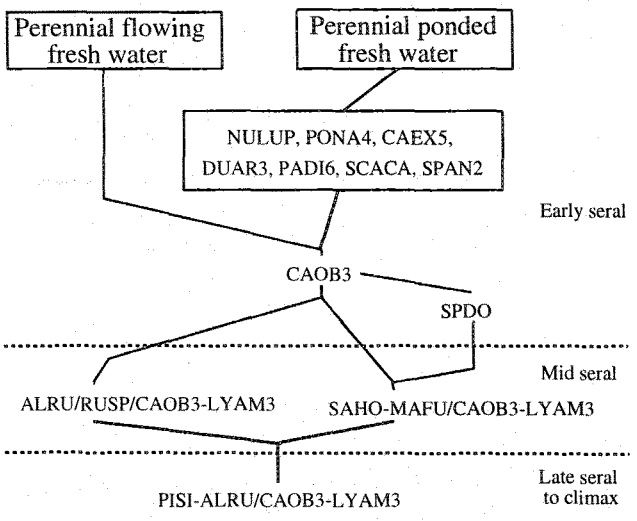


Fig. 4. Idealized successional pathways for freshwater wetland plant associations derived from perennial flowing or ponded fresh water, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

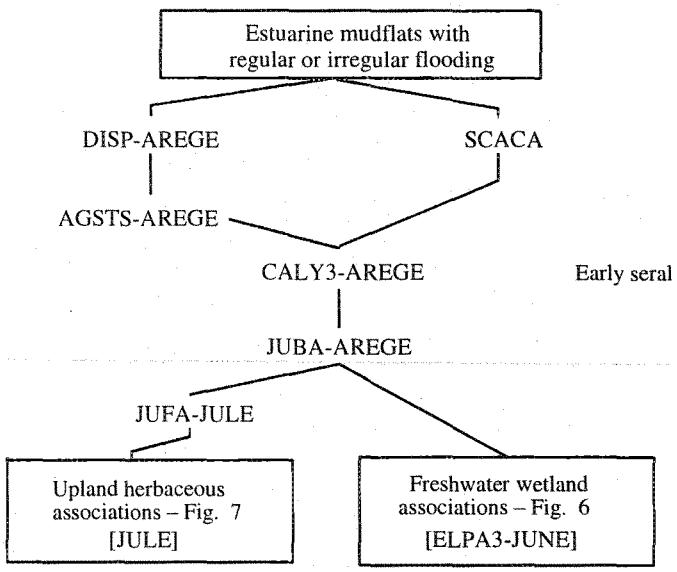


Fig. 5. Idealized successional pathways for brackish wetland plant associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure, while salinity decreases from top to bottom. Species codes are defined in Appendix 3.

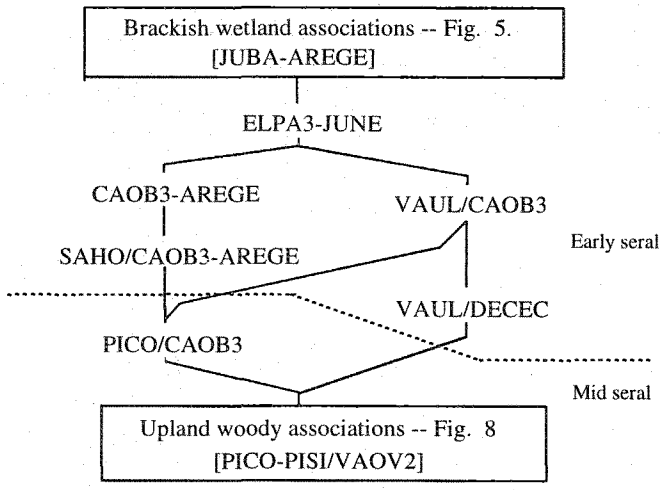


Fig. 6. Idealized successional pathways for freshwater wetland plant associations on sandy soils, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

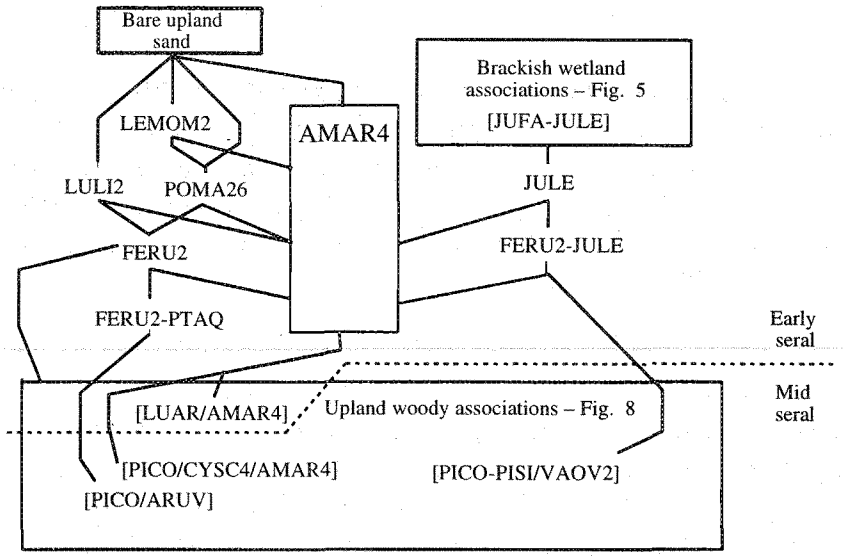


Fig. 7. Idealized successional pathways for upland herbaceous associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

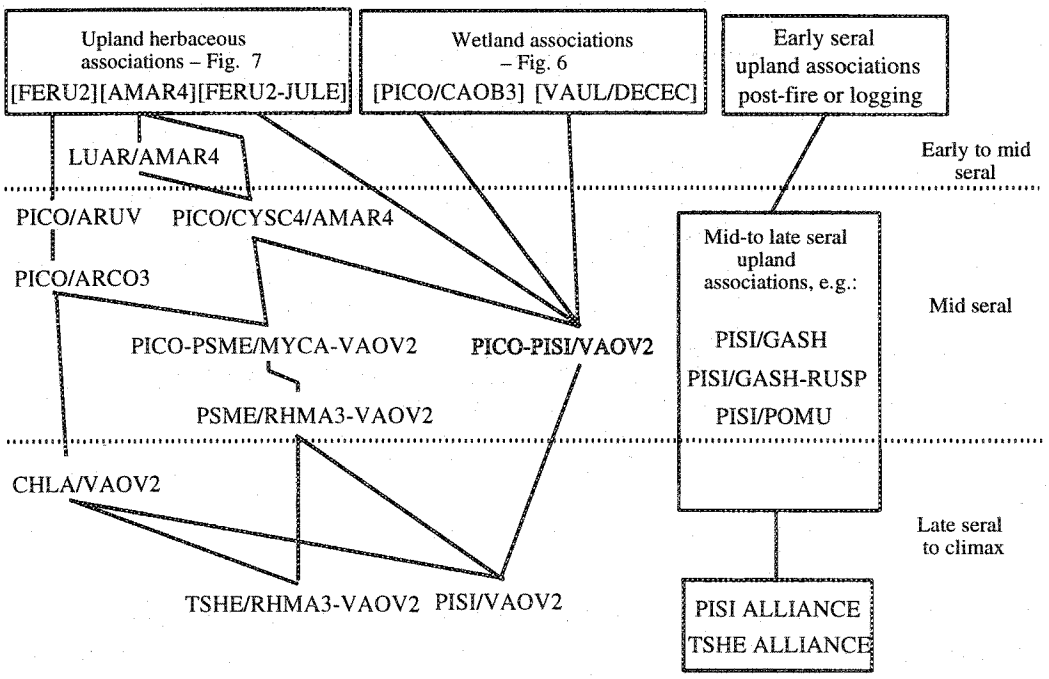


Fig. 8. Idealized successional pathways for upland woody plant associations, in absence of disturbance, Oregon Dunes National Recreation Area. Time since disturbance increases from top to bottom of figure. Species codes are defined in Appendix 3.

Scot's broom was planted in the Recreation Area as early as 1910 as a source of nitrogen for plantations of European beachgrass and shore pine (McLaughlin and Brown 1942; Munger 1967; Pinto et al. 1972). Two or three species of broom were planted along the Pacific Coast, and have spread aggressively by self-seeding (McClintock 1979, 1985). They invade many habitats and alter both soils and plant succession (Mountjoy 1979). Control efforts, while successful locally, have had little effect on the continued spread of Scot's broom (Bravo 1985).

Tree lupine, also called yellow bush lupine, is less common on the Recreation Area than European beachgrass. Most populations are now limited to the South Jetty of the Siuslaw River, where many have died in recent years. In northern California, 50 years of aerial photographs showed that it had spread at an average rate of 6.4 acres per year (Miller 1987). Tree lupine originally was native as far north as Marin County (Davy 1902; Miller 1988) or Mendocino County (Sawyer and Keeler-Wolf 1995). More northerly populations, including those on the Recreation Area, originated from plantings for dune stabilization, ornamental purposes, and subsequent self-seeding (Miller 1988).

**Sites with intermittent flooding.** Recently drained sites with exposures of bare sand are favored habitat for false dandelion, birds-foot trefoil, velvet grass, sweet vernal grass, silver hairgrass, and Australian fireweed. These sites include seasonally-flooded deflation plains and recently-drained beaver ponds. Plant associations most affected are the salt rush, sickle-leaved rush-salt rush, and aquatic bed associations. The seasonally-flooded habitats exhibit high densities of weedy species, but the

associations are not replaced completely by invading species. These associations have the highest species diversity of any sampled on the Recreation Area. The aquatic bed associations are replaced by Australian fireweed, followed by native species such as slough sedge or Douglas spiraea, until new beaver dams flood the sites.

**Open water and marshes.** Open water and marshes are favored habitat for parrotfeather, Brazilian waterweed, and yellow iris. Aquatic bed associations and those in freshwater emergent marshes are most at risk of invasion. Native species may be replaced by monocultures of alien species, with little food or habitat value for vertebrates and invertebrates. The lagoon on the Siltcoos River has an especially large infestation of parrotfeather.

**Forests of Coast Range foothills.** Forest stands east of Highway 101 are being invaded by English ivy and holly. Both of these species are shade tolerant and produce prolific crops of bird-dispersed seed. They alter the structure of the understory and can outcompete native species in the herb layer.

## FLORA

**Fungi.** Fungi have never been inventoried systematically in the Recreation Area, but hundreds of species are no doubt present. Mycorrhizal fungi are present in all plant associations, and are critical for survival under poor soil conditions, such as those present in sand. In northern California, all vascular plants of the "dune mat" of Pickart et al. (1990) hosted mycorrhizae. Their "dune mat" contains elements of the red fescue and seashore bluegrass associations described in this guide. Fungal spore density and colonization reportedly were directly correlated to stability of the site. Edible mushrooms, particularly chanterelles and matsutake, are plentiful and much sought after in shore pine associations, including plantations, on the Recreation Area. Studies are underway to examine the effect of different habitats on matsutake productivity, and to monitor response to different harvest regimes (Pilz et al. 1996; Hosford et al. 1997).

**Lichens.** The lichen flora of the Recreation Area is rich, and includes many species known to occur in the Pacific Northwest only along the immediate coastline. Leuthner (1969) reported 33 species from dune habitats in the Florence area, including two sites in the Recreation Area at Cleawox Lake and Carter Lake. Recent collecting indicates there could be as many as 100 species present. Neitlich and McCune (1995) reported 74 taxa from the Bureau of Land Management's 216-acre Heceta Dunes Area of Critical Environmental Concern, just north of the Siuslaw River.

Drift logs, shore pine and Sitka spruce forest, and the shore pine/bearberry and shore pine/hairy manzanita woodland associations are particularly rich in lichens (Leuthner 1969, McCune et al. 1997). The ground in the shore pine/bearberry and shore pine/hairy manzanita woodland associations is often covered by conspicuous stands of the reindeer lichens *Cladina portentosa* ssp. *pacifica*, *Cladonia cervicornis*, *Cladonia furcata,* and at least six other taxa of *Cladonia*. These stands are rich in pollution-intolerant, nitrogen-fixing species of *Lobaria, Nephroma, Pannaria, Peltigera, Pseudocyphellaria,* and *Sticta*. These taxa are best developed in older forests (Forest Ecosystem Management Assessment Team 1993), but because old forests are rare in the dune sheet, the lichens occur instead on shrubs in these relatively long-lived seral plant associations, and also in mature stands of the Hooker willow-crabapple/slough sedge-skunk cabbage association (McCune et al. 1997).

Shore pines support showy populations of *Coccotrema*, *Ochrolechia*, *Parmotrema*, and *Pertusaria*, characteristic of coastal forest and woodland, but rare or absent inland. Epiphytic *Alectoria*, *Bryoria*, *Hypogymnia*, *Platismatia*, and *Usnea* are ubiquitous. Rare lichens occurring in or adjacent to the Recreation Area include *Anaptychia setifera*, *Buellia oidalea*, *Erioderma sorediatum*, *Hypogymnia subphysodes*, *Pannaria rubiginosa*, *Pseudocyphellaria mougeotiana*, *Leioderma sorediatum*, and *Usnea hesperina* (Neitlich and McCune 1995; McCune and Rosentreter 1997; McCune et al. 1997). These species of *Erioderma*, *Hypogymnia* and *Leioderma* are otherwise known only from the Southern Hemisphere. Most of the common epiphytic species on trees persist into later seral stands, but the uncommon species disappear as light levels diminish. The reindeer lichens characteristic of woodland associations persist in openings of later seral stands, as long as enough light is available to support hairy manzanita, but eventually disappear entirely with canopy closure. The presence of rare lichens along the immediate coast may in part be due to the historically low incidence of fire in dune habitats.

**Bryophytes.** Bryophytes have never been systematically surveyed on the Recreation Area, but probably about 75 species occur there (J.A. Christy, unpublished data). Mosses, particularly *Ceratodon purpureus*, *Dicranum scoparium*, *Pleurozium schreberi*, *Polytrichum juniperinum*, *Polytrichum piliferum*, and *Racomitrium canescens*, are most conspicuous in shore pine woodland associations, where light levels are high and nutrient levels are low. Mosses are always present in more mature forest stands, with epiphytic species sometimes occurring in great abundance in the dense shrub layer. Species diversity in these stands is low, and varies little from one plant association to the next. Liverworts are not common in the Recreation Area, in part because of the lack of large-diameter decaying logs and lack of streams and other moist, shady sites.

Almost all the bryomass in forests on the Recreation Area is composed of the mosses *Eurhynchium oreganum*, *Isothecium myosuroides*, *Plagiothecium undulatum*, and *Rhytidiadelphus loreus*. Well-developed mats of *Antitrichia curtipendula*, best represented in late-seral forests (Christy and Wagner 1996), were seen only in the old-growth western hemlock/western rhododendron-evergreen huckleberry forest near Loon Lake. The rare *Campylopus schmidii*, occurring on deflation plains of the South Jetty, and in the shore pine/slough sedge association north of Florence in the Heceta Dunes and Sutton Creek area, has a trans-Pacific distribution extending to Hawaii and Malaysia. It has been known from the Florence area since the 1930's, but has failed to expand its range since then. In contrast, *Campylopus introflexus*, native to the southern hemisphere, is a weedy immigrant that has rapidly invaded stabilized sandy areas throughout the Recreation Area.

**Vascular plants.** Some 260 species of vascular plants have been reported from the Recreation Area (Appendix 3). The diversity of landforms, soils, and presence of both brackish and fresh water, account for the great number of species. Dry and seasonally wet deflation plains have the highest species diversity (Table 5). Knobcone pine, black pine, Monterey pine, Scots pine, and coast redwood were planted for dune stabilization and also as ornamentals, but are not known to be reproducing. Scots broom, tree lupine, birdfoot trefoil and European beachgrass were planted for stabilization programs, and all have naturalized. Many other species are widespread, invasive Eurasian weeds. Rare species include whorled marsh pennywort, pink sandverbena, salt-marsh birds's-beak, bog clubmoss, and adder's tongue. Pink sandverbena occurs in dry dune habitat threatened by European beachgrass and off-road vehicles, and the other species occur in estuarine or freshwater wetlands.

**Plant associations.** This guide describes and classifies 52 plant associations found in the Recreation Area, and there are no doubt others that escaped our attention. The extent of a number these associations has declined throughout the region, because of exclusion by invasive species, dune stabilization, and

possibly the absence of fire. Rare associations of open dunes include the American dunegrass, red fescue, and seashore bluegrass associations, declining because of invasion by European beachgrass. The shore pine/bearberry and shore pine/hairy manzanita associations are becoming rare because of damage by off-road vehicles, and changes in succession resulting from dune stabilization and possibly cessation of fire. The bog blueberry/tufted hairgrass association and the shore pine/slough sedge association are rare because they were never common or of large extent, although the latter may be increasing because of the expansion of deflation plains. The Sitka spruce-red alder/slough sedge-skunk cabbage association is rare because it may never have been common, and almost all known occurrences have been logged. The Port Orford cedar/evergreen huckleberry association is rare because most stands have been logged, and the few remaining examples on or adjacent to the Recreation Area are being infected by the lethal Port Orford cedar root disease.

## FAUNA

A number of references reviewed by Wiedemann (1984) and Pickart (1990) describe the fauna of the coastal area, but make no specific mention of the Recreation Area. The complex topography, vegetation, and presence of both fresh and salt water in the Recreation Area creates a great variety of wildlife habitat. Wiedemann (1984) identified seven structural types in a classification of wildlife habitat: open dunes, grassland and meadow, shrub thicket, forest, marsh, riparian, and lakes and ponds. To this list could be added the habitat of streams and rivers cutting across the dunes, and salt marsh, with its fauna so different from freshwater systems. Pickart (1990) reviewed work documenting the relative paucity of vertebrates in open dune habitats, and the rich fauna of willow swamps and conifer forest, in dunes of northern California. Shore pine forest had fewer species, thought to reflect the large amount of edge habitat unsuitable for forest birds. Amphibians were limited to the coniferous forest, where greater moisture and organic content provided more habitat. Because of the lack of cover in the open dunes, tracks in the sand suggest that most use of this area by both vertebrates and invertebrates is nocturnal.

Pinto et al. (1972) listed 426 species of birds, fish, shellfish, mammals, reptiles and amphibians known or expected to occur in the Recreation Area. A more recent source estimates the total number of wildlife species to be about 470, including 316 birds, 54 mammals, 12 amphibians, 3 reptiles, 54 estuarine fish, 20 freshwater fish, 9 anadromous fish, and 2 shellfish (Siuslaw National Forest 1994). Larger mammals include black bear, elk, bobcat, coyote, black-tailed deer, beaver, skunks and raccoons. Bird life is abundant, including great blue heron, egrets, osprey and a variety of songbirds. Rare species include the bald eagle and western snowy plover. Eagle nests have been recorded from Tenmile Creek, near Siltcoos Lake and near Gardner, while the plover nests have been recorded near Siltcoos River, the North Spit, south of Tahkenitch Creek, and in the Tenmile Creek estuary. Tenmile Creek, Threemile Creek, and the Siltcoos and Siuslaw rivers are thought to support runs of coho salmon. The larger lakes contain trout and bass, the latter an introduced species. Estuarine mud flats contain a variety of marine invertebrates, including shellfish. Wiedemann (1984) and Pickart (1990) reviewed what little is known of the invertebrate fauna of the dunes, many of whose tracks and burrows can be seen on the sand.

## SITE PRODUCTIVITY

Drought, low nutrient status, and low pH render most soils on the Recreation Area unproductive for tree growth. Despite moderate temperatures and low rates of evaporation, moisture stress in droughty

sand may limit plant growth in late summer. During summer, fog drip may be the only source of moisture for weeks at a time. Burial by shifting sand also stunts or terminates tree growth and may initiate attack by insects (Pinto et al. 1972) or fungi. Templeton silt loam is the most productive soil for commercial conifer production, while most other soils of the Recreation Area have low productivity (Table 2).

Management constraints on dry, highly permeable dune soils include slumping, windthrow, drought, and rejuvenation of sand movement by wind erosion. Constraints for upland silt loams include compaction, sheet and gully erosion, and unstable slopes (Patching 1987; Haagan 1989).

## METHODS

**Data collection.** Plant associations were identified by collecting data in sample plots, and analyzing the data to group together similar vegetation types. Vegetation data were collected from plots sampled along permanent transects, as well as larger reconnaissance plots scattered throughout the Recreation Area. Plots were sampled in all types of vegetation in an attempt to obtain a complete picture of the diversity of plant associations on the Recreation Area, both naturally-occurring and those originating from human activity. These included early seral associations on shifting sand, plantations, stands dominated by introduced species, and natural forest stands more than 600 years old. All vegetation and plot location data are on file at the headquarters of the Siuslaw National Forest, in Corvallis, Oregon.

Table 2. Site productivity for selected tree species on soils occurring in the Oregon Dunes National Recreation Area. From Patching (1987) and Haagen (1989).

| Soil type | Tree species | Mean site index | Site index curve (yr) |
|---|---|---|---|
| Bandon | Douglas fir | 137-138 | 100 |
| | Douglas fir | 105 | 50 |
| Blacklock | Shore pine | 90 | 100 |
| Bullards | Douglas fir | 144 | 100 |
| Netarts | Douglas fir | 80-124 | 100 |
| | Douglas fir | 100 | 50 |
| Salander | Sitka spruce | 180 | 100 |
| Templeton | Sitka spruce | 169-180 | 100 |
| | Douglas fir | 170 | 100 |
| Waldport | Shore pine | 90-92 | 100 |

In 1987, twelve permanent transects were installed in the Recreation Area, each extending from foredunes or deflation plains inland to the edge of the forest. They were placed subjectively, to capture a cross-section of herbaceous and shrubby vegetation types, including ecotonal areas between beaches and forest, as well as to cover any potential variability throughout the length of the Recreation Area. The transects were intended to identify gradients between plant associations, and to monitor long-term changes to vegetation due to succession and shifting sand. Changes in vegetation were recorded along each transect, using the vegetation/landform mapping units of Pinto et al. (1972), and three plots

overing 1m$^2$ each (hereafter called "**transect plots**") were sampled in each mapping unit. A total of 330 ransect plots were sampled. The ends of each transect were marked with reinforcing bar and PVC pipe, nd marked on air photos and maps. A hand-held global positioning satellite receiver was used later to btain coordinates for both the end points of each transects, as well as some of the boundaries of each andform type along each transect.

A second series of plots (hereafter called "**recon plots**") were designed to sample larger areas, articularly shrub and forest associations. A total of 290 recon plots were sampled between 1987 and 993, allowing a relatively rapid assessment of vegetation diversity. Plots of 500 m$^2$ were used for most tands. Some wetland associations required smaller plots of 10-50 m$^2$, because of limited size or linear onfiguration around bodies of water. Selection of plot sizes were based upon published literature of pecies-area curves for different vegetation types (Mueller-Dombois and Ellenberg 1974; Bonham 1989; Krebs 1989), and upon our own experience of working in these plant associations. Plots were placed ubjectively in more or less uniform stands of vegetation, avoiding obvious ecotonal features (Mueller-Dombois and Ellenberg 1974). We tried to sample discrete associations of plants, repeated elsewhere n the landscape, and tried to avoid obvious ecotonal areas. Using this method, sampling some ecotonal lots could not be avoided. Locations were recorded on aerial photographs, but not marked permanently n the field.

Variables for which data were collected in transect plots and recon plots are described in Appendix 1.

**Data analysis.** Because of the differences in plot size and environmental data gathered in each, data rom recon plots and transect plots were analyzed separately. Plots were grouped into plant associations sing the clustering programs SYN-TAX (Podani 1990) and TWINSPAN (Hill 1979), and were further egregated by analysis of association tables generated by ECOAID (Smith 1993). In all cases, ECOAID vas used to average cover values for all plots within a plant association, rather than for only those plots n which specific taxa occurred. CANOCO (ter Braak 1988) was used to ordinate data from recon plots, o help identify environmental gradients influencing distribution of vegetation. Data from transect plots vere not ordinated, because few environmental variables were recorded when vegetation was sampled.

Because recon plots covered a larger area than transect plots, and offered more environmental lata, we used them for most descriptive purposes, except in cases where the only data available were rom transect plots. Many of the transect plots occurred in ecotonal areas, and did not sort well in the luster analysis. Data from transect plots were used to corroborate differences observed in recon plots, nd in most cases the groupings in each plot type were similar.

**Botanical nomenclature.** Scientific names used in this guide follow the PLANTS database for vascular lants (USDA, NRCS 1997), Esslinger and Egan (1995) for lichens, and Anderson (1990) and Anderson t al. (1990) for mosses. The species codes are those used in the PLANTS database.

**Classification concepts.** Construction of a vegetation classification for the Recreation Area was hallenging because of the unique dynamics of the sand dune ecosystem. Countless local episodes of and destabilization by wind, fire and tectonic disturbance have created complex patterns of both andform and vegetation, many of which occur side-by-side in small areas.

Our vegetation classification for the Recreation Area is structured to conform with the National Vegetation Classification System (NVCS) currently in preparation (Federal Geographic Data Committee

1996; Anderson et al. 1998; Grossman et al. 1998). The NVCS is a hierarchical classification designed to standardize vegetation classification in the United States. To date, multiple approaches by multiple agencies, each driven by differing classification philosophies and program needs, have produced a variety of classification schemes with little conformity between them. The NVCS employs a nested system of seven higher-order physiognomic ranks, derived from previous classifications by UNESCO (1973) and Driscoll et al. (1984), and two lower-order floristic ranks (Anderson et al. 1998; Grossman et al. 1998). It accommodates both natural and human-influenced associations, including plantations and stands dominated by introduced species.

Like the vegetation classification developed for Alaska (Viereck et al. 1992), the NVCS classification focuses on existing vegetation types, de-emphasizing climax or potential vegetation types. The concept of climax associations is difficult to apply in the Recreation Area, because of the pervasive threat of burial by sand, erosion of previously stabilized surfaces by wind, proximity to salt spray, and the uncertainty of some successional pathways. The majority of stands sampled in the study area are early seral to mid-seral associations, and the environmental stability needed for late seral or old-growth types is rare.

The NVCS uses the plant association as the basic unit of classification (Federal Geographic Data Committee 1996). The associations are named after one or more diagnostic species in each vegetation layer. These associations are grouped under alliances, named by one or more diagnostic species occurring in the uppermost layer. Plant associations are assemblages of plants that occur together at specific sites, identified by variables defining species composition and structure. They share one or more diagnostic overstory and understory species, and occur as repeatable patterns of assemblages across the landscape (Johnson and Clausnitzer 1992; Shephard 1995; Federal Geographic Data Committee 1996). Stands in a given association need not have identical species composition or environmental parameters (Thilenius 1995). The species-based approach to naming associations and alliances helps to identify specific units of vegetation on the ground. It differs from some approaches that have used landforms to classify dune vegetation, such as the "dune mat" and "dune hollow" associations of Duebendorfer (1990, 1992) and Pickart (1987, 1990).

Many wetland species tend to form monotypic stands over relatively large areas, but they are also capable of forming mixed stands with other types. In these cases, we recognize the monotypic expression of these species as plant associations, and consider the mixed stands to be ecotones. Some researchers would sample these mixed stands as single units, and would lump several types that we would recognize as being distinct.

## RESULTS

**Classification of plant associations.** We identified 52 plant associations from the Recreation Area (Table 3). A few associations were not sampled in the field; these are included in Table 3, the identification key, and have brief association descriptions, but most are not included in the successional schemes. Summary data for both recon and transect plots are given in Appendix 1 and Appendix 2. Five vegetation classes, defined by the National Vegetation Classification System, are present on the Recreation Area: forest, woodland, shrubland, dwarf-shrubland, and herbaceous vegetation. Forest is represented by eight alliances, containing 13 forest associations, dominated by either Port Orford cedar, Sitka spruce, Douglas fir, western hemlock, shore pine, or red alder, with two additional wetland shore pine and Sitka spruce alliances. Woodland is represented by one alliance with three associations, all

lominated by shore pine. Five shrub alliances include six associations, dominated by either Scots ›room, tree lupine, Hooker willow, or Douglas spiraea. Dwarf-shrub has two alliances with three ıssociations, all dominated by bog blueberry. Herbaceous vegetation is represented by 27 alliances, :ontaining 31 associations, ranging from dry dunes to both fresh and saltwater wetlands.

**Ordination of plant associations.** Ordination of the 1993 plot data, containing the most complete set ›f environmental variables, shows clear distinctions between forest and herbaceous dune associations, ınd between upland and wetland associations (Fig. 9). The horizontal axis is characterized by a gradient rom bare sand (right side) to vegetated sand (left side), with a corresponding increase from right to left n shading, soil development, nutrient status, stand structure, and age. The vertical axis is characterized ›y a moisture gradient, dry at the top and wet at the bottom, with a corresponding increase from top to ›ottom in vegetative cover, soil development, nutrient status, and stand structure. Slope, aspect, total noss cover, and cover of tall shrubs are most important in well-developed, well-drained forest stands. Cover of low shrubs is greatest in wetland shrub associations.

**Tree growth rate, stand structure, and successional status.** Current growth data from forest stands, :xpressed in 20ths of an inch for the most recent ten years of radial growth, reveal the growth rate of ndividual species in different stands (Table 4). These data, together with relative amounts live and dead ›asal area (Fig. 10), give some indication of successional trends in forest and woodland on the Recreation Area. Figure 10 shows that tree height rarely exceeds 100 feet, and live basal area probably ıever exceeds 150 $ft^2$ per acre. Limitation of tree height and live basal area is presumably attributable o dry soils, low nutrient status, high winds, and salt spray in the dune environment. Higher dead basal ırea on the Recreation Area is generally correlated with mid-seral to climax status.

**Wetlands.** Wetlands, occupying about 20 percent of the Recreation Area, account for half the plant ıssociations present. Water regimes present are identified at the alliance rank in Table 3, and are defined n Cowardin et al. (1979). Water regimes for tidal wetlands include regularly flooded ("low salt marsh") ınd irregularly flooded ("high salt marsh"). Freshwater regimes include permanently flooded, emipermanently flooded, seasonally flooded, saturated, and temporarily flooded. Three of the 13 forest ıssociations, one of the three woodland associations, four of the six shrubland associations, both dwarf-hrubland associations, and 22 of the 31 herbaceous associations are wetlands. Although most wetland pecies are circumboreal or cosmopolitan in distribution, plant associations dominated by particular pecies tend to be more restricted in range, because of regional differences in species composition. While most wetland associations present on the Recreation Area are widespread in the Pacific Northwest, a few have a more restricted distribution. The wetland associations on deflation plains have ome of the highest diversity of plant species in the Recreation Area (Table 5). High species diversity s correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and ›iennials, and a seasonally-fluctuating water regime that allows for favorable germination and :stablishment.

Table 3. Classification of plant associations recorded from the Oregon Dunes National Recreation Area, based on National Vegetation Classification System (NVCS). For the purposes of this guide, we have substituted the scientific plant names with common names. Some of these associations have not yet been incorporated into the NVCS. Species codes are defined in Appendix 3.

Forest (Trees with crowns overlapping, generally 60-100 % cover)
- Evergreen forest (Evergreen species generally > 75 % total tree cover)
  - Upland
    - PORT ORFORD CEDAR FOREST ALLIANCE
      - Port Orford cedar/evergreen huckleberry forest (CHLA/VAOV2)
    - SITKA SPRUCE FOREST ALLIANCE
      - Sitka spruce/salal forest (PISI/GASH)
      - Sitka spruce/salal-salmonberry forest (PISI/GASH-RUSP)
      - Sitka spruce/sword fern forest (PISI/POMU)
      - Sitka spruce/evergreen huckleberry forest (PISI/VAOV2)
    - DOUGLAS FIR GIANT FOREST ALLIANCE
      - Douglas fir/western rhododendron-evergreen huckleberry forest (PSME/RHMA3-VAOV2)
    - WESTERN HEMLOCK GIANT FOREST ALLIANCE
      - Western hemlock/western rhododendron-evergreen huckleberry forest (TSHE/RHMA3-VAOV2)
    - SHORE PINE FOREST ALLIANCE
      - Shore pine-Sitka spruce/evergreen huckleberry forest (PICOC-PISI/VAOV2)
      - Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest (PICOC-PSME/MYCA-VAOV2)
      - Shore pine/Scots broom/European beachgrass forest (PICOC/CYSC4/AMAR4)
  - Seasonally flooded
    - SHORE PINE SEASONALLY FLOODED FOREST ALLIANCE
      - Shore pine/slough sedge forest (PICOC/CAOB3)
  - Saturated
    - SITKA SPRUCE SATURATED FOREST ALLIANCE
      - Sitka spruce-red alder/slough sedge-skunk cabbage forest (PISI-ALRU/CAOB3-LYAM3)
- Deciduous forest (Deciduous species generally > 75 % of total tree cover)
  - Saturated
    - RED ALDER SATURATED FOREST ALLIANCE
      - Red alder/salmonberry/slough sedge-skunk cabbage forest (ALRU/RUSP/CAOB3-LYAM3)

Woodland (Open stands with crowns not usually touching, generally forming 25-60 % cover, sometimes less)
- Evergreen woodland (evergreen species generally > 75 % of total tree cover)
  - Upland
    - SHORE PINE WOODLAND ALLIANCE
      - Shore pine/hairy manzanita woodland (PICOC/ARCO3)
      - Shore pine/bearberry woodland (PICOC/ARUV)

Shrubland (> 0.5 m tall, generally > 25 % cover; tree cover generally < 25 %)
- Deciduous shrubland (deciduous species generally > 75% of total shrub cover)
  - Upland
    - TREE LUPINE SHRUBLAND ALLIANCE
      - Tree lupine/European beachgrass shrubland (LUAR/AMAR4)
  - Seasonally flooded
    - HOOKER WILLOW SEASONALLY FLOODED SHRUBLAND ALLIANCE
      - Hooker willow/slough sedge-Pacific silverweed shrubland (SAHO/CAOB3-AREGE)
  - Saturated
    - DOUGLAS SPIRAEA SATURATED SHRUBLAND ALLIANCE
      - Douglas spiraea shrubland (SPDO)
    - HOOKER WILLOW SATURATED SHRUBLAND ALLIANCE
      - Hooker willow-crabapple/slough sedge-skunk cabbage shrubland (SAHO-MAFU/CAOB3-LYAM3)

warf-shrubland (shrubs < 2 feet tall, generally > 25 % cover; tree cover generally < 25 % )
Deciduous dwarf-shrubland
Seasonally flooded
BOG BLUEBERRY SEASONALLY FLOODED DWARF-SHRUBLAND ALLIANCE
Bog blueberry/slough sedge dwarf-shrubland (VAUL/CAOB3)
Bog blueberry/tufted hairgrass dwarf-shrubland (VAUL/DECEC)
erbaceous vegetation (graminoids, forbs and ferns generally > 25 % cover; trees and shrubs generally < 25 % cover)
Perennial graminoid vegetation (generally > 50% of total herbaceous cover)
Upland
EUROPEAN BEACHGRASS HERBACEOUS ALLIANCE
European beachgrass herbaceous vegetation (AMAR4)
AMERICAN DUNEGRASS HERBACEOUS ALLIANCE
American dunegrass herbaceous vegetation (LEMOM2)
RED FESCUE HERBACEOUS ALLIANCE
Red fescue herbaceous vegetation (FERU2)
Red fescue-salt rush herbaceous vegetation (FERU2-JULE)
Red fescue-bracken fern herbaceous vegetation (FERU2-PTAQ)
SALT RUSH HERBACEOUS ALLIANCE
Salt rush herbaceous vegetation (JULE)
SICKLE-LEAVED RUSH HERBACEOUS ALLIANCE
Sickle-leaved rush-salt rush herbaceous vegetation (JUFA-JULE)
SEASHORE BLUEGRASS HERBACEOUS ALLIANCE
Seashore bluegrass herbaceous vegetation (POMA26)
Seasonally flooded
SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE
Slough sedge seasonally flooded herbaceous vegetation (CAOB3)
Slough sedge-Pacific silverweed herbaceous vegetation (CAOB3-AREGE)
INFLATED SEDGE SEASONALLY-FLOODED HERBACEOUS ALLIANCE
Inflated sedge herbaceous vegetation (CAEX5)
THREEWAY SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE
Threeway sedge herbaceous vegetation (DUAR3)
CREEPING SPIKERUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE
Creeping spikerush-Nevada rush herbaceous vegetation (ELPA3-JUNE)
KNOTGRASS SEASONALLY FLOODED HERBACEOUS ALLIANCE
Knotgrass herbaceous vegetation (PADI6)
HARDSTEM BULRUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE
Hardstem bulrush herbaceous vegetation (SCACA)
Tidally flooded
CREEPING BENTGRASS IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Creeping bentgrass-Pacific silverweed tidal herbaceous vegetation (AGSTS-AREGE)
LYNGBY SEDGE REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Lyngby sedge-Pacific silverweed tidal herbaceous vegetation (CALY3-AREGE)
TUFTED HAIRGRASS IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Tufted hairgrass-Pacific silverweed tidal herbaceous vegetation (DECEC-AREGE)
SALTGRASS REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Saltgrass-Pacific silverweed tidal herbaceous vegetation (DISP-AREGE)
BALTIC RUSH IRREGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Baltic rush-Pacific silverweed tidal herbaceous vegetation (JUBA-AREGE)
THREE-SQUARE BULRUSH REGULARLY FLOODED TIDAL HERBACEOUS ALLIANCE
Three-square bulrush tidal herbaceous vegetation (SCAM6)
Perennial forb vegetation, including ferns (generally > 50% total herbaceous cover)
Upland
SEASHORE LUPINE HERBACEOUS ALLIANCE
Seashore lupine herbaceous vegetation (LULI2)
Seasonally flooded
WATERPEPPER SEASONALLY FLOODED HERBACEOUS ALLIANCE
Waterpepper-water purslane herbaceous vegetation (POHY2-LUPA)

Semipermanently flooded

FLOATING WATER-PENNYWORT SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

Floating water-pennywort herbaceous vegetation (HYRA)

POND LILY SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

Pond lily herbaceous vegetation (NULUP)

WATER SMARTWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

Water smartweed herbaceous vegetation (POAM8)

FLOATING-LEAVED PONDWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

Floating-leaved pondweed herbaceous vegetation (PONA4)

SIMPLESTEM BUR-REED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

Simplestem bur-reed herbaceous vegetation (SPAN2)

Hydromorphic rooted vegetation (non-emergent graminoids or forbs structurally supported by water)

Permanently flooded

SOUTH AMERICAN WATERWEED PERMANENTLY FLOODED HERBACEOUS ALLIANCE

South American waterweed herbaceous vegetation (EGDE)

PARROT-FEATHER PERMANENTLY FLOODED HERBACEOUS ALLIANCE

Parrot-feather herbaceous vegetation (MYAQ2)

COMMON BLADDERWORT PERMANENTLY FLOODED HERBACEOUS ALLIANCE

Common bladderwort herbaceous vegetation (UTMA)

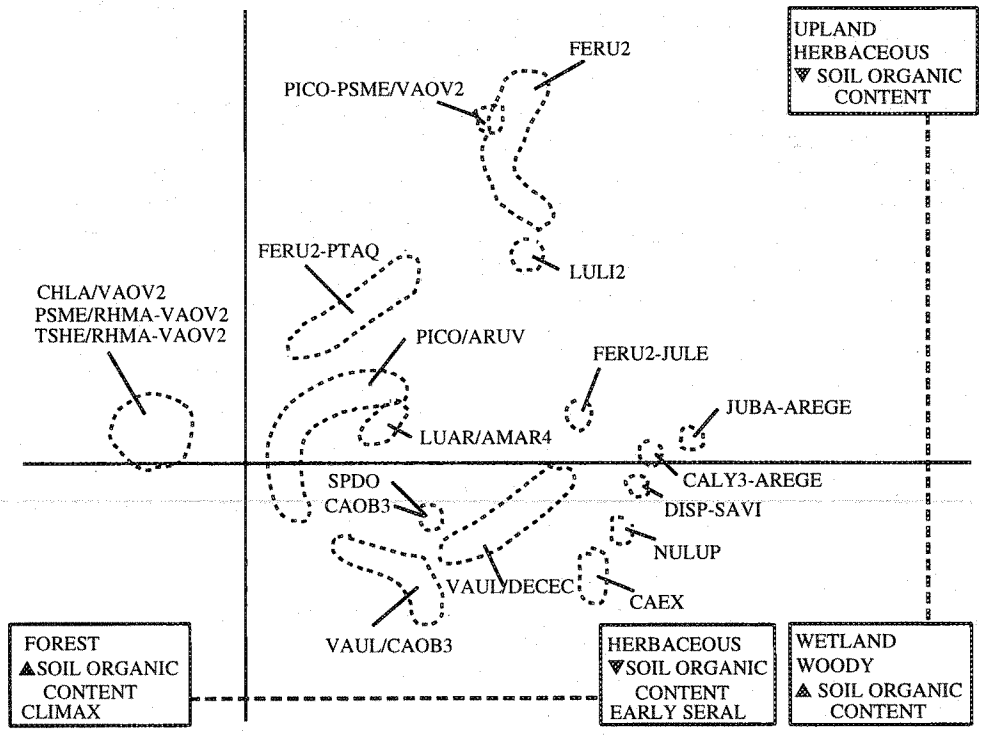


Fig. 9. Ordination of selected plant associations, Oregon Dunes National Recreation Area. Species codes are defined in Appendix 3.

'able 4. Current growth (last 10 yr of radial growth, in 20ths of an inch) for trees sampled in recon plots in Oregon Dunes National Recreation Area. Species codes are defined in Appendix 3.

| lant association | Species | Curr. growth (mean) | No. trees sampled |
|---|---|---|---|
| .LRU/RUSP/CAOB3-LYAM3 | ALRU | 33 (33) | 1 |
| 'HLA/VAOV2 | CHLA | 2-10 (6) | 8 |
| | PISI | 2-24 (12) | 5 |
| | PICOC | 8 (8) | 2 |
| | PSME | 4-15 (9) | 5 |
| | TSHE | 12-14 (13) | 2 |
| ICOC/ARCO3 | PICOC | 6-13 (9) | 4 |
| | PSME | 22-23 (23) | 2 |
| ICOC/ARUV | PICOC | 6-10 (8) | 6 |
| ICOC/CAOB3 | PISI | 16 (16) | 1 |
| | PICOC | 6-22 (12) | 4 |
| ICOC/CYSC4/AMAR4 | PICOC | 7-61 (30) | 5 |
| | PSME | 56 (56) | 1 |
| 'ISI-PICOC/VAOV2 | PISI | 6-46 (17) | 13 |
| | PICOC | 7-44 (18) | 16 |
| | PSME | 13-35 (23) | 3 |
| | TSHE | 15 (15) | 1 |
| 'ICOC-PSME/MYCA-VAOV2 | PISI | 16 (16) | 1 |
| | PICOC | 3-21 (8) | 16 |
| | PSME | 2-42 (11) | 13 |
| | TSHE | 20 (20) | 1 |
| 'ISI/GASH-RUSP | PISI | 21 (21) | 1 |
| 'ISI/GASH | PISI | 21 | 1 |
| 'ISI/VAOV2 | PISI | 2-27 (13) | 13 |
| | PICOC | 7 (7) | 1 |
| | PSME | 6-30 (15) | 3 |
| | THPL | 11 (11) | 1 |
| | TSHE | 6-8 (7) | 2 |
| 'SME/RHMA3-VAOV2 | PISI | 26 (26) | 1 |
| | PICOC | 4-14 (8) | 4 |
| | PSME | 2-18 (8) | 13 |
| | THPL | 17-20 (19) | 2 |
| 'SHE/RHMA3-VAOV2 | PISI | 2-78 (21) | 8 |
| | PSME | 2-10 (6) | 12 |
| | THPL | 8-27 (14) | 6 |
| | TSHE | 5-33 (14) | 9 |

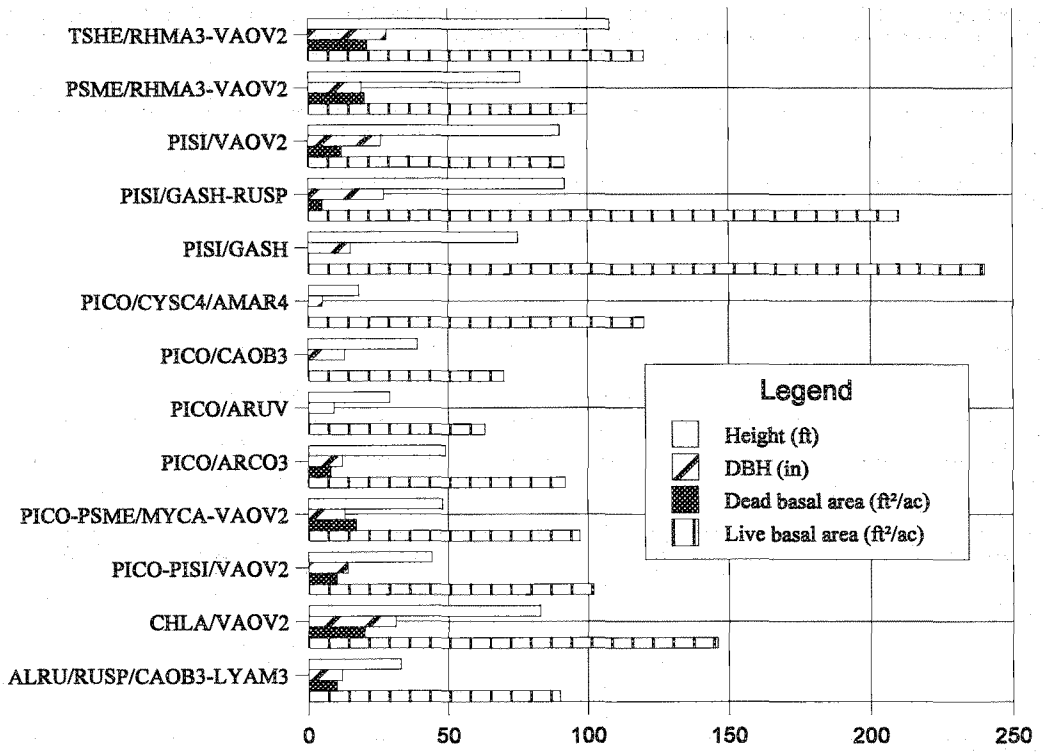


Fig. 10. Forest and woodland tree structure, Oregon Dunes National Recreation Area.

Table 5. Number of plant species recorded in plots sampled on Oregon Dunes National Recreation Area, by layer. (n) = number of recon plots.

| | Overstory trees | Understory trees | Shrubs & woody groundcover | Herbs, ferns & graminoids |
|---|---|---|---|---|
| **Forest** | | | | |
| ALRU/RUSP/CAOB3-LYAM3 (2) | 3 | 4 | 10 | 7 |
| CHLA/VAOV2 (11) | 6 | 8 | 7 | 9 |
| PICOC/CAOB3 (6) | 2 | 3 | 10 | 24 |
| PICOC/CYSC4/AMAR4 (14) | 3 | 4 | 9 | 31 |
| PICOC-PSME/MYCA-VAOV2 (15) | 4 | 5 | 11 | 8 |
| PISI/GASH (1) | 1 | 1 | 2 | 5 |
| PISI/GASH-RUSP (4) | 3 | 4 | 6 | 9 |
| PISI-PICOC/VAOV2 (12) | 5 | 7 | 13 | 19 |
| PISI/VAOV2 (14) | 6 | 6 | 9 | 12 |
| PSME/RHMA3-VAOV2 (11) | 4 | 5 | 8 | 8 |
| TSHE/RHMA3-VAOV2 (16) | 6 | 6 | 9 | 10 |
| **Woodland** | | | | |
| PICOC/ARCO3 (5) | 2 | 2 | 7 | 10 |
| PICOC/ARUV (11) | 3 | 5 | 7 | 18 |
| **Shrubland** | | | | |
| LUAR/AMAR4 (2) | 0 | 2 | 8 | 24 |
| SAHO-MAFU/CAOB3-LYAM3 (2) | 3 | 0 | 8 | 12 |
| SAHO/CAOB3-AREGE (18) | 2 | 3 | 11 | 42 |
| SPDO (1) | 0 | 0 | 2 | 4 |
| **Dwarf-shrubland** | | | | |
| VAUL/CAOB3 (10) | 1 | 3 | 10 | 32 |
| VAUL/DECEC (3) | 1 | 3 | 5 | 26 |
| **Herbaceous** | | | | |
| AGSTS-AREGE | 0 | 0 | 0 | 8 |
| AMAR4 (16) | 1 | 2 | 9 | 44 |
| CALY3-AREGE (4) | 0 | 0 | 0 | 22 |
| CAEX5 (3) | 0 | 0 | 2 | 12 |
| CAOB3 (1) | 0 | 0 | 0 | 0 |
| CAOB3-AREGE (15) | 1 | 2 | 8 | 54 |
| DISP-AREGE (6) | 0 | 0 | 0 | 23 |
| ELPA3-JUNE (11) | 0 | 0 | 5 | 49 |
| FERU2 (9) | 0 | 2 | 1 | 17 |
| FERU2-JULE (6) | 0 | 3 | 6 | 52 |
| FERU2-PTAQ (3) | 0 | 1 | 2 | 8 |
| JUBA-AREGE (1) | 0 | 0 | 0 | 8 |
| JUFA-JULE (10) | 1 | 2 | 7 | 48 |
| JULE (7) | 1 | 2 | 7 | 52 |
| LEMOM2 (4) | 0 | 1 | 4 | 28 |
| LULI2 (4) | 0 | 0 | 0 | 16 |
| NULUP (1) | 0 | 0 | 1 | 11 |
| POMA26 (1) | 0 | 0 | 0 | 5 |
| PONA4 (1) | 0 | 0 | 0 | 6 |
| SCACA (1) | 0 | 0 | 2 | 3 |
| SCAM6 (3) | 0 | 0 | 1 | 16 |
| SPAN2 (1) | 0 | 0 | 0 | 5 |

# KEY TO PLANT ASSOCIATIONS OF THE OREGON DUNES NATIONAL RECREATION AREA

1a. Tree species (any layer) generally > 60 % cover [**FOREST ASSOCIATIONS**] . . . . . 5 (p. 33)
1b. Tree species (any layer) generally < 60 % cover . . . . . 2

2a. Tree species (any layer) generally 25-60 % cover [**WOODLAND ASSOCIATIONS**] . . . . . 17 (p. 34)
2b. Tree species (any layer) generally < 25 % cover . . . . . 3

3a. Shrubs > 25 % cover . . . . . 4
3b. Shrubs < 25 % cover [**HERBACEOUS ASSOCIATIONS**] . . . . . 31 (p. 35)

4a. Mature shrubs over 2 ft tall [**SHRUBLAND ASSOCIATIONS**] . . . . . 24 (p. 35)
4b. Mature shrubs under 2 ft tall [**DWARF-SHRUBLAND ASSOCIATIONS**] . . . . . 29 (p. 35)

## FOREST ASSOCIATIONS

5a. Red alder > 20 % cover . . . . . **Red alder/salmonberry/slough sedge-skunk cabbage saturated forest** (p. 64)
5b. Red alder < 20 % cover . . . . . 6

6a. Port Orford cedar (any layer) > 10 % cover . . . . . **Port Orford cedar/evergreen huckleberry forest** (p. 40)
6b. Port Orford cedar (any layer) < 10 % cover . . . . . 7

7a. Western hemlock or Douglas fir (any layer) > 20 % cover . . . . . 8
7b. Western hemlock or Douglas fir (any layer) < 20 % cover . . . . . 10

8a. Western hemlock (any layer) > 20 % cover . . . . . **Western hemlock/western rhododendron-evergreen huckleberry forest** . . . . . (p. 52)
8b. Western hemlock (any layer) < 20 % cover . . . . . 9

9a. Shore pine (any layer) > 20 % cover . . . . . **Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest** (p. 56)
9b. Shore pine (any layer) < 20 % cover . . . . . **Douglas fir/western rhododendron-evergreen huckleberry forest** (p. 50)

10a. Of conifers present (any layer), Sitka spruce only one > 20 % cover . . . . . 11
10b. Sitka spruce and shore pine (any layer) both > 20 % cover, or of conifers present (any layer), shore pine only one > 20 % cover . . . . . 15

11a. Evergreen huckleberry > 10 % cover . . . . . **Sitka spruce/evergreen huckleberry forest** (p. 48)
11b. Evergreen huckleberry < 10 % cover . . . . . 12

12a. Skunk cabbage > 10 % cover . . . . . **Sitka spruce-red alder/slough sedge-skunk cabbage forest** (p. 62)
12b. Skunk cabbage < 10 % cover . . . . . 13

13a. Salmonberry > 10 % cover . . . . . **Sitka spruce/salal-salmonberry forest** (p. 44)
13b. Salmonberry < 10 % cover . . . . . 14

14a. Salal > 10 % cover . . . . . **Sitka spruce/salal forest** (p. 46)
14b. Salal < 10 % cover . . . . . **Sitka spruce/sword fern forest** (p. 42)

15a. Sitka spruce and shore pine (any layer) both > 20 % cover . . . . . **Shore pine-Sitka spruce/evergreen huckleberry forest** (p. 54)
15b. Of conifers present (any layer), shore pine only one > 20 % cover . . . . . 16

16a. Slough sedge > 10 % cover, European beachgrass < 10 % cover . . . . . **Shore pine/slough sedge forest** (p. 60)
16b. Slough sedge < 10 % cover, European beachgrass > 10 % cover . . . . . **Shore pine/Scots broom/European beachgrass forest** (p. 58)

## WOODLAND ASSOCIATIONS

17a. Of conifers present (any layer), shore pine only one > 20 % cover . . . . . 18
17b. Shore pine with either Douglas fir or Sitka spruce (any layer) > 20 % cover . . . . . 21

18a. Shrub layer with hairy manzanita or bearberry . . . . . 19
18b. Shrub layer lacking hairy manzanita or bearberry . . . . . 20

19a. Hairy manzanita > 10 % cover, bearberry < 10 % cover . . . . . **Shore pine/hairy manzanita woodland** (p. 70)
19b. Hairy manzanita < 10 % cover, bearberry > 10 % cover . . . . . **Shore pine/bearberry woodland** (p. 68)

20a. Slough sedge > 10 % cover, European beachgrass < 10 % cover . . . . . see **Shore pine/slough sedge forest** (p. 60)
20b. Slough sedge < 10 % cover, European beachgrass > 10 % cover . . . . . see **Shore pine/Scots broom/European beachgrass forest** (p. 58)

21a. Shore pine (any layer) > 20% cover . . . . . 22
21b. Shore pine (any layer) < 20 % cover . . . . . 23

22a. Douglas fir (any layer) > 20 % cover . . . . . see **Shore pine-Douglas fir/wax myrtle-evergreen huckleberry forest** (p. 56)
22b. Sitka spruce (any layer) > 20 % cover . . . . . see **Shore pine-Sitka spruce/evergreen huckleberry forest** (p. 54)

23a. Douglas fir (any layer) > 20 % cover . . . . . see **Douglas fir/western rhododendron-evergreen huckleberry forest** (p. 50)
23b. Sitka spruce (any layer) > 20 % cover . . . . . see **Sitka spruce/evergreen huckleberry forest** (p. 48)

## SHRUBLAND ASSOCIATIONS

24a. Hooker willow > 20 % cover . . . . . 25
24b. Hooker willow < 20 % cover . . . . . 27

25a. Pacific silverweed > 10 % cover . . . . . **Hooker willow/slough sedge-Pacific silverweed shrubland** (p. 76)
25b. Pacific silverweed < 10 % cover . . . . . 26

26a. Bird-foot trefoil > 10 % cover, slough sedge < 10 % cover . . . . . see **Sickle-leaved rush-salt rush herbaceous vegetation** (p. 102)
26b. Bird-foot trefoil < 10 % cover, slough sedge > 10 % cover . . . . . **Hooker willow-crabapple/slough sedge-skunk cabbage shrubland** (p. 80)

27a. Tree lupine > 10 % cover, Douglas spiraea < 10 % cover . . . . . **Tree lupine/European beachgrass shrubland** (p. 74)
27b. Tree lupine < 10 % cover . . . . . 28

28a. Scots broom > 10 % cover, Douglas spiraea < 10 % cover . . . . . see **Shore pine/Scots broom/European beachgrass forest** (p. 58)
28b. Scots broom < 10 % cover, Douglas spiraea > 10 % cover . . . . . **Douglas spiraea saturated shrubland** (p. 78)

## DWARF-SHRUBLAND ASSOCIATIONS

29a. Bearberry > 10 % cover . . . . . see **Shore pine/bearberry woodland** (p. 68)
29b. Bearberry < 10 % cover . . . . . 30

30a. Tufted hairgrass > 10 % cover, slough sedge < 10 % cover . . . . . **Bog blueberry/tufted hairgrass dwarf-shrubland** (p. 86)
30b. Tufted hairgrass < 10 % cover, slough sedge > 10 % cover . . . . . **Bog blueberry/slough sedge dwarf-shrubland** (p. 84)

## HERBACEOUS ASSOCIATIONS

31a. Cover of graminoids (grasses, sedges, rushes, bulrushes, creeping spikerush, bur-reed, or threeway sedge) > cover of forbs . . . . . 32
31b. Cover of graminoids < cover of forbs . . . . . 53

32a. Cover of grasses > cover of other graminoids . . . . . 33
32b. Cover of grasses < cover of other graminoids . . . . . 42

33a. Red fescue > cover of other grass species . . . . . 34
33b. Red fescue < cover of other grass species . . . . . 36

34a. Bracken fern > 10 % cover . . . . . **Red fescue-bracken fern herbaceous vegetation** (p. 98)
34b. Bracken fern < 10% cover . . . . . 35

35a. Total herb cover < 30 %; upland dunes; beach knotweed, seashore bluegrass, seashore lupine and beach silvertop frequent associates . . . . . **Red fescue herbaceous vegetation** (p. 94)
35b. Total herb cover > 30 %; deflation plains; salt rush, little hairgrass, European centaury, Nevada rush, tufted hairgrass and velvet grass frequent associates . . . . . **Red fescue-salt rush herbaceous vegetation** (p. 96)

36a. Upland dunes; well-drained . . . . . 37
36b. Deflation plain; often with seasonal flooding . . . . . 39

37a. European beachgrass > 20 % cover . . . . . **European beachgrass herbaceous vegetation** (p. 90)
37b. European beachgrass < 20 % cover . . . . . 38

38a. American dunegrass > 10 % cover, seashore bluegrass < 10 % cover . . . . . **American dunegrass herbaceous vegetation** (p. 92)
38b. American dunegrass < 10 % cover, seashore bluegrass > 10 % cover . . . . . **Seashore bluegrass herbaceous vegetation** (p.104)

39a. Saltgrass > 20 % cover . . . . . **Saltgrass-Pacific silverweed tidal herbaceous vegetation** (p. 124)
39b. Saltgrass < 20 % cover . . . . . 40

40a. Creeping bentgrass > 20 % cover . . . . . **Creeping bentgrass-Pacific silverweed tidal herbaceous vegetation** (p. 118)
40b. Creeping bentgrass < 20 % cover . . . . . 41

41a. Tufted hairgrass > 20 % cover, knotgrass < 20 % cover . . . . . **Tufted hairgrass-Pacific silverweed tidal herbaceous vegetation** (p. 122)
41b. Tufted hairgrass < 20 %, knotgrass > 20 % cover . . . . . **Knotgrass herbaceous vegetation** (p. 114)

42a. Cover of sedges > cover of other graminoids . . . . . 43
42b. Cover of sedges < cover of other graminoids . . . . . 46

43a. Lyngby sedge > 20 % cover . . . . . **Lyngby sedge-Pacific silverweed tidal herbaceous vegetation** (p. 120)
43b. Lyngby sedge < 20 % cover . . . . . 44

44a. Slough sedge > 20 % cover . . . . . 45
44b. Slough sedge < 20 % cover . . . . . **Inflated sedge herbaceous vegetation** (p. 110)

45a. Pacific silverweed > 10 % cover . . . . . **Slough sedge-Pacific silverweed herbaceous vegetation** (p. 108)
45b. Pacific silverweed < 10 % cover . . . . . **Slough sedge seasonally flooded herbaceous vegetation** (p. 106)

46a. Cover of rushes > cover of other graminoids . . . . . 47
46b. Cover of rushes < cover of other graminoids . . . . . 49

47a. Salt rush present . . . . . 48
47b. Salt rush absent . . . . . **Baltic rush-Pacific silverweed tidal herbaceous vegetation** (p. 126)

48a. Sickle-leaved rush > 10 % cover . . . . . **Sickle-leaved rush-salt rush herbaceous vegetation** (p. 102)
48b. Sickle-leaved rush < 10 % cover . . . . . **Salt rush herbaceous vegetation** (p. 100)

49a. Cover of bulrushes > cover of other graminoids . . . . . 50
49b. Cover of bulrushes < cover of other graminoids . . . . . 51

50a. Hardstem bulrush > 20 % cover, three-square bulrush < 20 % cover . . . . . **Hardstem bulrush herbaceous vegetation** (p. 116)
50b. Hardstem bulrush < 20 % cover, three-square bulrush > 20 % cover . . . . . **Three-square bulrush tidal herbaceous vegetation** (p. 128)

51a. Threeway sedge > 20 % cover . . . . . **Threeway sedge herbaceous vegetation** (p. 111)
51b. Threeway sedge < 20 % cover . . . . . 52

52a. Creeping spikerush > 20 % cover, simplestem bur-reed < 20 % cover . . . . . **Creeping spikerush-Nevada rush herbaceous vegetation** (p. 112)
52b. Creeping spikerush < 20% cover, simplestem bur-reed > 20 % cover . . . . . **Simplestem bur-reed herbaceous vegetation** (p. 138)

53a. Seashore lupine present; upland dunes . . . . . **Seashore lupine herbaceous vegetation** (p. 130)
53b. Seashore lupine absent; permanently or seasonally flooded wetlands . . . . . 54

54a. Leaves entire, > 1 inch diameter . . . . . 55
54b. Leaves finely dissected, < 1 inch diameter . . . . . 59

55a. Waterpepper or water smartweed present . . . . . 56
55b. Waterpepper or water smartweed absent . . . . . 57

56a. Waterpepper > 20 % cover, water smartweed < 20 % cover . . . . . **Waterpepper-water purslane herbaceous vegetation** (p. 131)
56b. Waterpepper < 20 % cover, water smartweed > 20 % cover . . . . . **Water smartweed herbaceous vegetation** (p. 133)

57a. Floating water-pennywort > 20 % cover . . . . . **Floating water-pennywort herbaceous vegetation** (p. 132)
57b. Floating water-pennywort < 20 % cover . . . . . 58

58a. Floating-leaved pondweed > 20 % cover, pond lily < 20 % cover . . . . . **Floating-leaved pondweed herbaceous vegetation** (p. 136)
58b. Floating-leaved pondweed < 20 % cover, pond lily > 20 % cover . . . . . **Pond lily herbaceous vegetation** (p. 134)

59a. South American waterweed > 20 % cover . . . . . **South American waterweed herbaceous vegetation** (p. 139)
59b. South American waterweed < 20 % cover . . . . . 60

60a. Parrot-feather > 20 % cover, common bladderwort < 20 % cover . . . . . **Parrot-feather herbaceous vegetation** (p. 140)
60b. Parrot-feather < 20 % cover, common bladderwort > 20 % cover . . . . . **Common bladderwort herbaceous vegetation** (p. 141)

# FOREST ASSOCIATIONS



Douglas fir/western rhododendron-evergreen huckleberry forest

# 'ORT ORFORD CEDAR GIANT FOREST ALLIANCE

CHLA/VAOV2

## 'ORT ORFORD CEDAR/EVERGREEN HUCKLEBERRY FOREST

*'hamaecyparis lawsoniana/Vaccinium ovatum*

CHLA/VAOV2
(Sampled: 11 recon plots)
CTS404

**nvironment.** This unique association occurs on narrow, dry stabilized dune ridges, troughs and :asonally dry deflation plains at the southern end of the Recreation Area, where less than 200 acres have :en identified. All aspects and slopes are represented. Soils are poorly to moderately developed, from to 12 inches deep.

**egetation and ecology.** Stands are dominated by a mixture of Port Orford cedar, Douglas fir and Sitka )ruce. Cover of overstory trees varies from 20-90 percent, with an average of 64 percent. In this layer, )rt Orford cedar is most abundant at 15-80 percent cover. Tree age varies from 150-350 years old, with ameters 12-61 inches. Live basal area for this association is the second largest recorded on the ecreation Area, averaging 146 $ft^2$ per acre. Large, horizontal branches with Scouler's polypody create )od nesting structure for marbled murrelets. Many large Port Orford cedars have charred bark, and :es of fire-sensitive trees present suggest that stands were last burned about 80-100 years ago. Port rford cedar reproduction occurs mostly at the edges of stands, where there is much edge effect. Shore ne occurs at the edges of the stands but is senescent in the interior. The shrub layer, dominated by /ergreen huckleberry, has 60-95 percent cover, averaging 82 percent cover. Shrub height averages 9 et. Because of dense shading, the herb layer is depauperate. Moss cover averages 27 percent, with *urhynchium oreganum*, *Isothecium myosuroides* and *Dicranum fuscescens* being the most common )ecies. Lichens are scarce except for a few *Usnea* and *Lepraria* on the trees. Egler (1934) noted that )rt Orford cedar may survive sand burial by producing adventitious roots along the trunk.

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**Succession.** Mid to late seral. Stands of this type replace the shore pine/hairy manzanita association, remnants of which persist around the edges of old-growth stands. Both Sitka spruce and western hemlock exhibit the greatest current growth in these stands (Table 4). If stands grow larger, with decreasing edge effect, they may be replaced by the western hemlock/western rhododendron-evergreen huckleberry association, or the Sitka spruce-evergreen huckleberry association. Proximity to salt spray may inhibit growth of hemlock, and lead to a Sitka spruce/evergreen huckleberry association.

**Distribution and history.** This association originally occurred along the coast between Port Orford and Winchester Bay, Oregon. Port Orford cedar has long been of great commercial value (Zobel 1986), and old-growth stands on sand dunes are exceedingly rare. On the Recreation Area, six old-growth stands are known, five between the Trans-Pacific Highway and Horsfall Road, and one east of Beale Lake. Hawk (1977) described two 40-50 year-old stands on dunes and deflation plains near Saunders Lake.

**Management.** Port Orford cedar is being decimated throughout its limited range by the fungal root rot *Phytopthora lateralis* (Zobel et al. 1985; Kliejunas 1994). The fungus spreads in the soil by water-borne spores, and is dispersed further by soil adhering to machinery and livestock. Droughty sand does not appear to inhibit dispersal of spores, as *Phytopthora* is killing trees in the dunes as well as on loamy soils farther inland. Stands should be managed to avoid any possibility of accidental introduction of the root rot fungus. All stands should be protected and monitored, and all motorized vehicles should be excluded. Hiking trails or viewing platforms are not recommended, as any intrusion may inadvertently introduce the root rot.

**Other studies.** Egler (1934) noted the presence of Port Orford cedar in the dunes, but not as an association. Hawk (1977) described a young Port Orford cedar-Sitka spruce association on dunes and deflation plains. Stand structure differed considerably from old-growth, but nearby stands 90-125 years old had a structure more similar to the Port Orford cedar/evergreen huckleberry association. Jimerson (1994) described a tanoak-Port Orford cedar/evergreen huckleberry association from gravelly loams in northern California, and Randall (1996) described a Port Orford cedar/evergreen huckleberry/sword fern association from southwestern Oregon. Stands on the Recreation Area differ from these significantly in species composition, and have much less sword fern.

Common plants of the Port Orford cedar/evergreen huckleberry association (n = 11 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Port Orford cedar | 100 | 48 | 15-80 |
| Douglas fir | 82 | 10 | 0-25 |
| Sitka spruce | 73 | 11 | 0-50 |
| Shore pine | 55 | 5 | 0-30 |
| Western hemlock | 45 | 2 | 0-10 |
| UNDERSTORY TREES | | | |
| Port Orford cedar | 73 | 3 | 0-15 |
| Douglas fir | 45 | 1 | 0-3 |
| Western hemlock | 36 | 1 | 0-10 |
| Sitka spruce | 36 | 1 | 0-2 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 63 | 40-90 |
| Salal | 91 | 9 | 0-20 |
| Wax myrtle | 82 | 7 | 0-25 |
| Western rhododendron | 36 | 8 | 0-25 |
| Red huckleberry | 36 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 64 | 1 | 0-5 |
| Sword fern | 27 | Tr | 0-1 |
| Licorice fern | 27 | Tr | 0-1 |
| Deer fern | 27 | Tr | 0-1 |

# SITKA SPRUCE GIANT FOREST ALLIANCE

PISI/GASH
PISI/GASH-RUSP
PISI/POMU
PISI/VAOV2

## SITKA SPRUCE/SALAL FOREST

*Picea sitchensis/Gaultheria shallon*

PISI/GASH
(Sampled: 1 recon plot)
CSS321

**Environment.** This association occurs on silt loam soils on Coast Range foothills along the eastern edge of the Recreation Area, the "mountain front" of Pinto et al. (1972). They are the most productive soils on the Recreation Area. Slopes are moderate to steep, and most aspects are represented. Soil depth varies from 6-40 inches deep, averaging about 15 inches.

**Vegetation and ecology.** The canopy is dominated by Sitka spruce, with an average cover of 85 percent. Most stands seen were either 50-75 year-old second growth, or had been selectively logged for red cedar prior to 1940, leaving Sitka spruce up to 200 years old. Like the Sitka spruce/salal-salmonberry association, this association differed significantly from those on sand dunes by its high canopy cover, high basal area, and low shrub cover. The shrub layer has been suppressed by the dense, even-aged canopy developed after logging. In the single stand sampled, moss cover on the ground was 15 percent, and ferns were absent. These stands are similar to the Sitka spruce/salal-salmonberry association, except that salmonberry is absent, and the herb and moss layers are depauperate. The exaggerated live basal area and lack of dead basal area shown in Fig. 10 is probably attributable to the small sample size.

**Succession.** Mid to late seral. Associations antecedent to this type were not sampled, but would probably be red alder types developed after fire or logging. Stands may eventually be replaced by the western hemlock alliance, but no older examples were found to sample on the Recreation Area.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. On the Recreation Area, most stands occur on the silt loams of the Coast Range

foothills. Examples may be seen along the Siltcoos Lake Trail, and both north and south of Threemile Lake, along the Threemile Lake Trail.

**Management.** Well-developed soils render these sites the most productive on the Recreation Area for timber production. These stands are favored collecting areas for mushrooms, particularly chanterelle and lobster mushrooms. Mycorrhizae are plentiful, and visibility is good because of low shrub densities. Old-growth examples of this vegetation type have been decimated along the coast from a long history of logging. Holly and English ivy, both exotic species, are invading these stands in Oregon and Washington, and will become serious pests.

**Other studies.** Pinto et al. (1972) described other 12-60 year-old stands occurring on soils of the "mountain front," ranging from pure stands of Sitka spruce, western hemlock or Douglas fir, to mixtures of all three species, with pockets of western red cedar and shore pine. The Sitka spruce/salal association would have been one of these forest types. Hemstrom and Logan (1986) described a similar Sitka spruce/salal association, but with significantly greater shrub cover. On the Recreation Area, shrub cover will likely increase as stands mature and the canopy opens up, and this type will closely resemble that described by Hemstrom and Logan. Fong (1996) described a Sitka spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/salal association.

Common plants of the Sitka spruce/salal association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Sitka spruce | 100 | 85 | 85 |
| UNDERSTORY TREES | | | |
| Cascara | 100 | Tr | Tr |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Salal | 100 | 5 | 5 |
| Evergreen huckleberry | 100 | 1 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Candyflower | 100 | 1 | 1 |
| Field woodrush | 100 | 1 | 1 |
| Evergreen violet | 100 | 1 | 1 |
| Swamp bedstraw | 100 | 1 | 1 |

## SITKA SPRUCE/SALAL-SALMONBERRY FOREST

*Picea sitchensis/Gaultheria shallon-Rubus spectabilis*

PISI/GASH-RUSP
(Sampled: 4 recon plots)
CSS322

**Environment.** This association is best developed on silt loam soils on Coast Range foothills along the eastern edge of the Recreation Area, the "mountain front" of Pinto et al. (1972). These soils are the most productive on the Recreation Area. Slopes are moderate to steep, and most aspects are represented. Soil depth varies from 6-40 inches deep, averaging about 15 inches.

**Vegetation and ecology.** The canopy is dominated by Sitka spruce, with red cedar and western hemlock present in both the canopy and understory. Most stands seen were either 50-75 year-old second growth, or had been selectively logged for red cedar prior to 1940, leaving Sitka spruce up to 200 years old. These stands differed significantly from other forest associations on sand dunes by their high canopy cover, high basal area, high moss cover, and low shrub cover. Moss cover on the ground ranges from 45-70 percent, *Eurhynchium oreganum* being most abundant. Basal area is the highest recorded on the Recreation Area, averaging 216 $ft^2$ per acre. Cover of sword fern is the highest recorded in any plots sampled, and salmonberry and deer fern are conspicuous, indicating more mesic conditions than those occurring on sand. Evergreen huckleberry and salal have noticeably lower cover than in other forest plots on the Recreation Area, attributable to the dense, even-aged canopy developed after logging. Live basal area (Fig. 10) for the Sitka spruce/salal-salmonberry association is no doubt exaggerated because of small sample size.

**Succession.** Mid to late seral. Quaye (1982) considered this type to be transitional between the Sitka spruce/sword fern association and his western hemlock/salal/sword fern association. On the Recreation Area, shrub cover in these stands will likely increase as stands mature and the canopy opens up, and this type will closely resemble the Sitka spruce/salmonberry-salal association described by Hemstrom and Logan (1986).

**Distribution and history.** This association occurs along the coast between northern California and British Columbia. On the Recreation Area, most stands occur on the silt loams of the Coast Range foothills along the eastern edge of the Recreation Area. Good places to see examples of this association are along Siltcoos Lake Trail, and both north and south of Threemile Lake, along the Threemile Lake Trail.

**Management.** Well-developed soils render these sites the most productive on the Recreation Area for timber production. These stands are favored collecting areas for mushrooms, particularly chanterelle and lobster mushrooms. Mycorrhizae are plentiful, and visibility is good because of low shrub densities. Old-growth examples of this vegetation type have been decimated along the coast from a long history of logging. Holly and English ivy, both exotic species, are invading some of these stands and will become serious pests if not removed.

**Other studies.** Pinto et al. (1972) described 12-60 year-old forest stands occurring on soils of the "mountain front," ranging from pure Sitka spruce, western hemlock or Douglas fir, to mixtures of all three species, with pockets of western red cedar and shore pine. Sitka spruce/salal-salmonberry association would have been among these forest types. Quaye's (1982) Sitka spruce/sword fern-deer fern and Sitka spruce/salal/sword fern-deer fern associations are very similar to this association, but with somewhat higher fern cover. Wiedemann (1984, 1993) described a western hemlock-Sitka spruce/salal/deer fern association as a rare zonal or climatic climax on moister sites. Hemstrom and Logan (1986) described a similar Sitka spruce/ salmonberry-salal association, but with significantly greater shrub cover. The Sitka spruce/ salmonberry association described from Alaska by de Meo et al. (1992) and Boggs (1998) has a very different species composition, and lacks both salal and red cedar. Fong (1996) described a Sitka spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/salal-salmonberry association.

Common plants of the Sitka spruce/salal-salmonberry association (n = 4 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Sitka spruce | 100 | 81 | 75-90 |
| Western hemlock | 80 | 11 | 5-15 |
| Western red cedar | 10 | 7 | 5-20 |
| UNDERSTORY TREES | | | |
| Cascara | 75 | 9 | 0-15 |
| Western red cedar | 50 | 1 | 0-3 |
| Western hemlock | 50 | 1 | 0-2 |
| Sitka spruce | 25 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Salal | 100 | 19 | 5-35 |
| Salmonberry | 100 | 18 | 10-30 |
| Evergreen huckleberry | 100 | 5 | 4-5 |
| Red huckleberry | 100 | 5 | 2-10 |
| Fool's huckleberry | 75 | 3 | 0-5 |
| Thimbleberry | 75 | 2 | 0-2 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Deer fern | 100 | 9 | 1-25 |
| Sword fern | 100 | 6 | 1-10 |
| Fairy lantern | 75 | 1 | 0-1 |
| Small-flowered woodrush | 50 | Tr | 0-1 |

## ITKA SPRUCE/SWORD FERN FOREST

*'icea sitchensis/Polystichum munitum*

PISI/POMU
(Not sampled)
CSF121

This mid to late seral association was seen on the Recreation Area, but never sampled. It is lominated by second-growth Sitka spruce, on slopes of both the silt loams of the "mountain front" east of Highway 101, as well as older dunes north and south of Threemile Lake, along the Threemile Lake Trail. All slopes and aspects are represented, and soils may be well-developed. The association extends rom northern California to British Columbia. Based on descriptions from other areas, canopy cover anges from 60-85 percent. Sword fern may have up to 55 percent cover, and few shrubs are present. Quaye (1982) and Hemstrom and Logan (1986) described a Sitka spruce/sword fern association very imilar to those seen on the Recreation Area. The Sitka spruce/sword fern association of Sawyer and Keeler-Wolf (1995) may be similar to this association. Of the spruce stands sampled by Quaye (1982), his association had the greatest basal area, and is highly productive.

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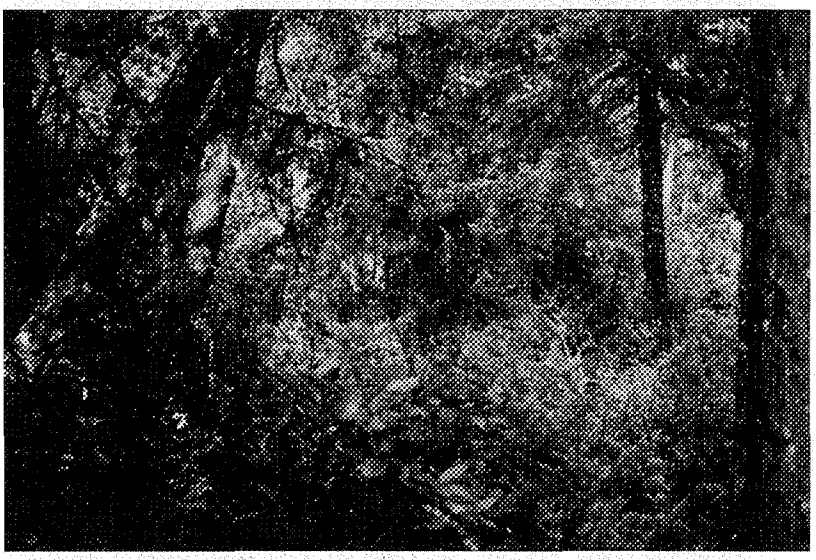
## SITKA SPRUCE/EVERGREEN HUCKLEBERRY FOREST

*Picea sitchensis/Vaccinium ovatum*



PISI/VAOV2
(Sampled: 14 recon plots)
CSS101

**Environment.** This association occurs on dry ridgetops, slopes, deflation plains and floodplains in the dune sheet, usually near the ocean. It is a common component of tree islands. Most aspects are represented. Stands in elevated areas close to the ocean are subject to wind pruning, windthrow and salt damage. Soil contains little organic matter, ranging from one to six inches, averaging three inches.

**Vegetation and ecology.** Stands are dominated by Sitka spruce, with lesser amounts of Douglas fir and a senescing component of shore pine. The canopy is often open, averaging 60 percent cover, but ranging from 35-90 percent. Some stands contain spruce trees up to 450 years old, the oldest of this species seen on the Recreation Area. The shrub layer is dominated by evergreen huckleberry and salal, with one of the highest densities recorded in the Recreation Area, averaging 85 percent cover, with heights to 15 feet. Because of dense shade, the herb layer is depauperate, and the moss layer has moderately high cover, although much of it is obscured by shrubs. Live basal area is low, compared to most other dune associations. Stands are typically littered with fallen trees, mostly shore pine from earlier seral stages.

**Succession.** Late seral to climax. The shore pine-Sitka spruce/evergreen huckleberry, Douglas fir/western rhododendron-evergreen huckleberry, and Port Orford cedar/evergreen huckleberry associations would be antecedent to this type.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. On the Recreation Area, good examples can be seen on most of the larger tree islands in the dune sheet.

**Management.** Most stands of this association are remote and impenetrable to casual visitors. It is favored habitat for black bear. Considerable off-road vehicle damage has occurred on several more accessible tree islands, where such activity can rejuvenate sand movement and erode tree islands.

**Other studies.** Byrd (1950), Kumler (1963, 1969), and Kunze (1983, 1985) described similar forest associations on dunes dominated by Sitka spruce. These had shrubby understories dominated by evergreen huckleberry, salal, wax myrtle and western rhododendron. Fong (1996) described a Sitka

spruce/salal-evergreen huckleberry association from southwestern Oregon, but the species composition differs significantly from our Sitka spruce/evergreen huckleberry association, and the shrub layer is much less dense.

Common plants of the Sitka spruce/evergreen huckleberry association (n = 14 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Sitka spruce | 100 | 50 | 15-85 |
| Douglas fir | 43 | 5 | 0-25 |
| Shore pine | 36 | 2 | 0-5 |
| Western red cedar | 21 | 4 | 0-50 |
| Western hemlock | 21 | 1 | 0-10 |
| UNDERSTORY TREES | | | |
| Sitka spruce | 57 | 1 | 0-5 |
| Cascara | 29 | 3 | 0-20 |
| Western hemlock | 21 | 1 | 0-5 |
| Shore pine | 21 | Tr | 0-2 |
| Douglas fir | 14 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 54 | 5-85 |
| Salal | 100 | 26 | 3-65 |
| Wax myrtle | 64 | 8 | 0-35 |
| Western rhododendron | 43 | 3 | 0-25 |
| Silk tassel | 36 | 4 | 0-15 |
| Trailing blackberry | 35 | Tr | 0-1 |
| Black twinberry | 29 | 1 | 0-4 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 79 | 1 | 0-5 |
| False lily-of-the-valley | 64 | 1 | 0-5 |
| Sword fern | 21 | Tr | 0-2 |

# DOUGLAS FIR GIANT FOREST ALLIANCE

PSME/RHMA3-VAOV2

## DOUGLAS FIR/WESTERN RHODODENDRON-EVERGREEN HUCKLEBERRY FOREST

*Pseudotsuga menziesii/Rhododendron macrophyllum-Vaccinium ovatum*

PSME/RHMA3-VAOV2
(Sampled: 11 recon plots)
CDS301

**Environment.** This association occurs on dry ridges, upper slopes and tree islands throughout the dune sheet. Most aspects and slopes are represented. Soil has little organic matter, ranging from one to seven inches, averaging five inches.

**Vegetation and ecology.** The canopy is dominated by Douglas fir, with some Sitka spruce and a senescing component of shore pine. Western hemlock is absent. Canopies are open, ranging from 35-80 percent cover, averaging 65 percent. Conifer reproduction is almost nonexistent, and stands are littered with fallen logs, mostly shore pine. The shrub layer, dominated by evergreen huckleberry, salal and western rhododendron, is enormous and nearly impenetrable, ranging from 85-97 percent cover, averaging 94 percent. Shrub height ranges from 8-15 feet, averaging 11 feet. Some species present here, such as ocean spray, red huckleberry and western rattlesnake-plantain, are uncommon in other dune associations. Because of the dense shrub cover, a ground layer is virtually absent.

**Succession.** Mid seral. This association is preceded by the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association. Given the lack of western hemlock, it is probably replaced by the climax Sitka spruce/evergreen huckleberry association.

**Distribution and history.** This association is common along the coast between northern California and Tillamook Bay, Oregon. On the Recreation Area, it occurs on most of the larger tree islands, and along the eastern edge of the dune sheet.

**Management.** Most stands of this association are remote and impenetrable to casual visitors. It is favored habitat for black bear. Considerable off-road vehicle damage has occurred on several more

accessible tree islands, where machines have opened a path through the shrub layer. Such activity can rejuvenate sand movement and erode tree islands.

**Other studies.** Wiedemann (1984, 1990, 1993) described a Douglas fir/western rhododendron association as a climax type on dry soils, although frequent presence of western hemlock in his plots suggest that it may have been closer to our concept of the western hemlock/western rhododendron-evergreen huckleberry association.

Common plants of the Douglas fir/western rhododendron-evergreen huckleberry association (n = 11 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Douglas fir | 100 | 60 | 30-80 |
| Shore pine | 73 | 3 | 0-10 |
| Sitka spruce | 36 | 3 | 0-10 |
| Western red cedar | 18 | 3 | 0-25 |
| UNDERSTORY TREES | | | |
| Cascara | 45 | 1 | 0-5 |
| Douglas fir | 36 | 1 | 0-2 |
| Sitka spruce | 9 | Tr | 0-3 |
| Western red cedar | 9 | Tr | 0-2 |
| Shore pine | 9 | Tr | 0-2 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 67 | 40-95 |
| Salal | 100 | 14 | 1-35 |
| Western rhododendron | 91 | 41 | 0-75 |
| Wax myrtle | 82 | 6 | 0-30 |
| Ocean spray | 36 | 2 | 0-10 |
| Silk tassel | 36 | 1 | 0-5 |
| Rev huckleberry | 9 | Tr | 0-5 |
| Trailing blackberry | 9 | Tr | 0-2 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 64 | 1 | 0-2 |
| Sword fern | 45 | 1 | 0-2 |
| Gnome plant | 27 | Tr | 0-1 |
| Ground-cone | 18 | Tr | 0-1 |
| Western rattlesnake-plantain | 9 | Tr | 0-1 |

## WESTERN HEMLOCK/WESTERN RHODODENDRON-EVERGREEN HUCKLEBERRY FOREST

*Tsuga heterophylla/Rhododendron macrophyllum-Vaccinium ovatum*

TSHE/RHMA3-VAOV2
(Sampled: 16 recon plots)
CHS324

**Environment.** Stands occur along the landward edge of the dune sheet, where dunes have been stabilized for several hundred years and are remote from salt spray. In all cases, stands are contiguous with forest extending inland into the Coast Range. Mid to lower slopes and interdunal valleys are the most common locations, with all aspects represented. The association does not occur on tree islands, or in areas with more recent sand movement. The litter and humus layer varies from 1-6 inches deep, averaging 4 inches.

**Vegetation and ecology.** The canopy is dominated by western hemlock, Douglas fir or both. Douglas fir may be entirely absent, but hemlock is always present with at least 5 percent cover. The canopy is moderately dense, with cover ranging from 30-95 percent, averaging 73 percent. Basal area is the third largest recorded on the Recreation Area, averaging 125 $ft^2$ per acre. Douglas fir up to 337 years old, and Sitka spruce up to 633 years old, both obviously suppressed in the last 150 years, were recorded from this association. Hemlock in the same plots ranged from 140-170 years old. Old-growth trees have broken tops and gnarly horizontal limbs, supporting large mats of Scouler's polypody and the moss *Antitrichia curtipendula*. Conifer reproduction is sparse. The shrub layer is dominated by evergreen huckleberry, western rhododendron and salal, with cover ranging from 25-95 percent, averaging 83 percent. Shrub height averages nine feet. The herb layer is sparse.

**Succession.** Late seral to climax. Remote from salt spray, and depending on latitude, this association is preceded by either the Port Orford cedar/evergreen huckleberry association, or the Douglas fir/western rhododendron-evergreen huckleberry association.

**Distribution and history.** This association occurs along the coast between northern California and Tillamook Bay, Oregon. On the Recreation Area, the best examples seen occur west of Tahkenitch Campground, and south and west of Loon Lake.

**Management.** Old-growth stands have a canopy structure seemingly ideal as nesting habitat for marbled murrelets. Stands of this type are exceedingly rare along the coast, and the only example we saw on the Recreation Area was near Loon Lake. It is a remnant of an 80-acre stand of old-growth forest, half of which was clearcut in the 1960's (Pinto et al. 1972). This remnant needs to be protected.

**Other studies.** Kumler (1963, 1969) and Wiedemann (1984, 1990, 1993) described a similar forest type with western hemlock, Sitka spruce, western rhododendron, evergreen huckleberry and salal. Wiedemann's concept of a Douglas fir/western rhododendron climax association on dry dunes may fit here, because western hemlock was frequently present. Quaye's (1982) western hemlock/salal/sword fern association appears to be somewhat similar, but lacks rhododendron, has less salal and evergreen huckleberry, and has nearly 40 percent cover of sword fern. White (1996) described a western hemlock-tanoak/evergreen huckleberry-western rhododendron association from southwestern Oregon, but species composition differs significantly from stands sampled on the Recreation Area.

Common plants of the western hemlock/western rhododendron-evergreen huckleberry association (n = 16 recon plots).

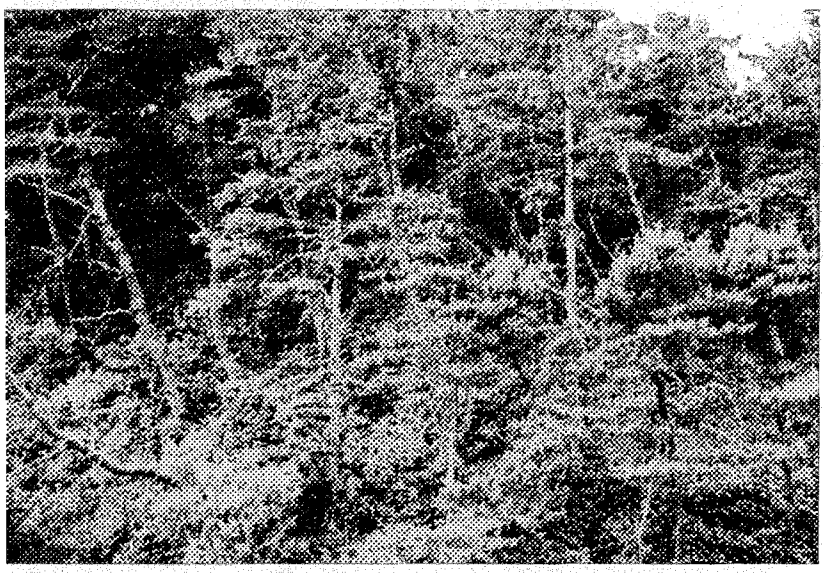
| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Western hemlock | 100 | 28 | 4-85 |
| Douglas fir | 88 | 34 | 0-80 |
| Sitka spruce | 63 | 11 | 0-70 |
| Western red cedar | 44 | 10 | 0-45 |
| Shore pine | 13 | Tr | 0-3 |
| UNDERSTORY TREES | | | |
| Cascara | 56 | 2 | 0-10 |
| Western hemlock | 56 | 1 | 0-5 |
| Douglas fir | 19 | 1 | 0-5 |
| Western red cedar | 19 | Tr | 0-3 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 52 | 20-80 |
| Western rhododendron | 100 | 39 | 5-70 |
| Salal | 100 | 22 | 5-75 |
| Red huckleberry | 56 | 1 | 0-5 |
| Ocean spray | 38 | 1 | 0-4 |
| Wax myrtle | 31 | 2 | 0-10 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 69 | 1 | 0-3 |
| Sword fern | 38 | 1 | 0-3 |
| Scouler's polypody | 31 | 1 | 0-3 |
| False lily-of-the-valley | 25 | 1 | 0-15 |
| Ground-cone | 25 | Tr | 0-1 |

# SHORE PINE FOREST ALLIANCE

PICOC-PISI/VAOV2
PICOC-PSME/MYCA-VAOV2
PICOC/CYSC4/AMAR4

## SHORE PINE-SITKA SPRUCE-/EVERGREEN HUCKLEBERRY FOREST

*Pinus contorta* var. *contorta-Picea sitchensis/Vaccinium ovatum*



PICOC-PISI/VAOV2
(Sampled: 12 recon plots)
CLC601

**Environment.** This association is widespread on the Recreation Area, occurring on dry stabilized dunes, tree islands and deflation plains. Most aspects and slopes are represented. A poorly-developed humus layer from one to six inches deep overlies sand.

**Vegetation and ecology.** Stands are dominated by shore pine and Sitka spruce, with smaller amounts of Douglas fir. Young stands on deflation plains may be composed of low, nearly impenetrable, wind-pruned thickets subject to salt spray and sand abrasion. Shore pine and Sitka spruce are the dominant reproducing conifers. Older stands may be littered with fallen trees, mostly shore pine. The shrub layer is generally dense, dominated by evergreen huckleberry, salal and wax myrtle, with up to 95 percent cover. Shrub height averages eight feet and can be up to 12 feet. The ground layer is depauperate because of the high shrub cover, but mosses are moderately abundant.

**Succession.** Mid seral. This association appears to replace the red fescue-salt rush, shore pine/slough sedge, bog blueberry/tufted hairgrass, and the shore pine/Scots broom/European beachgrass associations. Current growth of Sitka spruce and western hemlock (Table 4) indicate that they will eventually replace Douglas fir and shore pine. Hemlock will be successful only in areas sheltered from salt spray.

**Distribution and history.** This association is common along the coast between northern California and southwestern Washington. It reaches its southern limit on the North Spit of Humboldt Bay, California (Pickart 1987, Duebendorfer 1992). On the Recreation Area, stands can be seen anywhere a moderate amount of shore pine and Sitka spruce have developed. Dense young stands can be seen on deflation plains north and south of Tenmile Creek

**Management.** In most cases, dense vegetation excludes human intrusion. The extent of stands on deflation plains are increasing as herbaceous associations are replaced during succession. A few stands on dunes are subject to entry by recreational vehicles, with hazard of subsequent wind erosion.

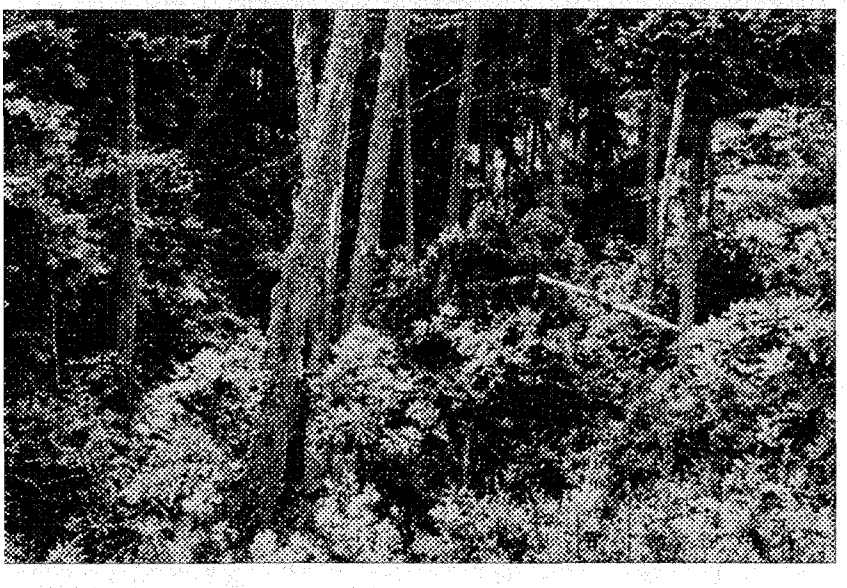
**Other studies.** Kumler (1963, 1969) described a shore pine-Sitka spruce-shrub association as one of the forest types occurring on coastal dunes. Wiedemann (1984, 1993) described a salal-evergreen huckleberry association with tree seedlings occurring on sand plains, slopes and ridges. Pickart (1990) included this type in a broader concept of "coniferous forest." Duebendorfer (1992) described his association clearly, noting the impenetrable and wind-pruned characteristics of stands near beaches. The beach pine series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the shore pine-Sitka spruce/ evergreen huckleberry association (n = 12 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Sitka spruce | 83 | 25 | 0-65 |
| Shore pine | 83 | 24 | 0-65 |
| Douglas fir | 25 | 2 | 0-20 |
| UNDERSTORY TREES | | | |
| Sitka spruce | 58 | 5 | 0-30 |
| Shore pine | 42 | 13 | 0-70 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 32 | 2-80 |
| Salal | 100 | 25 | 5-40 |
| Wax myrtle | 83 | 17 | 0-40 |
| Bearberry | 33 | 2 | 0-25 |
| Western rhododendron | 17 | 2 | 0-15 |
| Silk tassel | 17 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 42 | 1 | 0-5 |
| False lily-of-the-valley | 33 | Tr | 0-2 |

## SHORE PINE-DOUGLAS FIR/WAX MYRTLE-EVERGREEN HUCKLEBERRY FOREST

*Pinus contorta* var. *contorta-Pseudotsuga menziesii/Myrica californica-Vaccinium ovatum*



PICOC-PSME/MYCA-VAOV2
(Sampled: 15 recon plots)
CLC201

**Environment.** This association is widespread on warm, dry ridges and slopes on the dunes, primarily with south to west-facing aspects. The poorly-developed humus layer is rarely more than one inch thick on slopes, but where organic material accumulates at the toe of slopes the layer may be up to nine inches deep.

**Vegetation and ecology.** Stands are dominated by shore pine and Douglas fir, with low incidence of Sitka spruce and western hemlock. Madrone is also present on ridges and toe slopes. Total canopy cover ranges from 40-85 percent. Live basal area is one of the lowest of the native forest stands occurring on the Recreation Area. Conifer reproduction is sparse or nonexistent. Stands are typically littered with fallen trees, mostly shore pine. The shrub layer, dominated by the ubiquitous evergreen huckleberry and salal, ranges from 5-95 percent, with an average height of 8 feet. The lowest shrub cover appears to be on dry, warm exposures, where bracken fern may be conspicuous. The ground layer is otherwise sparse to nonexistent. Charcoal is present in some stands.

**Succession.** Mid seral. Stands appear to derive from the shore pine/hairy manzanita association, and the shore pine/Scots broom/European beachgrass association. In this association, western hemlock and Sitka spruce have the greatest current growth, followed by Douglas fir (Table 4). Douglas fir will replace shore pine, and will in turn will be replaced by either Sitka spruce or western hemlock. Hemlock will succeed only in areas sheltered from salt spray.

**Distribution and history.** This association is common along the coast between northern California and Tillamook Bay, Oregon. Douglas fir becomes increasingly scarce on dunes farther north, where it is replaced by Sitka spruce. On the Recreation Area, stands of this association occur along the forested edge of the dune sheet, and are also the most common type on tree islands with southern to western exposure. Good examples may be seen south of Siltcoos River, and both north and south of Threemile Road.

**Management.** In most cases, dense vegetation or remoteness excludes human intrusion. A few stands on dunes are subject to entry by recreational vehicles, with hazard of subsequent wind erosion.

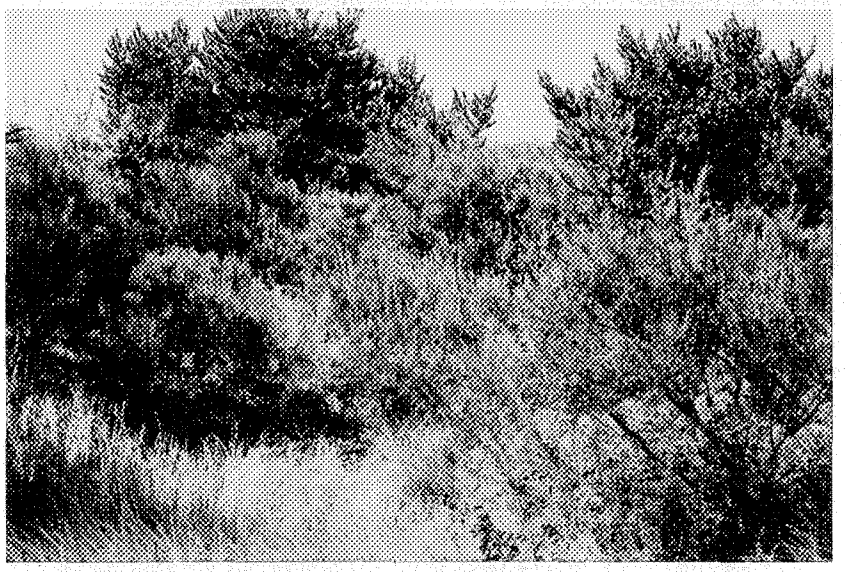
**Other studies.** Wiedemann (1984, 1990, 1993) described a shore pine/western rhododendron association containing Douglas fir in both overstory and understory, which may be closer to our concept of the Douglas fir/western rhododendron-evergreen huckleberry association. Pickart (1990) included this type in a broader concept of "coniferous forest." The beach pine series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association (n = 15 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 100 | 43 | 30-60 |
| Douglas fir | 100 | 22 | 5-45 |
| Sitka spruce | 33 | 1 | 0-5 |
| Western hemlock | 20 | 1 | 0-10 |
| UNDERSTORY TREES | | | |
| Douglas fir | 33 | 1 | 0-5 |
| Sitka spruce | 33 | 1 | 0-5 |
| Shore pine | 33 | 1 | 0-3 |
| Western hemlock | 33 | Tr | 0-2 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 52 | 5-90 |
| Salal | 100 | 21 | 2-70 |
| Western rhododendron | 80 | 22 | 0-60 |
| Wax myrtle | 73 | 7 | 0-30 |
| Scots broom | 60 | 1 | 0-2 |
| Bearberry | 40 | Tr | 0-2 |
| Hairy manzanita | 33 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 93 | 4 | 0-20 |
| Ground-cone | 40 | Tr | 0-2 |
| False lily-of-the-valley | 20 | Tr | 0-4 |
| Candystick | 20 | Tr | 0-1 |

## SHORE PINE/SCOTS BROOM/EUROPEAN BEACHGRASS FOREST

*Pinus contorta* var. *contorta/Cystisus scoparius/Ammophila arenaria*



PICOC/CYSC4/AMAR4
(Sampled: 14 recon plots)
CLS832

**Environment.** This weedy association occurs on dry sand, on all aspects and slopes, between deflation plains and the forest edge. The substrate is sand.

**Vegetation and ecology.** Many stands of this association were planted for dune stabilization between 1935 and 1970, but naturally-occurring stands with the same composition are also common on the Recreation Area. Although we sampled only 30-50 year-old stands, we have lumped here younger shrubland stands as well, all characterized by presence of Scots broom, usually with a weedy understory dominated by European beachgrass and many other species. Scots pine and black pine, both exotic species, were sometimes planted instead of shore pine, and Sitka spruce is often codominant. In stands with less than 25 percent tree cover, Scot's broom may reach densities of 90 percent cover and heights of 10 feet, after which entire stands begin to senesce. The understory is a mix of European beachgrass, little hairgrass, false dandelion, silver hairgrass, bracken, sheep sorrel and other Eurasian weeds. Dense stands of Scot's broom may have high cover of moss in the ground layer. In stands with tree cover greater than 25 percent, Scots broom and European beachgrass become less abundant. Moss cover is low in woodland stands because of diminished shade under Scot's broom, but in stands with a closed tree canopy, the ground layer becomes dominated by mosses, especially *Eurhynchium oreganum*, with up to 95 percent cover. In these more mature stands, relictual Scots broom and European beachgrass may persist in openings. Around the mouth of the Columbia River, this association may contain American beachgrass (*Ammophila breviligulata*), native to the east coast of North America. This species has not been reported from the Recreation Area.

**Succession.** Early to mid seral. Unless they were planted, stands develop from either the European beachgrass association or the tree lupine/European beachgrass association. The seral status of the association is confirmed by the virtual lack of dead trees (Fig. 10). Douglas fir had the greatest current growth (Table 4), indicating that Douglas fir will eventually replace the shore pine. Depending on exposure to wind and salt spray, stands are replaced by either the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association, or the shore pine-Sitka spruce/evergreen huckleberry association.

**Distribution and history.** This association occurs along the coast between northern California and southwestern Washington. On the Recreation Area, mature plantations with closed canopies can be seen north of Siltcoos River. Younger stands with open canopies can be seen near Cleawox Lake, south of Siltcoos River, and south of Tenmile Creek. McLaughlin and Brown (1942) and Pinto et al. (1972) described protocol for dune stabilization work that called for planting European beachgrass with a nitrogen-fixing species such as Scots broom, followed a year or two later by shore pine. Such plantings develop into the shore pine/Scots broom/European beachgrass association.

**Management.** Plantations 30-50 years old with closed canopies are good areas for collecting matsutake mushrooms. Motorized recreation here should be restricted to trails, in order to maintain mushroom-picking opportunities. Open stands with dense populations of Scots broom serve as seed sources for this invasive species. Scots broom could be eliminated by repeated burning, pulling, and several years of subsequent monitoring, with additional pulling as required.

**Other studies.** The broom series of Sawyer and Keeler-Wolf (1995) includes elements of this association.

Common plants of the shore pine/Scots broom/European beachgrass association (n = 14 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 71 | 25 | 0-80 |
| Sitka spruce | 43 | 1 | 0-10 |
| Douglas fir | 7 | Tr | 0-5 |
| UNDERSTORY TREES | | | |
| Shore pine | 71 | 4 | 0-20 |
| Sitka spruce | 64 | 5 | 0-20 |
| Douglas fir | 14 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Scots broom | 100 | 36 | 1-90 |
| Evergreen huckleberry | 50 | 4 | 0-35 |
| Salal | 29 | 1 | 0-8 |
| Chaparral broom | 21 | Tr | 0-1 |
| Wax myrtle | 14 | 2 | 0-15 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| European beachgrass | 100 | 36 | 1-95 |
| Little hairgrass | 71 | 11 | 0-85 |
| False dandelion | 71 | 1 | 0-3 |
| Sword fern | 64 | 1 | 0-1 |
| Silver hairgrass | 43 | 5 | 0-45 |
| Licorice fern | 43 | Tr | 0-1 |

## SHORE PINE/SLOUGH SEDGE SEASONALLY FLOODED FOREST

*Pinus contorta* var. *contorta/Carex obnupta*

PICOC/CAOB3
(Sampled: 6 recon plots)
CLM101

**Environment.** This wetland association occurs in depressions on deflation plains and on ancient marine terraces. A high water table in winter, or impeded drainage from iron-cemented hardpan, precludes invasion by upland species of shrubs and trees. The depressions fill with one to three feet of standing water in winter and early spring, but dry up by early summer. Sand in dried-up depressions may be stained with iron. Peat does not develop at these sites because summer drying oxidizes any organic material.

**Vegetation and ecology.** These stands are dominated by shore pines up to 130 years old, but most range from 30-75 years. Canopy cover between 70-85 percent, and shore pine is the only reproducing conifer present. The sparse shrub layer, ranging from 1-25 percent cover, contains wax myrtle, salal and evergreen huckleberry, growing on mounds in and around the depressions. Slough sedge dominates the ground layer, with density varying inversely with depth and duration of winter flooding. Moss cover ranges from 2-95 percent cover, with drought-tolerant *Warnstorfia exannulata, Fontinalis howellii, Sphagnum mendocinum* and *Polytrichum commune* being most conspicuous. Live basal area is one of the lowest of any forest association in the Recreation Area (Fig. 10). Inclusions of the Hooker's willow-crabapple/slough sedge association may occur in deeper depressions where water persists later in the season. The seasonally high water table inhibits invasion of upland species, and this association persists long after surrounding vegetation has developed into upland forest. Long-term infilling by organic material causes transition to upland vegetation. Pumping of groundwater for municipal use may be causing the water table to drop in some areas of the Recreation Area, and may hasten invasion of upland species.

**Succession.** Early to mid seral. This association replaces the Hooker willow/slough sedge-Pacific silverweed association, and possibly the bog blueberry/slough sedge association, although we saw no evidence of the latter. The seral status of the association is confirmed by the virtual lack of dead trees

in most stands (Fig. 10). It may be replaced by the shore pine/Labrador tea association, and eventually by the shore pine-Sitka spruce/evergreen huckleberry association, as seen on Goose Pasture.

**Distribution and history.** This association occurs sporadically along the coast between northern California and southwestern Washington, with most known occurrences concentrated between the Siuslaw River and Heceta Head. Old-growth stands are rare. Some stands are developing on deflation plains as an artifact of the expansion of this landform after the advent of European beachgrass. Individual stands rarely exceed 10 acres in size. On the Recreation Area, the best-developed old-growth sites occur near Horsfall Lake.

**Management.** Some of these sites are favored for picking chanterelle mushrooms. After the standing water dries up in early to mid-summer, stands are vulnerable to damage from off-road vehicles. Privately-owned stands in the Florence area are being destroyed by residential and commercial development. Management should include identification, protection and monitoring of old-growth stands, and monitoring of younger stands on deflation plains to see if they are developing into the same association. Groundwater pumping in the vicinity of Horsfall Lake and Beale Lake needs to be monitored to determine if it is detrimental to the plant associations there.

**Other studies.** Egler (1934), Wiedemann (1966, 1984, 1993), Wiedemann et al. (1969) and Christy (1979) described this association clearly. The beach pine series of Sawyer and Keeler-Wolf (1995) include this association.

Common plants of the shore pine/slough sedge association (n = 6 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 100 | 63 | 40-85 |
| UNDERSTORY TREES | | | |
| Shore pine | 50 | 1 | 0-3 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Evergreen huckleberry | 100 | 6 | 1-15 |
| Wax myrtle | 83 | 9 | 0-20 |
| Salal | 67 | 2 | 0-5 |
| Hooker willow | 50 | 5 | 0-12 |
| Bog blueberry | 50 | 2 | 0-8 |
| Black twinberry | 50 | 1 | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 48 | 25-75 |
| Pacific silverweed | 33 | 4 | 0-20 |
| Tufted hairgrass | 33 | 3 | 0-15 |
| Northern bugleweed | 33 | 2 | 0-8 |

## SITKA SPRUCE-RED ALDER/SLOUGH SEDGE-SKUNK CABBAGE SATURATED FOREST

*Picea sitchensis-Alnus rubra/Carex obnupta-Lysichiton americanum*

PISI-ALRU/CAOB3-LYAM3
(Not sampled)
CSH401

**Environment.** Small examples of this association were seen on the Recreation Area, but never sampled quantitatively. It occurs in depressions between old stabilized dunes, and on floodplains adjacent to perennial streams. Soils are perennially wet, usually with high organic content.

**Vegetation and ecology.** Stands of this type are dominated by Sitka spruce, with cover ranging from 0 to 85 percent. Red alder may cover 10 to 50 percent of the plot, with lesser amounts of western hemlock and western red cedar occurring on root mounds and decaying logs. While spruce may reach large diameters typical of those growing in upland sites, growth rates in perennially wet soils are slow, and ages of trees often greatly exceed estimates based on familiarity with upland stands. Shallow root systems, buttressed roots, yellowing needles, a reduced branching pattern, thick boles tapering rapidly toward the crown, and reduced crown spread are typical of swamp spruce. Large wads of Scouler's polypody, and thick mats of epiphytic mosses, particularly *Antitrichia curtipendula*, are typical on upper trunks and limbs. In stands with lower canopy cover, high light levels may favor a dense growth of red alder, crabapple, black twinberry, salmonberry and Hooker willow, with salal, evergreen huckleberry, and vine maple occurring on root mounds and decaying stumps and logs. The herb layer is a mix of slough sedge, skunk cabbage, water-parsley, and lady fern, with sword fern and false lily-of-the-valley occurring on root mounds. Bare exposures of often deep, mucky soil often occur among the sedge. Windthrow is frequent, creating gaps for spruce regeneration, often as resprouts from fallen boles. Because of logging, old-growth examples of this association are rare.

**Succession.** Late seral to climax. Stands of this type replace both the red alder/salmonberry/slough sedge-skunk cabbage association and the Hooker willow-crabapple/slough sedge-skunk cabbage association. They appear to be climax, and spruce may reach ages of 300 years or more.

**Distribution and history.** This association occurs along the coast from southwestern Oregon to Washington. Old-growth stands are rare, because most swamps were readily accessible for logging, and suitable sites were never numerous or extensive. This association is rare on the Recreation Area, as there are few floodplains or sites with perennially wet, organic soils. Small examples were be seen along Eel Creek and Siltcoos River. Other known sites include Cape Blanco State Park, Cape Lookout State Park, near the Waldport Job Corps site, and at Blind Slough Preserve on the lower Columbia River.

**Management.** Remnant old-growth stands of this association may contain considerable volumes of timber, but should be protected because this association is so rare. Large horizontal limbs and their moss mats may provide nesting sites for marbled murrelets. Because of shallow rooting in waterlogged soils, sites are vulnerable to catastrophic windthrow, and windfirm buffers may help avert damage in some cases. Some sites are also vulnerable to tsunamis or drowning caused by subsidence following an earthquake. The exotic English ivy is invading many stands, where it roots on elevated bases of trees, and may form dense stands in the upper canopy.

**Other studies.** The Sitka spruce/devils club/skunk cabbage, Sitka spruce/blueberry/skunk cabbage, mixed conifer/salal/skunk cabbage, and mixed conifer/blueberry/skunk cabbage associations of DeMeo et al. (1992), Shepard (1995), Martin et al. (1995) and Boggs (1998) have site characteristics similar to those of this association, but they differ floristically. Kunze (1994) described a Sitka spruce-red alder/salmonberry/slough sedge association and a Sitka spruce-red alder/skunk cabbage association that are similar to this type. Her sites typify "tidewater" spruce swamps occurring along low-gradient coastal rivers, where stands are regularly irrigated or subirrigated with freshwater tidal flooding.

## RED ALDER/SALMONBERRY/SLOUGH SEDGE-SKUNK CABBAGE SATURATED FOREST

*Alnus rubra/Rubus spectabilis/Carex obnupta-Lysichiton americanum*

ALRU/RUSP/CAOB3-LYAM3
(Sampled: 2 recon plots)
HAM101

**Environment.** The red alder/salmonberry/slough sedge-skunk cabbage association is poorly represented in the Recreation Area because of the dearth of streams and floodplains. It occurs on perennially saturated stream terraces within the forest zone of the Recreation Area, east of the dune sheet. These streams are small, and confined to relatively narrow valleys. Terraces are rarely broader than 50 feet. Substrate is sand, silt or peat on a floodplain that may be inundated during brief periods of high runoff after winter storms.

**Vegetation and ecology.** Stands are dominated by red alder between 20-50 years old, with canopy cover ranging from 65-85 percent. Sitka spruce, though sparse, is the major conifer in the canopy and understory. The scanty shrub layer is dominated by black twinberry and salmonberry. The ground layer is dominated by slough sedge 1-3 feet tall, with 70-85 percent cover. Floods that rework floodplain sediments and destroy vegetation are probably the major disturbance factor.

**Succession.** Mid seral. Stands of this type may be preceded by the slough sedge association. Henderson (1979) projected that stands lacking regeneration of alder deteriorate after about 150 years. Presence of Sitka spruce, with its ability to grow in perennially wet soils, suggests that these stands develop into the Sitka spruce-red alder/slough sedge-skunk cabbage association.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. In the Recreation Area, early logging on uplands no doubt increased runoff and sediment loads, diminished the amount of woody debris in the stream channel, and changed the configuration and composition of stream terraces. Small examples of this association can be seen along the Threemile Creek road and along Tenmile Creek at Spinreel Campground.

**Management.** Road construction and debris torrents are the main threat to these associations. Good watershed management will reduce flood hazard, and placement of roads on uplands rather than stream terraces will reduce losses. Roads on stream terraces could be removed in some places.

**Other studies.** Henderson (1970, 1979) described a red alder/salmonberry associes along the Alsea River in Oregon's Coast Range, inland from the Sitka spruce zone. Stands on the Recreation Area appear to be wetter than those sampled by Henderson, and the shrub and ground layers are very different. Duebendorfer (1992) described a "riparian deciduous forest" dominated by red alder, that may be similar to stands on the Recreation Area. The Sitka spruce-red alder association of DeMeo et al. (1992) occupies similar sites, but lacks slough sedge. Kunze (1994) described a Sitka spruce-red alder/salmonberry/slough sedge association occurring along low-gradient streams that may be similar to this association.

Common plants of the red alder/salmonberry/ slough sedge-skunk cabbage association (n = 2 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Red alder | 100 | 60 | 40-80 |
| Sitka spruce | 50 | 8 | 0-15 |
| Western hemlock | 50 | 2 | 0-3 |
| UNDERSTORY TREES | | | |
| Cascara | 100 | 5 | Tr-10 |
| Sitka spruce | 100 | 1 | 1 |
| Crabapple | 50 | 8 | 0-15 |
| Western hemlock | 50 | 1 | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Black twinberry | 100 | 2 | 1-2 |
| Salmonberry | 100 | 1 | 1 |
| Hooker willow | 50 | 3 | 0-5 |
| Douglas spiraea | 50 | 3 | 0-5 |
| Trailing blackberry | 50 | 1 | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 80 | 75-85 |
| Sword fern | 100 | 2 | 1-3 |
| Skunk cabbage | 50 | 2 | 0-4 |
| False lily-of-the-valley | 50 | 2 | 0-4 |

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# WOODLAND ASSOCIATIONS



Shore pine/hairy manzanita association.

# SHORE PINE WOODLAND ALLIANCE

PICOC/ARUV
PICOC/ARCO

## SHORE PINE/BEARBERRY WOODLAND

*Pinus contorta* var. *contorta/Arctostaphylos uva-ursi*

PICOC/ARUV
(Sampled: 11 recon plots)
CLS301

**Environment.** This association occurs on all aspects on dry, partially-stabilized sand ridges, slopes, and flats, between open sand and the forest edge. Stands also occur on dry deflation plains. Requirements seem to be minimal sand movement, and well-drained, exposed sites.

**Vegetation and ecology.** Stands are dominated by conspicuous mats of bearberry, reindeer lichens and mosses. Common species of lichens and mosses include *Cladina portentosa* ssp. *pacifica*, *Cladonia cervicornis* ssp. *verticillata*, *Racomitrium ericoides*, *Polytrichum juniperinum* and *Polytrichum piliferum*. These form thin, fragile mats growing over bare sand, with very little organic matter. Bearberry may cover up to 75 percent of stands, mosses up to 80 percent, and lichens up to 25 percent. These mats are closely associated with young shore pine in typically open stands, and Douglas fir and Sitka spruce are present in small amounts. The early seral status of the association is confirmed by the virtual lack of dead trees, and live basal area is the lowest of any forest association in the Recreation Area (Fig. 10). The shrub layer is sparse, and most vegetation is confined to the ground layer. Bracken fern, little hairgrass and candystick may be conspicuous. Areas of open sand often contain remnants of earlier seral stages, such as red fescue, seashore bluegrass or seashore lupine. Scots broom is invading many sites.

**Succession.** Early to mid seral. This association can replace either the red fescue association, or the red fescue-bracken fern association. It is in turn replaced by the shore pine/hairy manzanita association, and often contains elements of both. Remnants of this type persist in openings in the shore pine/hairy manzanita association, and in the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association.

**Distribution and history.** This association occurs discontinuously along the coast between northern California and southwestern Washington, although Douglas fir and hairy manzanita become scarce north

of Tillamook Bay, Oregon. It occurs throughout the Recreation Area along the border between open dunes and forests. Some of the best examples can be seen around the Eel Creek Campground, and west of Hauser. This association may be declining because of dune stabilization, and possibly the absence of stand-replacing fire. Bearberry is also called kinnikinnik.

**Management.** The fragile mats of lichens and bearberry in this association are readily destroyed by recreational vehicles and heavy foot traffic (Wiedemann 1990, 1993; Brown 1990). Reindeer lichens (*Cladina* and *Cladonia* spp.) are the first to disappear from the plots, followed by bearberry. The lichen layer may take more than 8 years to recover (Bayfield 1979; Bayfield et al. 1981). Recreational vehicles and heavy foot traffic need to be excluded from selected areas. Invading trees may be removed by cutting. This association is favored for collecting matsutake mushrooms, but mycorrhizal relationships and impacts from harvest and trampling are unknown.

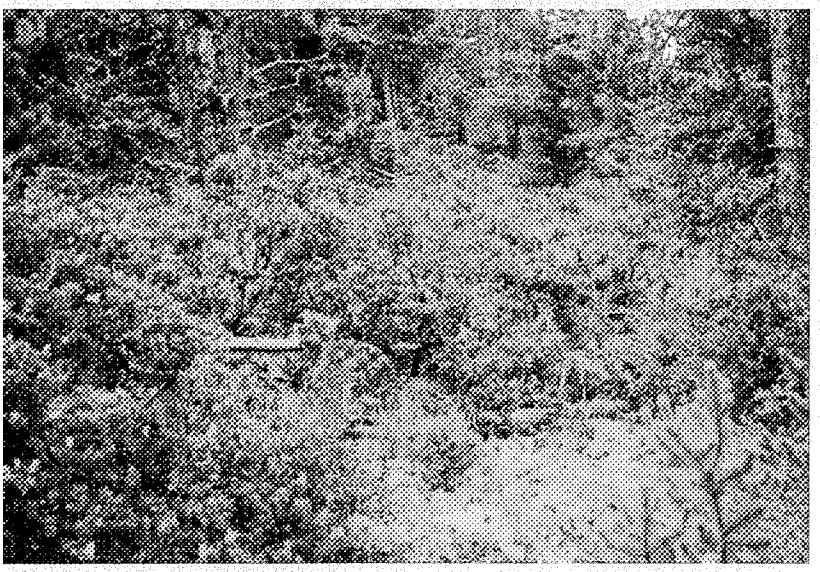
**Other studies.** Egler (1934) described a bearberry association that also included hairy manzanita. Kumler (1963, 1969) described a "secondary shrub intergrade" association and a "shore pine-shrub" association containing bearberry. Kunze (1983) described a mixed shrub association containing bearberry. Wiedemann (1984, 1990, 1993) described a very similar bearberry/*Racomitrium canescens* association on sheltered inactive bare sand. Pickart (1990) included this association in a broader concept of "coniferous forest." Duebendorfer (1992) described a phase of his "beach pine/Sitka spruce forest" with a sparse shrub layer, and a ground layer dominated by bearberry, *Cladina*, and other taxa.

Common plants of the shore pine/bearberry association (n = 11 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 91 | 31 | 0-75 |
| Douglas fir | 9 | Tr | 0-3 |
| Sitka spruce | 9 | Tr | 0-2 |
| UNDERSTORY TREES | | | |
| Shore pine | 100 | 7 | 1-25 |
| Douglas fir | 18 | Tr | 0-2 |
| Sitka spruce | 18 | Tr | 0-1 |
| Western hemlock | 9 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Bearberry | 100 | 28 | 3-75 |
| Hairy manzanita | 91 | 5 | 0-20 |
| Evergreen huckleberry | 91 | 3 | 0-10 |
| Salal | 91 | 2 | 0-10 |
| Scots broom | 45 | 4 | 0-15 |
| Wax myrtle | 36 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Red fescue | 82 | 1 | 0-5 |
| Little hairgrass | 82 | 1 | 0-1 |
| Candystick | 73 | 1 | 0-2 |
| Seashore lupine | 64 | 1 | 0-5 |
| False dandelion | 64 | 1 | 0-5 |
| Bracken fern | 36 | 1 | 0-10 |
| Seashore bluegrass | 36 | 1 | 0-5 |
| Silver hairgrass | 36 | Tr | 0-1 |

## HORE PINE/HAIRY MANZANITA WOODLAND

*'inus contorta* var. *contorta/Arctostaphylos columbiana*



PICOC/ARCO3
(Sampled: 5 recon plots)
CLS831

**:nvironment.** The shore pine/hairy manzanita association occurs on all aspects on dry, partially-:abilized sand ridges, slopes, and flats, between open sand and the forest edge. Requirements seem to e minimal sand movement, and well-drained sites. Burial by moving sand is occurring in some areas.

**'egetation and ecology.** This association is dominated by shore pine, with lesser amounts of Douglas r, forming an open canopy with 20-55 percent cover. Pines in mature stands are between 80-130 years ld. The shrub layer is dominated by hairy manzanita and evergreen huckleberry averaging 6 feet tall, 'ith 45-95 percent cover. The ground layer is sparse, with small ericaceous plants such as pinesap and inedrops occasional. Small openings contain remnants of the shore pine/bearberry association, with ıoss and reindeer lichens conspicuous, particularly *Cladina portentosa* ssp. *pacifica*. The lichen flora n the shrub layer is diverse, with many cyanolichens, and includes several rare species such as *'rioderma sorediatum* and *Leioderma sorediatum*. Droughty, nutrient-poor soils and slow growth make ıis a long-lived association.

**uccession.** Early to mid seral. Stands of this type replace the shore pine/bearberry association. )ouglas fir had a greater current growth than shore pine (Table 4), indicating that this association is mid-:ral, and that Douglas fir will eventually replace shore pine.
)epending on latitude, it is later replaced by either the Port Orford cedar/evergreen huckleberry ssociation, or the shore pine-Douglas fir/wax myrtle-evergreen huckleberry association.

**)istribution and history**. This association occurs discontinuously along the coast between northern 'alifornia and Tillamook Bay, Oregon. It occurs throughout the Recreation Area along the border :tween open dunes and forests. Typical examples can be seen around the Eel Creek Campground, and 'est of Hauser. It may now be in decline because of dune stabilization, and possibly the absence of :and-replacing fires.

**lanagement.** Stands are vulnerable to sand blowout that may follow fire or mechanical disturbance. lanagement should include protection and monitoring of several representative stands, with control of )nifer invasion by cutting. This association is favored for collecting matsutake mushrooms, but

mycorrhizal relationships and impacts from harvest and trampling are unknown (Pilz et al. 1996). Because the ground layer is fragile, recreational vehicles should be excluded.

**Other studies**. Egler (1934) included this association in his description of the bearberry association. Kumler (1963, 1969) described a "secondary shrub intergrade" association and a "shore pine-shrub" association containing hairy manzanita. Wiedemann (1984, 1993) described this association clearly.

Common plants of the shore pine/hairy manzanita association (n = 5 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 100 | 31 | 20-55 |
| Douglas fir | 40 | 3 | 0-15 |
| UNDERSTORY TREES | | | |
| Shore pine | 80 | 3 | 0-10 |
| Douglas fir | 40 | 1 | 0-3 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hairy manzanita | 100 | 39 | 15-65 |
| Evergreen huckleberry | 100 | 36 | 15-75 |
| Salal | 100 | 17 | 2-40 |
| Western rhododendron | 80 | 2 | 0-5 |
| Bearberry | 60 | 1 | 0-5 |
| Wax myrtle | 40 | 5 | 0-15 |
| Scots broom | 40 | 1 | 0-3 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 60 | 1 | 0-3 |
| Ground-cone | 40 | Tr | 0-Tr |
| Gnome plant | 20 | Tr | 0-Tr |
| Pinesap | 20 | Tr | 0-Tr |
| Candystick | 20 | Tr | 0-Tr |

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# SHRUBLAND ASSOCIATIONS



The Hooker willow/slough sedge-Pacific silverweed association on an old deflation plain.

## TREE LUPINE/EUROPEAN BEACHGRASS SHRUBLAND

*Lupinus arboreus/Ammophila arenaria*

LUAR/AMAR4
(Sampled: 2 recon plots)
SW8101

**Environment.** This association is restricted to deflation plains and the landward side of foredunes. Topography is flat or hummocky. Soils are dry sand with very little organic material. Occurrences of this association are partially sheltered from salt spray and high winds by foredunes. Sand movement is limited by dense growths of European beachgrass.

**Vegetation and ecology.** This association is dominated by species planted for dune stabilization, or species naturalized from stabilization programs. Shore pine, Sitka spruce, and Douglas fir can be present in small amounts as seedlings or saplings. Tree lupine is the major shrub present, with cover ranging from 40-70 percent. Scots broom, another species introduced for dune stabilization programs and subsequently naturalized, can have up to 15 percent cover. The herb layer is dominated by European beachgrass with up to 70 percent cover, but 23 other species are also present, most of them weedy, introduced species, much like those in the shore pine/Scots broom/European beachgrass association. Pickart et al. (1990) found that bush lupine elevated levels of ammonium in the sand, and increased soil moisture through shading. These changes fostered invasion of exotic annual grasses and other weeds that, in turn, increased levels of organic matter and nitrate in the soil. While these are precisely the objectives of dune stabilization programs, the effects disrupt the composition and succession of native plant associations.

**Succession.** Early seral. If not planted, the tree lupine/European beachgrass association replaces the European beachgrass association. It is in turn replaced by the shore pine/Scots broom/European beachgrass association.

**Distribution and history.** It is not known how extensively tree lupine was planted along the coast north of California, but it is now scarce in both Oregon and southwestern Washington. In Oregon, most populations are now limited to the Recreation Area, where they occur on the South Jetty of the Siuslaw

River. Many of these have died in recent years, presumably because of frost. Tree lupine is also called yellow bush lupine.

**Management.** In northern California, 50 years of aerial photographs show that tree lupine has spread at an average rate of 6.4 acres per year (Miller 1987). Tree lupine originally was native as far north as Marin County (Davy 1902; Miller 1988) or Mendocino County (Sawyer and Keeler-Wolf 1995). More northerly populations, including those on the Recreation Area, originated from plantings for dune stabilization, ornamental purposes, and subsequent self-seeding (Miller 1988). Tree lupine may never become a management problem on the Recreation Area. It appears to be restricted to the South Jetty, and the recent die-back there may prevent further spread of the species.

**Other studies.** Miller (1988) described vegetation dominated by tree lupine in northern California. The "lupine scrub" of Duebendorfer (1990) and Pickart (1990) is similar to that observed on the Recreation Area. The yellow bush lupine series of Sawyer and Keeler-Wolf (1995) do not include European beachgrass.

Common plants of the tree lupine/European beachgrass association (n = 2 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| UNDERSTORY TREES | | | |
| Shore pine | 100 | 2 | 2-2 |
| Douglas fir | 50 | 1 | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Tree lupine | 100 | 55 | 40-70 |
| Scots broom | 50 | 8 | 0-15 |
| Hooker willow | 50 | 1 | 0-2 |
| Black twinberry | 50 | 1 | 0-2 |
| Wax myrtle | 50 | 1 | 0-2 |
| Sitka willow | 50 | 1 | 0-2 |
| Evergreen huckleberry | 50 | 1 | 0-1 |
| Chaparral broom | 50 | 1 | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| European beachgrass | 100 | 40 | 20-60 |
| Pearly everlasting | 100 | 4 | 2-5 |
| False dandelion | 100 | 3 | 2-3 |
| Coast strawberry | 100 | 3 | 2-3 |
| Little hairgrass | 100 | 2 | 2-2 |
| Silver hairgrass | 100 | 2 | 1-2 |
| Velvet grass | 100 | 1 | 1-1 |
| Sheep sorrel | 100 | 1 | 1-1 |
| Seashore lupine | 50 | 3 | 0-5 |
| Yarrow | 50 | 3 | 0-5 |
| American dunegrass | 50 | 3 | 0-5 |
| Sword fern | 50 | 2 | 0-4 |
| Orchard-grass | 50 | 2 | 0-3 |
| Toothed Australian fireweed | 50 | 2 | 0-3 |

# HOOKER WILLOW SEASONALLY FLOODED SHRUBLAND ALLIANCE

SAHO/CAOB3-AREGE

## HOOKER WILLOW/SLOUGH SEDGE-PACIFIC SILVERWEED SHRUBLAND

*Salix hookeriana/Carex obnupta-Argentina egedii*

SAHO/CAOB3-AREGE
(Sampled: 18 recon plots)
SW1101

**Environment.** This wetland association occupies extensive areas of deflation plains and in interdunal swales. The substrate is an organic layer two to 20 inches thick, underlain by sand. Stands are seasonally flooded, and may dry out in midsummer. Although stands on deflation plains may be subject to salt spray, brackish water is absent.

**Vegetation and ecology.** This association is dominated by shrubs, particularly Hooker willow, with lesser amounts of wax myrtle, salal and evergreen huckleberry. Around the edges, it may intergrade with other deflation plain associations that share a number of the same herbaceous species. The tree layer, when present, is composed of young shore pine and Sitka spruce. The herb layer is rich, with a total of 42 species. It is dominated by slough sedge and Pacific silverweed, ranging from 55-90 percent cover. Bare sand may range from 0-40 percent. Marsh cinquefoil becomes a common component farther north. The density of Hooker willow increases as stands age.

**Succession.** Early seral. This association replaces the slough sedge-Pacific silverweed, when shrub densities exceed about 20 percent. If no sand burial or drainage occurs, the shore pine/slough sedge association will develop on these sites.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. On the Recreation Area, good examples may be seen along the South Jetty Road. Pacific silverweed has also been called *Potentilla pacifica*.

**Management.** Off-road vehicle use may be heavy along the margins of some stands. On the South Jetty, some areas have been destroyed by creation of wetlands for waterfowl production.

**Other studies.** Kunze (1983, 1985) described deflation plain associations dominated by Hooker willow, and Wiedemann (1984, 1990, 1993) described a Hooker willow-wax myrtle association that would fit our concept of the Hooker willow/slough sedge-Pacific silverweed association on the Recreation Area. The "woody hollow" association of Duebendorfer (1990, 1992), and the "deciduous swamp" association of Pickart (1990) and Duebendorfer (1992) are similar to our concept of the Hooker willow/slough sedge-Pacific silverweed association. Kunze (1994) described a Hooker willow/slough sedge association from deflation plains in Washington, but did not include Pacific silverweed. The Hooker willow series of Sawyer and Keeler-Wolf (1995) includes this association, while that of Shephard (1995) and Boggs (1998) are quite different floristically.

Common plants of the Hooker willow/slough sedge-Pacific silverweed association (n = 18 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 28 | 3 | 0-30 |
| Sitka spruce | 22 | 1 | 0-10 |
| UNDERSTORY TREES | | | |
| Shore pine | 33 | 2 | 0-35 |
| Sitka spruce | 17 | Tr | 0-2 |
| Western red cedar | 6 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 100 | 42 | 20-60 |
| Wax myrtle | 39 | 7 | 0-40 |
| Salal | 39 | 3 | 0-15 |
| Evergreen huckleberry | 28 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 50 | 10-80 |
| Pacific silverweed | 94 | 23 | 0-80 |
| Marsh speedwell | 67 | 1 | 0-5 |
| Bird-foot trefoil | 61 | 5 | 0-30 |
| Salt rush | 50 | 2 | 0-10 |
| Creeping buttercup | 50 | 1 | 0-4 |

## )OUGLAS SPIRAEA SATURATED SHRUBLAND

*'piraea douglasii*

SPDO
(Sampled: 1 recon plot)
SW4114

**Environment.** This wetland association occurs on perennially-wet organic muck and fibrous peat djacent to lakes and ponds, and on old deflation plains. Peaty muck forms under anaerobic conditions ı basins with impeded drainage. Sites may be flooded seasonally or year-round, or subirrigated in ummer. Water levels must be relatively constant to maintain hydrology. Dune-blocked lakes formed t the edge of the dune sheet are the most common sites. Gently-sloping, shallow lakeshores are ecessary for formation of this association.

**'egetation and ecology.** Stands are nearly monotypic, dominated by Douglas spiraea with lesser mounts of Hooker willow. A tree layer is absent. Total shrub cover in the single recon plot sampled /as 60 percent, and shrub height averaged 5 feet. The sparse herb layer is dominated by slough sedge, itka sedge and lady fern. Inclusions of other wetland species such as hardstem bulrush or pond lily are requently remnants of earlier seral associations. Toothed Australian fireweed, frequently present on levated hummocks in coastal wetlands, can increase dramatically when stands are drained. Changes ı hydrology may cause Douglas spiraea to increase in density. More northerly examples may contain weet gale (*Myrica gale*) and Labrador tea.

**uccession.** Early seral. This association is intermediate between herbaceous wetland associations, and ıose dominated by tall shrubs or trees. It replaces the simplestem bur-reed, hardstem bulrush, slough edge and inflated sedge associations. It is in turn replaced by the Hooker willow-crabapple/slough edge-skunk cabbage association.

**)istribution and history.** This association is common along the coast between northern California and outheastern Alaska. Stands of Douglas spiraea occurring in interior valleys have not been sampled.. )n the Recreation Area, examples may be seen in dune hollows in the Horsfall area, and at the northern nd of Threemile Lake.

**Management.** Wet soils and shrub density preclude any recreational use in this association.

**Other studies.** Thomas (1980) and Wiedemann (1984) and Kunze (1994) described coastal associations dominated by Douglas spiraea.

Common plants of the Douglas spiraea association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Douglas spiraea | 100 | 60 | 60 |
| Hooker willow | 100 | 2 | 2 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 20 | 20 |
| Toothed Australian fireweed | 100 | 10 | 10 |
| Hardstem bulrush | 100 | 3 | 3 |
| Lady fern | 100 | 2 | 2 |

# HOOKER WILLOW SATURATED SHRUBLAND ALLIANCE

SAHO-MAFU/CAOB3-LYAM3

## HOOKER WILLOW-CRABAPPLE/SLOUGH SEDGE-SKUNK CABBAGE SATURATED SHRUBLAND

*'alix hookeriana-Malus fusca/Carex obnupta-Lysichiton americanum*

SAHO-MAFU/CAOB3-LYAM3
(Sampled: 2 recon plots)
SW1102

**nvironment.** This association occurs on perennially wet mucky soils with high organic content. It sually occurs adjacent to lakes and ponds, and on old deflation plains. Sites may be flooded seasonally r year-round, but water is usually just below the ground surface in summer. Water levels must be latively constant to maintain hydrology. Dune-blocked lakes formed at the edge of the dune sheet are ıe most common sites. Gently-sloping, shallow lakeshores are necessary for formation of this ssociation.

**egetation and ecology.** The tree layer is sparse in most stands, with scattered red alder, shore pine or itka spruce growing on low hummocks or around the margin of the wetland. A dense, tangled layer f tall shrubs, dominated by crabapple and Hooker willow, forms a canopy ranging from 30-95 percent ɔver. Douglas spiraea and Labrador tea form a lower shrub layer on wet soils, especially in gaps in the ınopy of tall shrubs. Salal and black twinberry may occur on hummocks. The ground layer is ɔminated by slough sedge and skunk cabbage, with areas of bare, wet muck in the most shaded places. losses and licorice fern are abundant in the canopy of tall shrubs. Stands appear to be long-lived, aintained by wet soils and gap succession. The willow sustains frequent crown damage from winter inds, as well as from heavy browsing by beavers, followed by vigorous sprouting. While crabapple present on the Recreation Area, it did not occur in our plots. We consider the lack of crabapple to be ıly a local variant of this widespread and common association.

**ıccession.** Mid seral. The slough sedge and Douglas spiraea associations are the most likely ecursors to this association, and persist in gaps in the tall shrub canopy. It is replaced by the climax tka spruce-red alder/slough sedge-skunk cabbage association.

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**Distribution and history.** This association is common along the coast between northern California and British Columbia. It is not common on the Recreation Area, because most lakes are steep-sided, and most deflation plain soils have little organic content. The best examples were seen at Threemile Lake, in an abandoned meander of Siltcoos River near Lagoon Campground, and around the edges of Horsfall and Spirit Lakes. Crabapple has also been called *Pyrus fusca*.

**Management.** Because of the dense, nearly impenetrable shrub layer, these sites are virtually free of human disturbance. They are prime feeding and denning habitat for beaver. Perennially wet soils preclude establishment of conifers for many years.

**Other studies.** This association was described by Christy (1980, 1985), Banner et al. (1986), and Kunze (1994).

Common plants of the Hooker willow-crabapple/ slough sedge-skunk cabbage association (n = 2 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Red alder | 100 | 9 | 2-15 |
| Sitka spruce | 50 | 2 | 0-3 |
| Shore pine | 50 | 2 | 0-3 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 100 | 55 | 30-80 |
| Labrador tea | 100 | 10 | 10 |
| Salal | 100 | 3 | 1-5 |
| Evergreen huckleberry | 100 | 1 | 1 |
| Sitka willow | 50 | 8 | 0-15 |
| Douglas spiraea | 50 | 1 | 0-1 |
| Black twinberry | 50 | 1 | 0-1 |
| Wax myrtle | | 50 | 10-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 40 | 40 |
| Skunk cabbage | 100 | 28 | 5-50 |
| Lady fern | 100 | 2 | 2 |
| Licorice fern | 100 | 2 | 1-2 |
| Deer fern | 100 | 1 | 1 |
| Sword fern | 100 | 1 | 1 |

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# DWARF-SHRUBLAND ASSOCIATIONS



The bog blueberry/slough sedge association on a deflation plain.

# 3OG BLUEBERRY SEASONALLY FLOODED DWARF-SHRUBLAND ALLIANCE

VAUL/CAOB3
VAUL/DECEC

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## 3OG BLUEBERRY/SLOUGH SEDGE DWARF-SHRUBLAND

*/accinium uliginosum/Carex obnupta*

VAUL/CAOB3
(Sampled: 10 recon plots)
SW4102

**Environment.** This wetland association occurs primarily on deflation plains. Stands are seasonally looded and may dry out in summer. The substrate is organic material from two to 20 inches thick, underlain by sand. Stands are remote from saltwater intrusion, but may be subject to salt spray.

**/egetation and ecology.** This association occupies sites similar to those of the Hooker willow/slough edge-Pacific silverweed association. It is dominated by bog blueberry and a has a comparatively low cover of Hooker willow. The tree layer is sparse, composed of young shore pine, with reproduction of crabapple and shore pine present. Salal and evergreen huckleberry are sporadic and confined to drier hummocks. The ground layer is dominated by slough sedge, Pacific silverweed, salt rush and other species common to deflation plains. Eastern cranberry, escaped from cultivated stock, is sometimes present in this association. Mosses average 11 percent cover, ranging from 0-45 percent. Common species include *Polytrichum commune* and *Warnstorfia exannulata.*

**Succession.** Early seral. Like the slough sedge-Pacific silverweed association, this association appears to be derived from the creeping spikerush-Nevada rush association. If no sand burial or drainage occurs, the shore pine/slough sedge association will develop on these sites. If some sand burial or drainage occurs, the bog blueberry/tufted hairgrass association may replace the bog blueberry/slough sedge association.

**Distribution and history.** This association occurs sporadically along the coast between northern California and southwestern Washington. On the Recreation Area, good examples can be seen on deflation plains in the Horsfall area. The eastern cranberry occurring in our plots probably originated from nearby plantings on private land, where it has been grown commercially since 1885. There are

several abandoned cranberry bogs on the Recreation Area west and south of Hauser, and the species is readily bird-dispersed into native wetlands.

**Management.** Off-road vehicles can cause considerable damage to seasonally-flooded areas on deflation plains. However, most drivers prefer herb-dominated habitats, and avoid shrubby areas such as the bog blueberry/slough sedge association.

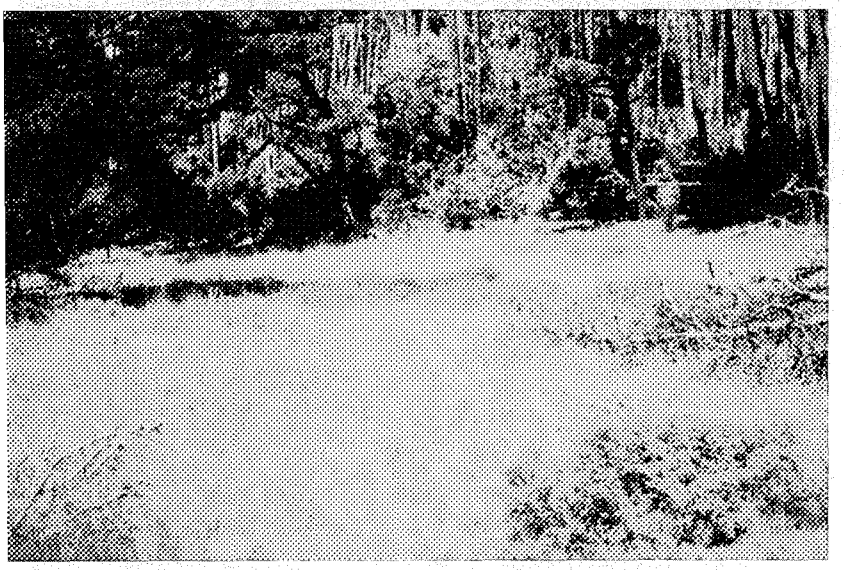
**Other studies.** Egler (1934) described a slough sedge-dwarf huckleberry (*Vaccinium caespitosum*) association on deflation plains. It is likely that Egler misidentified bog blueberry as dwarf huckleberry. Although dwarf huckleberry is known to occur at higher elevations in the Coast Range, it is unknown from the immediate coast. Bog blueberry associations occur north to Alaska (Viereck et al. 1992), but slough sedge does not extend north of British Columbia.

Common plants of the bog blueberry/slough sedge association (n = 10 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 20 | 2 | 0-20 |
| UNDERSTORY TREES | | | |
| Shore pine | 70 | 2 | 0-10 |
| Crabapple | 10 | Tr | 0-2 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Bog blueberry | 100 | 54 | 35-80 |
| Hooker willow | 90 | 13 | 0-35 |
| Labrador tea | 50 | 1 | 0-5 |
| Salal | 50 | 1 | 0-3 |
| Evergreen huckleberry | 40 | 1 | 0-5 |
| Eastern cranberry | 30 | 17 | 0-80 |
| Douglas spiraea | 30 | 2 | 0-10 |
| Wax myrtle | 30 | 2 | 0-15 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 27 | 2-60 |
| Marsh speedwell | 90 | 2 | 0-5 |
| Pacific silverweed | 80 | 9 | 0-40 |
| Salt rush | 60 | 2 | 0-10 |
| Creeping buttercup | 50 | Tr | 0-1 |
| California aster | 40 | 2 | 0-20 |
| Northern bugleweed | 40 | 1 | 0-2 |

## BOG BLUEBERRY/TUFTED HAIRGRASS DWARF-SHRUBLAND

*Vaccinium uliginosum/Deschampsia cespitosa* ssp. *cespitosa*



VAUL/DECEC
(Sampled: 3 recon plots)
SW4101

**Environment.** Never large in extent, this association occurs infrequently in shallow depressions on old deflation plains, around the edges of shallow dune lakes, and in sandy areas underlain by iron-cemented hardpan. Stands are seasonally flooded to a depth of 12 inches, and usually dry out by midsummer. Substrate is sand or a thin organic layer over sand.

**Vegetation and ecology.** The stands sampled on the Recreation Area contained more wetland species than others seen in the region, but were sampled during a wet summer when areas remained flooded longer than usual. The tree layer is sparse, mostly restricted to the periphery of stands, and is composed of shore pine only. The shrub layer is dominated by bog blueberry, with cover up to 40 percent. Douglas spiraea may have up to 25 percent cover, and Hooker willow up to 10 percent cover. Sites sampled outside of the Recreation Area have had up to 90 percent cover of bog blueberry, 25 percent cover of Douglas spiraea, and up to 10 percent cover of Hooker willow. Hooker willow sometimes has a higher constancy than bog blueberry, but cover values are much lower than those of bog blueberry. Lesser amounts of evergreen huckleberry, salal and wax myrtle may occur on elevated hummocks or around the margins. The herb layer is dominated by tufted hairgrass with up to 60 percent cover, with up to 80 percent in plots seen elsewhere, and may contain 20-30 percent cover of slough sedge. Bracken fern may be present in trace amounts. The moss *Sphagnum mendocinum* and the lichen *Cladina portentosa* ssp. *pacifica* occur at some sites.

**Succession.** Early seral. This association is probably preceded by the wetter bog blueberry/slough sedge association. Invading upland species indicate that it is replaced by the shore pine-Sitka spruce/evergreen huckleberry association.

**Distribution and history.** This association is apparently restricted to the immediate coastline between northern California and Heceta Head, Oregon. It appears to be declining because of successional changes caused by dune stabilization, and possibly by cessation of stand-replacing fires. It is also vulnerable to recreational and residential development. On the Recreation Area, small examples occur along the shore of Threemile Lake.

**Management.** Some stands are adjacent to areas favored for mushroom picking. Areas are usually too small or remote to be subject to off-road vehicle entry, but they can be damaged if entered. Stands larger than 2 or three acres, if found, should be protected and monitored, with removal of encroaching shrubs and trees by cutting. Threats from development are greatest between the Siuslaw River and Heceta Head.

**Other studies.** Martin and Frenkel (1978) described this association.

Common plants of the bog blueberry/tufted hairgrass association (n = 3 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 33 | 2 | 0-5 |
| UNDERSTORY TREES | | | |
| Crabapple | 33 | 1 | 0-2 |
| Cascara | 33 | Tr | 0-1 |
| Shore pine | 33 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 67 | 2 | 0-5 |
| Bog blueberry | 33 | 13 | 0-40 |
| Douglas spiraea | 33 | 2 | 0-5 |
| Wax myrtle | 33 | Tr | 0-1 |
| Salal | 33 | Tr | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Tufted hairgrass | 100 | 38 | 10-60 |
| Slough sedge | 100 | 7 | 1-20 |
| Toothed Australian fireweed | 67 | 2 | 0-5 |
| Pacific silverweed | 67 | 1 | 0-2 |
| Marsh speedwell | 67 | 1 | 0-2 |
| Field mint | 67 | Tr | 0-1 |

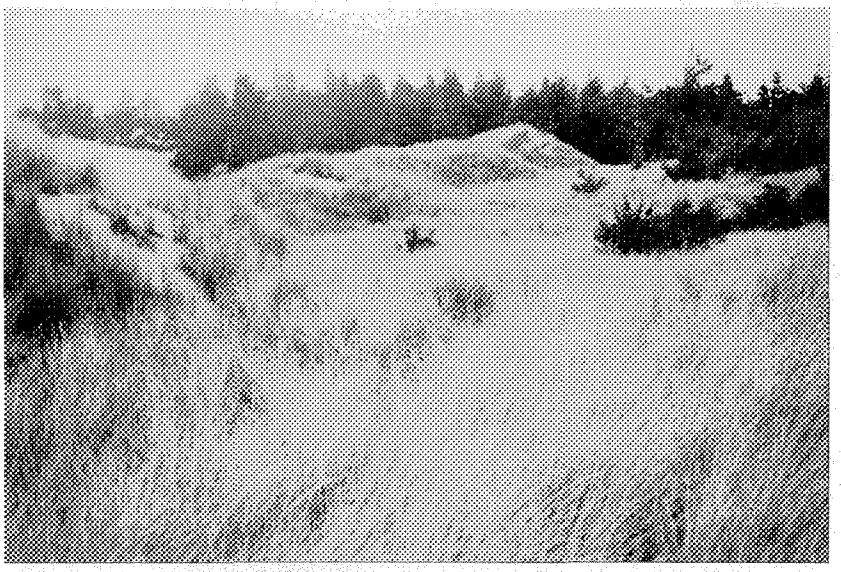
# HERBACEOUS ASSOCIATIONS



The saltgrass-Pacific silverweed tidal association occurs in bands surrounding an estuarine salt panne.

## EUROPEAN BEACHGRASS HERBACEOUS VEGETATION

*Ammophila arenaria*



AMAR4
(Sampled: 15 recon plots,
80 transect plots)
GR8211

**Environment.** This association is present throughout the dune sheet, from upper beaches to the forest edge, and occurs in open areas on all aspects and slopes. European beachgrass is best developed on foredunes, hummocks on deflation plains, and margins of winter transverse dunes, where seasonal sand movement is extensive. It tolerates salt spray on beaches and foredunes, continual burial by sand, and droughty conditions throughout the summer.

**Vegetation and ecology.** The herb layer of this association is dominated by nearly monotypic stands of European beachgrass, with 20-90 percent cover. There may be up to 75 percent bare sand. Introduced weedy species such as false dandelion, little hairgrass and silver hairgrass are frequent. Native dune species such as American dunegrass, seashore lupine and coast strawberry persist in these stands as relicts of native dune associations. Because most stands of European beachgrass occur on youthful sand dunes, many still actively shifting, woody species are nearly absent. Scots broom and tree lupine were sometimes interplanted with European beachgrass, and have also naturalized. Native shrubs such as salal, Hooker willow and wax myrtle occur in marginal stands that are succeeding to other types of associations. American beachgrass (*Ammophila breviligulata*), native to the east coast of North America, becomes common on dunes around the mouth of the Columbia River, but has not been reported from the Recreation Area.

While many stands of this introduced species were planted in dune stabilization programs, the majority appears to have invaded most localities by seed or vegetative propagation. European beachgrass is responsible for the buildup of large foredunes and creation of broad deflation plains, which have cut off the supply of beach sand to dunes further inland. Its competitive superiority and sand-trapping ability have enabled it to infiltrate and destroy nearly all stands of native plant associations on open, partially-stabilized dunes (Wiedemann 1984, 1990, 1993; Boyd 1992; Wiedemann and Pickart 1996).

**Succession.** Early seral. European beachgrass is a pioneer on bare, shifting sand. On foredunes and exposed interior dunes, it can replace native stands of the American dunegrass, seashore lupine, seashore bluegrass, and red fescue associations. On hummocks and deflation plains, European beachgrass can also replace the salt rush and red fescue-salt rush associations. Once sand movement diminishes, stands of European beachgrass are replaced by either the tree lupine/European beachgrass or the shore pine/Scots broom/European beachgrass associations. The successional pathways outlined here follow a hypothetical linear progression, influenced by the availability of shifting sand and the competitive ability of European beachgrass. Rejuvenation of sand movement in previously stabilized areas, or *de novo* infiltration or burial by sand, can trigger invasion by European beachgrass in nearly any association in nearly any locality in the Recreation Area. The putative successional sequence would then start over with European beachgrass, instead of whatever had been growing there previous to the advent of new sand.

**Distribution and history.** The European beachgrass association is common along the coast between northern California and British Columbia. On the Pacific coast of North America, it was first planted in California around 1890 (Davy 1902). On the Recreation Area, it was first planted on the North Spit around 1910. It began to spread naturally by 1930, and subsequently was planted widely until about 1970 (McLaughlin 1939; Arnst 1942; McLaughlin and Brown 1942; Meyer and Chester 1977). By 1970, it had spread the entire length and breadth of the dune sheet. In northern California dunes, 50 years of aerial photography show that the grass has increased its cover 574 percent, spreading at an average rate of 2.5 acres per year between 1939 and 1962, and 12 acres per year between 1962 and 1989 (Buell 1992). On the Recreation Area, typical examples may be seen on any foredune.

**Management.** Some of the rarest plant associations on the Recreation Area are threatened because they have been invaded and replaced by European beachgrass. European beachgrass is now so widespread on the Recreation Area that it will be impossible to eradicate except in small areas. Off-road vehicles have destroyed some stands in heavily used areas (Wiedemann 1993). The experimental breach in the foredune north of Siltcoos River, excavated in 1982, has caused very little sand movement onto the deflation plain. Much larger segments of foredune would need to be breached to initiate much movement. Management efforts should be directed instead toward control of European beachgrass in local areas where endangered native plant associations need to be restored and maintained. Fire, herbicides, saltwater, mechanical, and manual methods of control have been studied. Manual removal has been the most successful method of control, and the most expensive. Projects in northern California have shown dramatic recovery of relictual native species when European beachgrass was removed (Duebendorfer 1992; Miller 1994a, 1994b; Wiedemann and Pickart 1996).

Common plants of the European beachgrass association (n = 15 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Sitka spruce | 7 | Tr | 0-1 |
| UNDERSTORY TREES | | | |
| Shore pine | 33 | Tr | 0-2 |
| Sitka spruce | 20 | Tr | 0-2 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Scots broom | 27 | 1 | 0-15 |
| Salal | 20 | Tr | 0-2 |
| Hooker willow | 13 | 1 | 0-20 |
| Wax myrtle | 13 | 1 | 0-15 |
| Bearberry | 13 | 1 | 0-5 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| European beachgrass | 100 | 54 | 20-90 |
| False dandelion | 80 | 2 | 0-8 |
| Pearly everlasting | 73 | 1 | 0-5 |
| Seashore lupine | 67 | 2 | 0-8 |
| Coast strawberry | 60 | 2 | 0-10 |
| Little hairgrass | 53 | 2 | 0-10 |
| Silver hairgrass | 53 | 1 | 0-10 |
| Yarrow | 40 | Tr | 0-2 |

**Other studies.** Kunze (1985) and Wiedemann (1984, 1990, 1993) described this association clearly. It is the "beachgrass" and "European beachgrass" of Duebendorfer (1990, 1992). The European beachgrass series of Sawyer and Keeler-Wolf (1995) includes this association.

## AMERICAN DUNEGRASS HERBACEOUS VEGETATION

*Leymus mollis* spp. *mollis*

LEMOM2
(Sampled: 4 recon plots,
1 transect plot)
GR8213

**Environment**. This association can be found on beaches and in foredunes, and to a lesser extent on open deflation plains and in upper estuaries. Stands are exposed to salt spray, nearly continuous winds, abrasion, and ongoing burial by shifting sands.

**Vegetation and ecology**. Stands on well-drained upper beaches and foredunes are typically species-poor, with up to 70 percent bare sand. Sea pea is usually a conspicuous associate. Continual sand burial and inputs of salt spray on beaches, foredunes and exposed areas on deflation plains seem necessary for American dunegrass to thrive. A variant expression occurs on deflation plains and in upper estuaries, where additional moisture allows many more species to grow. These may have a total herb cover approaching 100 percent, and weedy species typical of the salt rush association may be conspicuous. Stands in most locations have been overrun by European beachgrass, but American dunegrass often persists in patches among the European beachgrass.

**Succession**. Early seral. At most sites on the Recreation Area, the European beachgrass association completely replaces the American dunegrass association. In the absence of European beachgrass, in slightly more stable areas, the American dunegrass association is replaced by the seashore bluegrass association.

**Distribution and history**. The American dunegrass association was once the dominant native vegetation on upper beaches and discontinuous, hummocky native foredunes. It originally ranged along the coast from northern California (Davy 1902) to southeastern Alaska. It is in decline throughout the region because of the ubiquitous invasion of European beachgrass. The best remaining examples can be seen at Lanphere-Christensen Dunes Preserve near Arcata, California (Wiedemann 1990). The species was used to a limited extent in stabilization plantings (McLaughlin and Brown 1942). Today, natural stands of this association are rare, and need protection. On the Recreation Area, small stands can

be seen on the South Jetty, and in the estuary of Tenmile Creek. This species has also been called *Elymus mollis*.

**Management**. The association tolerates dispersed foot traffic, but cannot sustain off-road vehicle traffic. Management should include restoration of some native foredunes, where some of the original components and local genotypes of this species can still be found.

**Other studies**. This association has been described by Johnson (1963), Parker (1974), Kunze (1983, 1985), Wiedemann (1984, 1990, 1993), and LaBanca (1993). This is the "northern foredune grassland" of Duebendorfer (1992), and the native dunegrass series of Sawyer and Keeler-Wolf (1995).

Common plants of American dunegrass association (n = 4 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| American dunegrass | 100 | 69 | 50-85 |
| Sea pea | 100 | 31 | 20-45 |
| Salt rush | 75 | 1 | 0-15 |
| Yarrow | 75 | 1 | 0-1 |

# :ED FESCUE HERBACEOUS ALLIANCE

FERU2
FERU2-JULE
FERU2-PTAQ

## :ED FESCUE HERBACEOUS VEGETATION

*'estuca rubra*

FERU2
(Sampled: 10 recon plots,
8 transect plots)
GM2001

**:nvironment.** The red fescue association once dominated well-drained, sand dunes with limited sand ıovement. The best remaining examples occur on partially-stabilized parabola dunes and slopes along ıe eastern edge of the dune sheet, adjacent to forest stands, where sites are somewhat sheltered from /inds. All aspects and microtopography are represented.

**'egetation and ecology.** Stands are typically species-poor, with individual fescue plants often spaced -4 feet apart. Bare sand varies from 20-90 percent, graminoid cover from 10-35 percent and herb cover :om 1-30 percent. Beach knotweed and beach silvertop are conspicuous associates. On stable sites /here other species have not invaded, red fescue can occasionally form a turf with seashore lupine odominant. Red fescue persists only on relatively inactive sand. It sustains dispersed foot traffic, and ) a lesser extent dispersed off-road vehicle traffic, but single vehicle tracks sometimes can leave long-ısting scars. Stands in many locations have been destroyed by intense off-road vehicle traffic, 'ampling, and occasional invasion by European beachgrass.

**uccession.** Early seral. This association can persist for decades if left undisturbed. Stands of this type re preceded by either the seashore bluegrass or the seashore lupine associations, both of which have ıore sand movement. It is replaced by either the red fescue-bracken fern association, or the shore ine/bearberry association. In most cases, European beachgrass loses vigor with the reduced movement f sand characteristic of sites dominated by red fescue. However, we have seen instances where the red :scue association has been replaced by the European beachgrass association, mostly at sites with greater xposure to wind.

**)istribution and history.** This association originally ranged along the coast from northern California Davy 1902) to British Columbia. It is in decline throughout the region because of intense off-road

vehicle traffic, trampling, and occasional invasion by European beachgrass. The species was used to a limited extent in stabilization plantings (McLaughlin and Brown 1942). Some of the best remaining sites on the Recreation Area can be seen on dunes along the east edge of the dune sheet, north and south of the Eel Creek Campground, and south of the Threemile Creek road.

**Management.** Today, natural stands of this association are one of the rarest on the Recreation Area, and need protection. Of all dune vegetation in northern California, Brown (1990), Pickart (1990), and Duebendorfer (1992) identified the red fescue association as being the most vulnerable to trampling and vehicular damage. Stands are destroyed by off-road vehicle traffic and concentrated foot traffic. Management should include restoration, protection and monitoring of the best remaining stands, with control of European beachgrass when needed.

**Other studies.** Wiedemann (1984, 1990, 1993), Wiedemann et al. (1969), and Kunze (1983, 1985) described this association clearly. Pickart (1987) described a "dune mat" association that contained elements of our concept of the red fescue association.

Common plants of the red fescue association (n = 10 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Red fescue | 100 | 20 | 5-35 |
| Beach knotweed | 90 | 1 | 0-2 |
| False dandelion | 70 | 1 | 0-3 |
| Seashore bluegrass | 60 | 3 | 0-10 |
| Seashore lupine | 50 | 8 | 0-35 |
| Beach silvertop | 50 | 1 | 0-2 |
| Pearly everlasting | 50 | Tr | 0-1 |
| Coast strawberry | 50 | Tr | 0-1 |

## RED FESCUE-SALT RUSH HERBACEOUS VEGETATION

*Festuca rubra-Juncus lesueurii*

FERU2-JULE
(Sampled: 6 recon plots)
GM2003

**Environment.** This association is unique to seasonally moist soils on deflation plains, deflated dune hollows, and in estuarine areas remote from salt intrusion. Topographically, stands are slightly higher and farther removed from the water table than is the salt rush association. The substrate is sand, with little organic material.

**Vegetation and ecology.** The red fescue-salt rush association occurs at the dry end of a moisture gradient on deflation plains (Newman 1983). The water table recedes to about 28 inches below the surface in summer. Because of its wide tolerance of soil moisture, salt rush is of little value in distinguishing wet from dry soils. Red fescue, little hairgrass, European centaury, and seashore lupine are better indicators of drier soil conditions. Herb cover ranges from 25-99 percent. Well-developed stands form meadows with little bare sand. The association is distinguished from the red fescue association by its location on seasonally moist deflation plains, high species diversity, high percent cover, and sods or turfs of red fescue, in contrast to the widely-spaced individual plants in the red fescue association. Additional moisture availability on deflation plains allows many more species to grow, producing one of the richest herb layers on the Recreation Area, many of them annual or biennial Eurasian weeds (Table 5). High species diversity is correlated with high light levels, areas of bare sand available for seasonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for favorable germination and establishment. Rapid invasion by salal, evergreen huckleberry, shore pine and Sitka spruce converts stands to impenetrable thickets.

**Succession.** Early seral. In the absence of European beachgrass, this association is preceded by the salt rush association. Evidence for this is the presence of high species diversity, a significant component of salt rush, and microposition on deflation plains. As invasion by conifers begins, it is replaced by the shore pine-Sitka spruce/ evergreen huckleberry association. In areas with rejuvenated sand movement, it may also be invaded and replaced by the European beachgrass association.

**Distribution and history.** This association occurs along the coast between northern California and British Columbia. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it is most easily seen at the outlet of Siltcoos

River. The association was once grazed by livestock at Goose Pasture, most of which has since become a stand of 50-year-old Sitka spruce. Red fescue was also seeded on deflation plains in the 1960's for wildlife habitat improvement (Wiedemann 1984).

**Management.** Stands not invaded by woody species are especially vulnerable to damage by off-road vehicles. Stands may be managed by cutting or limited use of fire, to remove exotic species of herbaceous and woody plants.

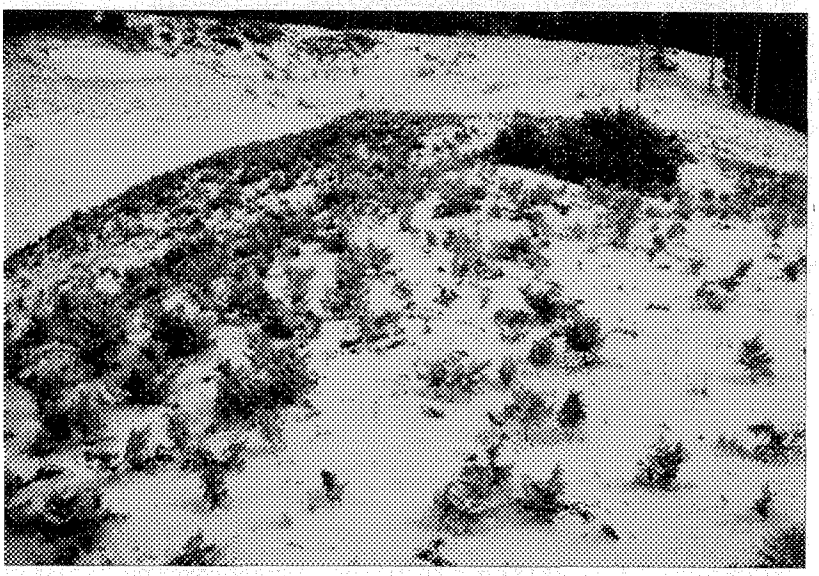
**Other studies.** Wiedemann et al. (1969) treated this association as a variant of their "meadow" association. Wiedemann (1984, 1993) treated it as a red fescue-seashore lupine association. Duebendorfer (1992) described a "brackish marsh" similar to the red fescue-salt rush association, but our concept of this association is freshwater.

Common plants of the red fescue-salt rush association (n = 6 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| UNDERSTORY TREES | | | |
| Sitka spruce | 33 | Tr | 0-1 |
| Shore pine | 33 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Salal | 67 | 3 | 0-12 |
| Wax myrtle | 67 | 1 | 0-2 |
| Scots broom | 50 | 1 | 0-1 |
| Evergreen huckleberry | 50 | 1 | 0-1 |
| Hooker willow | 33 | 1 | 0-3 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Red fescue | 100 | 23 | 9-35 |
| Salt rush | 100 | 10 | 1-25 |
| False dandelion | 83 | 4 | 0-15 |
| Little hairgrass | 67 | 4 | 0-15 |
| European centaury | 67 | 1 | 0-2 |
| Nevada rush | 50 | 8 | 0-30 |
| Tufted hairgrass | 50 | 7 | 0-35 |
| Velvet grass | 50 | 6 | 0-20 |
| Gumweed | 50 | 5 | 0-25 |
| Coast strawberry | 50 | 2 | 0-8 |
| Sheep sorrel | 50 | 2 | 0-5 |
| Spring-bank clover | 50 | 1 | 0-5 |
| Pacific silverweed | 50 | 1 | 0-3 |
| Silver hairgrass | 50 | 1 | 0-2 |
| Slough sedge | 50 | 1 | 0-2 |
| California aster | 50 | 1 | 0-2 |
| English plantain | 50 | 1 | 0-1 |

## RED FESCUE-BRACKEN FERN HERBACEOUS VEGETATION

*Festuca rubra-Pteridium aquilinum*



FERU2-PTAQ
(Sampled: 3 recon plots)
GM2002

**Environment.** The red fescue-bracken fern association occurs on slopes and tops of stabilized dunes, usually near the edge of the forest along the eastern edge of the dune sheet, or on the landward side of forest islands. The sand is droughty, and has little or no accumulation of organic matter. Some sand movement is present, and wind erosion may destroy some sites.

**Vegetation and ecology.** Stands occur on open, well-drained sites with little or no woody vegetation present. Bracken fern growing 1-3 feet tall dominates stands, with scattered bunches of red fescue and other herbs beneath. Bare sand ranges from 30 to 75 percent cover, with plants spaced 1 to 3 feet apart. Sand movement inhibits development of moss or lichen layers. Cover of bracken fern ranges from 15 to 40 percent, and herb cover from 1 to 30 percent. Seashore bluegrass, seashore lupine and beach silvertop are usually present in small numbers. Bracken fern spreads by an aggressive network of tough rhizomes, resistant to wind erosion. Some stands may be quite old, as bracken fern appears to be long-lived, and persists in considerable amounts in later seral stands dominated by shore pine and Douglas fir, as long as the canopy remains open, and the shrub layer thin or absent. It is possible that bracken fern invades red fescue stands occurring near forest stands, rather than originating *de novo* by propagules. In some places it could also be a long-lived relict of a previously forested surface buried by sand.

**Succession.** Early seral. The red fescue-bracken fern association replaces the red fescue association in certain sites, particularly near the forest edge. It is in turn replaced by the shore pine/bearberry association.

**Distribution and history.** This association occurs along the coast between northern California and southwestern Washington. On the Recreation Area, stands may be seen on the Umpqua Dunes, and in partially-stabilized areas north and south of Eel Creek Campground.

**Management.** Poorly-consolidated sands and sparse vegetative cover makes these stands vulnerable to damage by off-road vehicles.

**Other studies.** This association apparently has not been described from coastal dunes.

Common plants of the red fescue-bracken fern association (n = 3 recon plots).

| | Const. | Ave. (%) | Range cov. (%) |
|---|---|---|---|
| UNDERSTORY TREES | | | |
| Shore pine | 67 | 4 | 0-10 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Bearberry | 33 | 2 | 0-5 |
| Scots broom | 33 | Tr | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Bracken fern | 100 | 25 | 15-40 |
| Red fescue | 100 | 6 | 1-15 |
| Seashore bluegrass | 100 | 1 | 1-1 |
| Seashore lupine | 67 | 15 | 0-30 |
| Beach silvertop | 67 | 1 | 0-1 |
| False dandelion | 33 | 1 | 0-2 |
| Sheep sorrel | 33 | Tr | 0-Tr |
| Beach knotweed | 33 | Tr | 0-Tr |

## SALT RUSH HERBACEOUS VEGETATION

*Juncus lesueurii*

JULE
(Sampled: 7 recon plots,
29 transect plots)
MMB801

**Environment.** This association is unique to deflation plains, hummocks and dune hollows. Stands may be flooded in winter, but dry out by early summer. The substrate is sand, with an average of 19 percent exposed, ranging from 0-60 percent. Conditions limiting greater vegetative cover may be duration of winter flooding, followed by summer drought. Topography is more elevated than that of the sickle-leaved rush-salt rush association, because of sand infilling or drainage. Sand movement is limited or nonexistent.

**Vegetation and ecology.** The salt rush association occurs at the dry end of a seasonal moisture gradient on deflation plains (Newman 1983). The water table recedes to about 28 inches below the surface in summer. Because of its wide tolerance of soil moisture, salt rush is of little value in distinguishing wet from dry soils. Little hairgrass, seashore lupine, and European centaury are better indicators of seasonally drier soil conditions. This association has one of the richest herb layers on the Recreation Area, many of them annual or biennial Eurasian weeds (Table 5). High diversity may result from the large amount of bare sand available for colonization, combined with moisture availability in the spring for germination and establishment. It is rapidly invaded by woody species. Young shore pine occurred in more than half the plots, but cover averaged only 3 percent and ranged from 0-15 percent. Conifer reproduction is dominated by shore pine, and to a lesser extent Sitka spruce, but cover of both is scant. The shrub layer is sparse, with an average of 5 percent cover, ranging from 0-20 percent. Scots broom is the most common species, with lesser amounts of Hooker willow. The herb layer averages 69 percent

total cover, and is dominated by salt rush, false dandelion and little hairgrass, each averaging less than 15 percent cover. Moss cover is negligible. Salt rush can trap sand and initiate formation of hummocks. It also tolerates sand burial and can persist in dry associations as a relic of formerly wet, buried landforms.

**Succession.** Early seral. This association is preceded by the sickle-leaved rush-salt rush association, occurring on slightly wetter ground, and with higher overall vegetative cover. Stands are replaced by the red fescue-salt rush association. Rejuvenated movement of sand could initiate conversion to the European beachgrass association.

**Distribution and history.** This association occurs along the coast between northern California and British Columbia. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it can be seen on relatively dry deflation plains as long as the sites have not been overrun by woody species.

**Management.** The only recreational impact to this association is done by off-road vehicles, where machines may churn up what little vegetation is present.

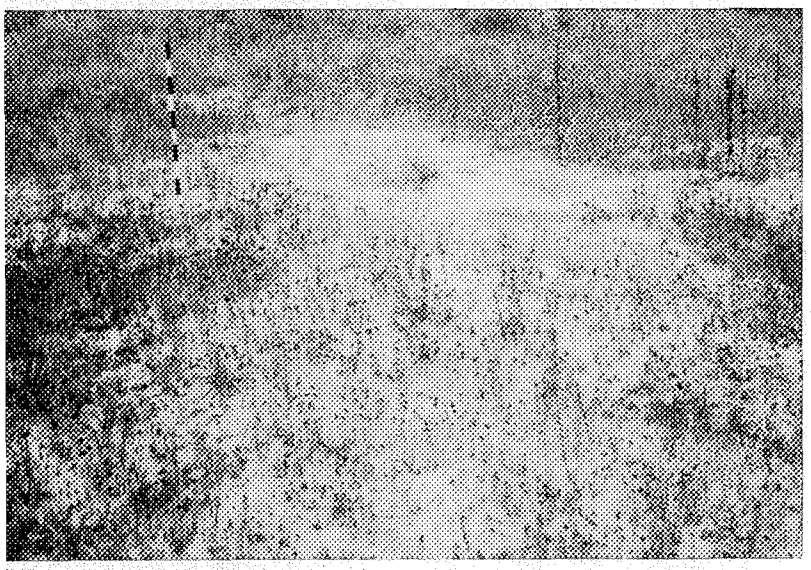
**Other studies.** Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration on winter flooding. Wiedemann (1966, 1984, 1990) and Wiedemann et al. (1969) included this association in a broader concept of a "dry meadow" association, dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Pickart (1990) described a salt rush type from a slightly drier phase of her "dune hollow" association.

Common plants of the salt rush association (n = 7 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 57 | 3 | 0-15 |
| UNDERSTORY TREES | | | |
| Shore pine | 71 | 2 | 0-5 |
| Sitka spruce | 29 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Scots broom | 71 | 2 | 0-8 |
| Hooker willow | 57 | 3 | 0-15 |
| Salal | 29 | Tr | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Salt rush | 100 | 12 | 2-25 |
| False dandelion | 100 | 9 | 1-20 |
| Little hairgrass | 86 | 11 | 0-40 |
| Slough sedge | 86 | 7 | 0-25 |
| Seashore lupine | 71 | 6 | 0-35 |
| European centaury | 71 | 2 | 0-10 |
| Purple cudweed | 71 | 2 | 0-6 |
| Silver hairgrass | 57 | 4 | 0-15 |
| Coast strawberry | 57 | 1 | 0-3 |
| Sheep sorrel | 57 | 1 | 0-3 |
| California aster | 57 | 1 | 0-1 |

## ICKLE-LEAVED RUSH-SALT RUSH HERBACEOUS VEGETATION

*ıncus falcatus-Juncus lesueurii*



JUFA-JULE
(Sampled: 10 recon plots,
29 transect plots)
MMB802

**ıvironment.** This association is unique to deflation plains and dune hollows. Stands may be flooded winter, but dry out by early summer, when the water table drops to about 12-18 inches below the ound surface. The substrate is sand, sometimes with a thin layer of organic material, with only an erage of 9 percent exposed. Because of sand infilling or drainage, topography is more elevated than at of either the Baltic rush-Pacific silverweed association, or the creeping spikerush-Nevada rush sociation. Sand movement is limited.

**ɛgetation and ecology.** The sickle-leaved rush-salt rush association occurs at the wet end of a ɔisture gradient on deflation plains (Newman 1983). Averaging 20 inches below the surface in mmer, the water table is eight inches closer than in either the salt rush or red fescue-salt rush sociations. Because of their wide tolerance of soil moisture, sickle-leaved rush and salt rush are of tle value in distinguishing wet from dry soils. Slough sedge, Pacific silverweed and creeping buttercup ɛ better indicators of wetter soil conditions. Presence of golden-eyed grass suggests that this sociation occurs on deflation plain surfaces that have been available for colonization for at least 40 ars (Newman 1983). Trees and shrubs, usually not over 5 or 6 feet tall, include shore pine, Sitka ruce, Hooker willow, salal, evergreen huckleberry, and wax myrtle. Woody material averages less ın 20 percent cover, but rarely may be as high as 60 percent. Herb cover averages 55 percent, ranging ɔm 0-80 percent, and species diversity is one of the highest on the Recreation Area (Table 5). High ecies diversity is correlated with high light levels, areas of bare sand available for seasonal lonization by annuals and biennials, and a seasonally-fluctuating water regime that allows for ʋorable germination and establishment. Sickle-leaved rush and salt rush are the dominant species, but ıny others are present with high constancy but low cover values. Moss cover varies from 0-30 percent. weedy phase may include up to 60 percent cover of bird-foot trefoil, a Eurasian species planted for ldlife forage and subsequently escaped, with lesser amounts of other introduced species such as

parentucellia, sweet vernal grass, and false dandelion. Summer drying on these sites enables relatively rapid invasion of woody species.

**Succession.** Early seral. This association replaces the wetter Baltic rush-Pacific silverweed association. It is in turn replaced by the salt rush association of better-drained sites.

**Distribution and history.** The sickle-leaved rush-salt rush association occurs along the coast between northern California and southwestern Washington. It has probably increased in area since enlargement of deflation plains, caused by the advent of European beachgrass. On the Recreation Area, it can be seen on relatively dry deflation plains, as long as the sites have not been overrun by woody species. The weedy phase with bird-foot trefoil can be seen at Goose Pasture.

**Management.** The only recreational impact to this association is off-road vehicles, where machines may churn up what little vegetation is present.

**Other studies.** Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration of winter flooding. Wiedemann (1966, 1984, 1990, 1993) and Wiedemann et al. (1969) included this association in a broader concept of a "rush meadow" association, dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Kunze (1994) described a sickle-leaved rush-Nevada rush association similar to this, but lacking salt rush.

Common plants of the sickle-leaved rush-salt rush association (n = 10 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 10 | Tr | 0-1 |
| UNDERSTORY TREES | | | |
| Shore pine | 70 | 2 | 0-10 |
| Sitka spruce | 20 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 100 | 20 | 1-60 |
| Salal | 50 | 2 | 0-10 |
| Evergreen huckleberry | 50 | 1 | 0-2 |
| Wax myrtle | 40 | 4 | 0-25 |
| Labrador tea | 20 | 2 | 0-20 |
| Scots broom | 20 | Tr | 0-1 |
| Red elderberry | 10 | Tr | 0-1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Sickle-leaved rush | 100 | 23 | 1-70 |
| False dandelion | 100 | 2 | 1-5 |
| Salt rush | 90 | 12 | 0-40 |
| Slough sedge | 90 | 4 | 0-15 |
| Golden-eyed grass | 80 | 2 | 0-5 |
| Pacific silverweed | 70 | 3 | 0-15 |
| Green sedge | 60 | 1 | 0-3 |
| California aster | 60 | 1 | 0-2 |
| European centaury | 60 | 1 | 0-1 |
| Nevada rush | 50 | 5 | 0-30 |
| Creeping buttercup | 50 | 3 | 0-20 |
| Giant helleborine | 50 | 1 | 0-5 |
| Shore sedge | 50 | 1 | 0-3 |
| Coast strawberry | 50 | 1 | 0-2 |

# EASHORE BLUEGRASS HERBACEOUS ALLIANCE

POMA26

## EASHORE BLUEGRASS HERBACEOUS VEGETATION

*ɔa macrantha*

POMA26
(Sampled: 1 recon plot,
20 transect plots)
GM8001

**nvironment.** The seashore bluegrass association was once common on well-drained foredunes, dry ɛflation plains, and partially-stabilized dunes further inland. The best remaining examples occur on ɹrtially-stabilized slopes and flats along the eastern edge of the dune sheet.

**egetation and ecology.** Stands are typically sparse and species-poor, with 75-98 percent bare sand. ed fescue, seashore lupine, beach knotweed and beach silvertop are frequent associates. Seashore uegrass is adapted to intermediate rates of sand burial, but cannot survive extensive sand movement. ɪands in most locations have been overrun by European beachgrass or eradicated by intense off-road ɛhicle traffic.

**ɯccession.** Early seral. In areas where movement of sand begins to diminish, the seashore bluegrass ɨsociation may develop *de novo*, or replace the American dunegrass association. With increasingly less ɯnd movement, it is in turn replaced by the red fescue association. Most sites, however, have been ɣerrun and replaced by the European beachgrass association.

**istribution and history.** This association originally occurred along the coast between northern alifornia (Davy 1902) and southwestern Washington. It is in decline throughout the region because ⁻ the widespread invasion of European beachgrass, and damage from intense off-road vehicle use. oday, natural stands of this association are one of the rarest on the Recreation Area, and need ɔotection. One of the few remaining sites can be seen north of Eel Creek Campground. Others occur ɔrth of Florence in the Sutton Creek Recreation Area, and in the Sand Lake Research Natural Area in illamook County.

**Management.** Stands tolerate dispersed foot and off-road vehicle traffic, but not sustained traffic of either sort. Management should include protection and monitoring of the best remaining stands, with control of European beachgrass when needed.

**Other studies.** Most studies from the region (Egler 1934; Byrd 1950; Kumler 1963, 1969; Wiedemann 1966, 1984, 1990; Kunze 1983, 1985) included seashore bluegrass as a species codominant with large-headed sedge, yellow sandverbena or seashore lupine, all occurring on foredunes, dry deflation plains, or dunes farther inland. Large-headed sedge and yellow sandverbena are now uncommon on the Recreation Area, and do not appear to be a major component of dune plant associations. The "seashore bluegrass-beach pea phase" of the "dune mat" association of Pickart (1987) and Duebendorfer (1990, 1992), and the sand-verbena-beach bursage series of Sawyer and Keeler-Wolf (1995) contain some elements of our concept of the seashore bluegrass association, but otherwise differ floristically.

Common plants of the seashore bluegrass association (n = 20 transect plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Seashore bluegrass | 100 | 10 | 1-20 |
| Seashore lupine | 35 | Tr | 0-2 |
| Beach silvertop | 30 | Tr | 0-2 |
| Pacific silverweed | 10 | Tr | 0-1 |
| Red fescue | 10 | Tr | 0-1 |

# SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

CAOB3
CAOB3-AREGE

## SLOUGH SEDGE SEASONALLY FLOODED HERBACEOUS VEGETATION

*Carex obnupta*

CAOB3
(Sampled: 1 recon plot)
MW8101

**Environment.** This association occurs in poorly-drained depressions adjacent to streams, lakes and ponds, on both the dune sheet and in foothills of the Coast Range. It is absent from deflation plains, where it is replaced by the more salt-tolerant slough sedge-Pacific silverweed association on sandy soils. The substrate is fibrous peat or muck soil. It is flooded seasonally, and saturated in summer by water just below the ground surface. Hydrology is often mediated by beaver dams.

**Vegetation and ecology.** These stands typically have enormous slough sedge growing on deep, perennially-wet muck soils, with little other vegetation present. Douglas spiraea is occasional. The ground layer is dominated by nearly monotypic stands of slough sedge 3-6 feet tall, with 80-95 percent cover. Individual plants may form tussocks up to 6 feet in diameter, spaced 3-6 feet apart, with conspicuous pedestaled bases separated by nearly bare expanses of wet, mucky soil. The herb layer is sparse, averaging 5 percent cover. Lady fern, bedstraw, and toothed Australian fireweed are typical species present, not all of which were present in the single stand sampled on the Recreation Area. Remnants of earlier, wetter seral types, such as hardstem bulrush or pond lily, are sometimes present. Other slough sedge associations on the Recreation Area occur on sand, or have an overstory of Hooker willow, and the sedge is usually only 1-2 feet tall. Elk and beaver often use these sites.

**Succession.** Early seral. This association replaces emergent marsh associations that require more surface water year-round. On the Recreation Area, these may be the simplestem bur-reed, hardstem bulrush or inflated sedge associations. Stands are eventually replaced by the red alder/salmonberry/slough sedge-skunk cabbage association, or the Hooker willow-crabapple/slough sedge-skunk cabbage association.

**Distribution and history.** This association has been seen only along the coasts of Oregon and southwestern Washington, where it is fairly common. It is most frequently associated with lakes and ponds east of Highway 101. Some sites are old beaver swamps, cleared for pasture and then abandoned because they were too wet for livestock. Beaver subsequently reclaimed most of these sites. On the Recreation Area, one example was seen at the north end of Threemile Lake.

**Management.** Wet soils preclude any recreational use. Elk and beaver use may be heavy. The association requires an adequate water supply, but needs little other maintenance.

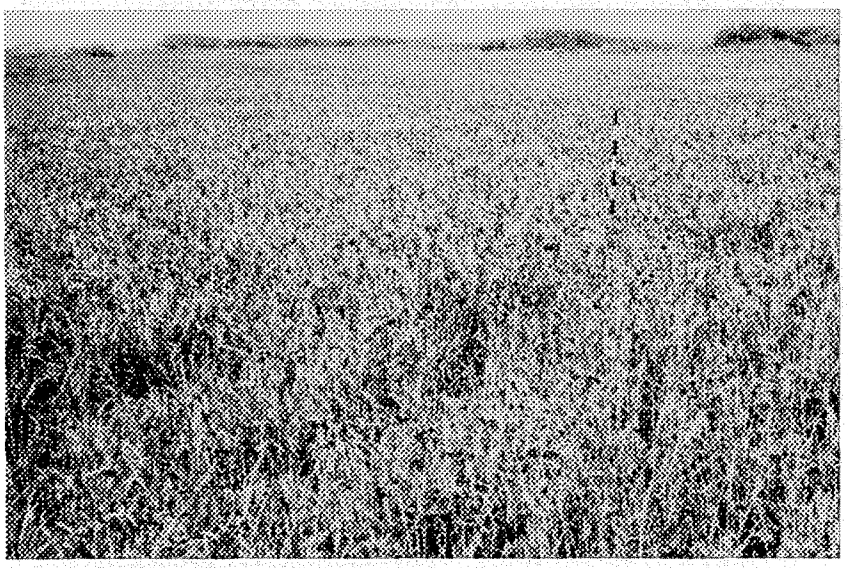
**Other studies.** Pickart (1990) described a monotypic slough sedge phase occurring in wet "dune hollow" association. Kunze's (1994) slough sedge association is very similar to this one.

Common plants of the slough sedge association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 90 | 90 |
| Toothed Australian fireweed | 100 | 2 | 2 |
| Water smartweed | 100 | 1 | 1 |
| Pond water-starwort | 100 | 1 | 1 |
| Hardstem bulrush | 100 | 1 | 1 |
| Field mint | 100 | 1 | 1 |
| Northern bedstraw | 100 | 1 | 1 |

## SLOUGH SEDGE-PACIFIC SILVERWEED HERBACEOUS VEGETATION

*Carex obnupta-Argentina egedii*



CAOB3-AREGE
(Sampled: 15 recon plots)
MW8102

**Environment.** This wetland association occurs on extensive areas of deflation plains and in interdunal swales. The substrate is an organic layer two to 20 inches thick, underlain by sand. Stands are seasonally flooded, and may dry out in midsummer. Although stands on deflation plains are subject to salt spray, they are freshwater and remote from areas of saltwater intrusion.

**Vegetation and ecology.** This association is dominated by slough sedge and Pacific silverweed, ranging from 20-90 percent cover. It may have up to 20 percent cover of shrubs, primarily Hooker willow. Around the edges, it intergrades with other deflation plain associations that share a number of the same herbaceous species. The tree layer, when present, is composed of young shore pine. The shrub layer, when present, is dominated by Hooker willow, with lesser amounts of wax myrtle, salal and evergreen huckleberry. The herb layer is the most diverse recorded on the Recreation Area, with a total of 54 species (Table 5). Bare sand may range from 0-30 percent.

**Succession.** Early seral. This association appears to be derived from the creeping spikerush-Nevada rush association. It is rapidly infilled by Hooker willow, and grades into the Hooker willow/slough sedge-Pacific silverweed association, following a temporal gradient and slight hydrologic gradient from wet to dry.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. On the Recreation Area, a profile of the entire successional gradient may be seen along the South Jetty Road, with the older portions dominated by Hooker willow to the south, extending northward into monotypic stands of slough sedge and Pacific silverweed as one nears the Siuslaw River estuary. Pacific silverweed has also been called *Potentilla pacifica*.

**Management.** The density of Hooker willow increases as stands age, and as they are dewatered by artificial drainage, groundwater pumping or natural infilling by sand or organic debris. Off-road vehicle use may be heavy along the margins of some stands. Flooding, clearing, or limited burning will be the only way to perpetuate this association before it is invaded by shore pine and Hooker willow.

**Other studies.** Wiedemann et al. (1969), Wiedemann (1966, 1984, 1993) and Kunze (1983, 1985) described this association clearly. The "herbaceous hollows" association of Duebendorfer (1990, 1992) fits our concept of the slough sedge-Pacific silverweed association.

Common plants of the slough sedge-Pacific silverweed association (n = 15 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| OVERSTORY TREES | | | |
| Shore pine | 27 | Tr | 0-3 |
| UNDERSTORY TREES | | | |
| Shore pine | 40 | 1 | 0-8 |
| Sitka spruce | 20 | Tr | 0-1 |
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 87 | 4 | 0-15 |
| Wax myrtle | 33 | 1 | 0-10 |
| Salal | 27 | 3 | 0-40 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Slough sedge | 100 | 55 | 20-90 |
| Pacific silverweed | 93 | 25 | 0-90 |
| Sickle-leaved rush | 60 | 5 | 0-20 |
| Creeping buttercup | 60 | 4 | 0-30 |
| Salt rush | 60 | 2 | 0-15 |
| California aster | 53 | 1 | 0-5 |
| Marsh speedwell | 53 | 1 | 0-8 |
| Spring-bank clover | 53 | 1 | 0-5 |

## NFLATED SEDGE HERBACEOUS VEGETATION

*'arex exsiccata*

CAEX5
(Sampled: 3 recon plots)
MW8103

**nvironment.** This emergent wetland association occurs in small to large, shallow basins on new and d deflation plains, and in interdunal areas further inland. Stands are usually seasonally flooded to a epth of one to three feet, or may dry out by midsummer, with the water table just below the ground rface. The substrate is sand or an organic layer to 5 inches thick.

**egetation and ecology.** Trees are absent, and the sparse shrub layer may include Douglas spiraea and ooker willow. Stands are dominated by inflated sedge with 65-90 percent cover, and herb cover ranges om 3-15 percent. Bare ground is usually absent. Slough sedge and mannagrass tolerate both seasonal id permanent flooding. Pond lily, when present, is a relic of an earlier open-water seral stage. Seasonal ooding precludes invasion of these sites by conifers.

**uccession.** Early seral. This association appears to replace aquatic bed associations such as pond lily floating-leaved pondweed, that occur in deeper basins with more permanent flooding. With infilling sediments and organic material, it is in turn replaced by either the slough sedge or Douglas spiraea sociations.

**istribution and history.** This association is infrequent along the coast and in the Coast Range of estern Oregon. On the Recreation Area, it is currently known only between Hauser and the Horsfall ea. A good example may be seen at Bluebill Lake. Some of these stands probably were grazed in the st. This species has also been called *Carex vesicaria* var. *major*. It occurs west of the Cascade Range, hile *Carex vesicaria* var. *vesicaria* occurs east of the Cascades.

**lanagement.** Groundwater pumping in the Horsfall area may dewater the old deflation plains where is association occurs, and lead to invasion by upland species. Known sites should be monitored for anges in water level and composition, to determine if the water table is being lowered.

**Other studies.** Kunze (1994) described this association (as *Carex vesicaria*) from the Puget lowlands of western Washington. Inflated sedge (*Carex vesicaria* var. *vesicaria*) associations reported from east of the Cascade Range differ substantially in composition from those on the Recreation Area (Christy 1993).

Common plants of the inflated sedge association (n = 3 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Douglas spiraea | 67 | 1 | 0-2 |
| Hooker willow | 33 | Tr | 0-Tr |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Inflated sedge | 100 | 78 | 65-90 |
| Pond lily | 100 | 9 | 2-15 |
| Slough sedge | 100 | 3 | 2-5 |
| Marsh speedwell | 100 | 1 | 1-2 |
| Northern mannagrass | 67 | 1 | 0-2 |
| Tall mannagrass | 33 | 2 | 0-5 |
| Creeping spikerush | 33 | 2 | 0-5 |
| Shore sedge | 33 | Tr | 0-1 |

# THREEWAY SEDGE SEASONALLY FLOODED HERBACEOUS ALLIANCE

DUAR3

## THREEWAY SEDGE HERBACEOUS VEGETATION

*Dulichium arundinaceum*

DUAR3
(Not sampled)
WL900

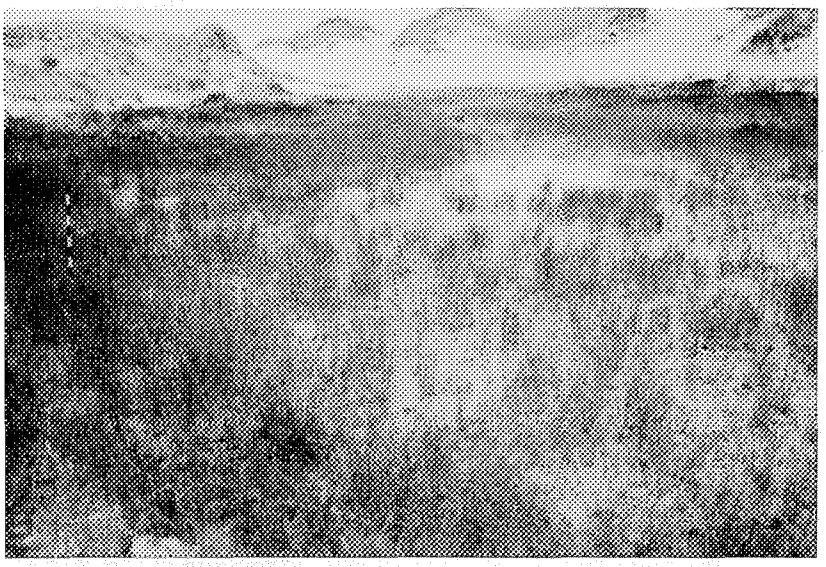
This early seral association was seen on the Recreation Area but never sampled. It forms emergent stands in shallow lakes, permanently flooded or subject to drying in summer. Most stands are monotypic, with cover ranging from 30-90 percent. The association ranges from the southern coast of Oregon, north to Alaska. On the Recreation Area, it may be seen in the shallow lakes between Hause and the Horsfall area. Kunze (1994) described this association.

# :REEPING SPIKERUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

ELPA3-JUNE

## :REEPING SPIKERUSH-NEVADA RUSH HERBACEOUS VEGETATION

*leocharis palustris-Juncus nevadensis*



ELPA3-JUNE
(Sampled: 11 recon plots,
30 transect plots)
MW9102

**nvironment.** The creeping spikerush-Nevada rush association appears to occur at the upper limit of :ackish water on deflation plains, or in dune hollows. It is primarily a freshwater association, but lerant of limited saline intrusion from spray or storm surges. Infilling by drifting sand creates complex icrotopography, hydrology and salinity gradients. Stands may be flooded seasonally or year-round. he substrate is sand or mud, with 0-55 percent exposed.

**egetation and ecology.** The shrub layer is sparse, dominated by Hooker willow with 0-20 percent )ver. Stands are predominantly herbaceous, averaging 68 percent cover, with high species diversity 'able 5). High species diversity is correlated with high light levels, areas of bare sand available for :asonal colonization by annuals and biennials, and a seasonally-fluctuating water regime that allows r favorable germination and establishment. Complex microtopographic, hydrologic and salinity :adients make species composition variable, and intergradation with adjoining associations is common. ominant species are creeping spikerush, lilaeopsis and Nevada rush, but some of these may not be esent in every plot. Moss cover ranges from 0-60 percent.

**ıccession.** Early seral. Based on the inclusion of species typical of brackish marshes, such as aeopsis, three-square bulrush and saltgrass, the association probably replaces the Baltic rush-Pacific lverweed association. It is replaced by either the slough sedge-Pacific silverweed association, or the )g blueberry/slough sedge association.

**istribution and history.** This association has been reported from the coasts of Oregon and 'ashington. Good examples may be seen in the deflation plain along the South Jetty road. It is )mmon along most of the coastal dune sheets.

**Management.** Stands drying out by midsummer may be damaged by off-road vehicles.

**Other studies.** This association is distinct from the nearly monotypic creeping spikerush associations described in the literature. Egler (1934) described a rush association composed of five phases determined by moisture gradients and the duration on winter flooding. Wiedemann (1966, 1990) and Wiedemann et al. (1969) included this association in a broader concept of a "rush meadow" association dominated by Nevada rush, sickle-leaved rush and spring-bank clover. Kunze (1994) described a similar sickle-leaved rush-Nevada rush association from the coast of Washington.

Common plants of the creeping spikerush-Nevada rush association (n = 11 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 73 | 3 | 0-20 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Creeping spikerush | 91 | 29 | 0-80 |
| Lilaeopsis | 91 | 14 | 0-40 |
| Nevada rush | 82 | 22 | 0-50 |
| Pacific silverweed | 82 | 3 | 0-10 |
| Shore sedge | 73 | 11 | 0-40 |
| Slough sedge | 73 | 3 | 0-10 |
| Creeping buttercup | 64 | 9 | 0-40 |
| Salt rush | 64 | 2 | 0-10 |
| Sickle-leaved rush | 55 | 8 | 0-40 |

# KNOTGRASS SEASONALLY FLOODED HERBACEOUS ALLIANCE

PADI6

## KNOTGRASS HERBACEOUS VEGETATION

*Paspalum distichum*

PADI6
(Not sampled)
WL9004

This early seral association was seen on the Recreation Area but not sampled. It is composed of nearly monotypic stands of knotgrass, occurring on mud and sand flats. Stands are flooded seasonally, but dry out in summer, although the water table is never far below the surface of the ground. Cover ranges from 30-80 percent. Knotgrass occurs occasionally along the coast, but the knotgrass association is more typical of the interior valleys of western Oregon and Washington. A single stand was observed on the floodplain of Tenmile Creek, where it may have been introduced by waterfowl. Kunze (1994) described this association.

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# [ARDSTEM BULRUSH SEASONALLY FLOODED HERBACEOUS ALLIANCE

SCACA

## ARDSTEM BULRUSH HERBACEOUS VEGETATION

*:hoenoplectus acutus* var. *acutus*

SCACA
(Sampled: 1 recon plot)
MT8101

**nvironment.** This emergent wetland association occurs around the margins of lakes and ponds on old eflation plains, in the dunes, and at the upper edge of brackish estuaries. The substrate may be sand, lt, mud or fibrous peat. Stands can be flooded year-round, flooded seasonally, or flooded diurnally in esh or brackish tidal cycles. Stands can tolerate seasonal drying, but the substrate always remains wet. Vater depth in flooded stands typically ranges from 1-2 feet.

**egetation and ecology.** In the single plot sampled on the Recreation Area, the stand was somewhat otonal, containing elements of associations on both sides of the hydrologic gradient. Douglas spiraea nd bog blueberry were present in small amounts, as was pond lily. It is more typical to see stands of ardstem bulrush with a sparse to moderately rich herb layer, with no woody species present. In plots ampled elsewhere along the coast (J.A. Christy, unpublished data), cover of hardstem bulrush ranges om 20-60 percent, with much of the remaining cover composed of herbs and previous years' bulrush tter. Total herb cover, exclusive of bulrush, ranges from 0-50 percent, with the lowest values occurring n permanently-flooded stands. Floating-leaved pondweed and water-shield are frequent in flooded sites. Lady fern, cattail, small-fruited bulrush, and Pacific silverweed may be present in sites that dry out easonally. Cover of individual species ranges from 1-5 percent. The surface layer is typically covered ith litter from the previous year's stand of bulrush, unless the site has been burned.

**uccession.** Early seral. This type is preceded by associations occurring in deeper water. On the ecreation Area, these include the pond lily and the floating-leaved pondweed associations. Stands are sually replaced by the slough sedge association or the Douglas spiraea association.

**Distribution and history.** This association is common along the coast between northern California and British Columbia. On the Recreation Area, examples may be seen in Loon Lake, the northern end of Threemile Lake, and along North Slough. The occurrence along North Slough may be an artifact of railroad construction, which cut off part of the slough from direct tidal influence, increasing the influence of fresh water west of the tracks. This species has also been called *Scirpus acutus*.

**Management.** No special management is needed to maintain this association, other than maintenance of water levels. Stands are too wet for recreational use. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. While hardstem bulrush can survive seasonal exposure of its roots when ponds dry up in late summer, it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of aquatic species will undoubtedly be diminished if pumping is really affecting water tables.

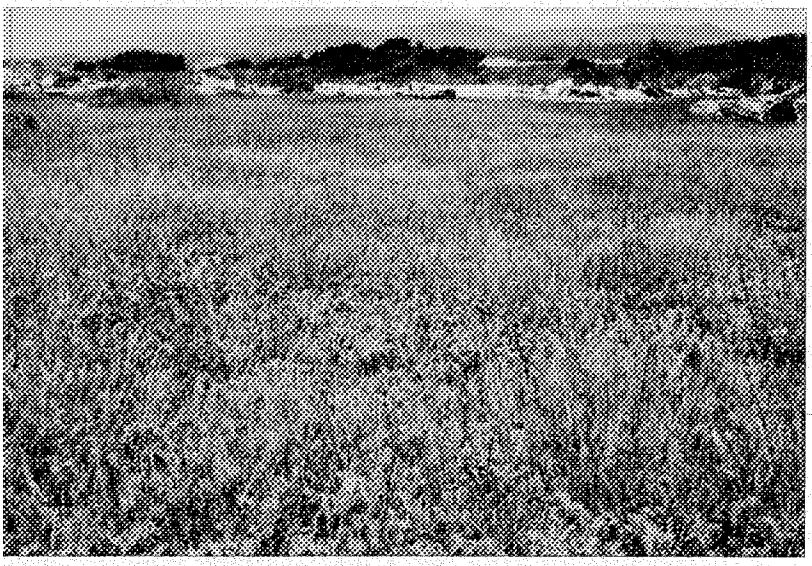
**Other studies.** Jefferson (1975) and Macdonald (1977) described a bulrush association in brackish marshes, and Thomas (1980) and Kunze (1994) described freshwater occurrences. Hardstem bulrush is frequently misidentified as softstem bulrush, which apparently does not occur in brackish water, and is generally absent from coastal areas. The bulrush series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the hardstem bulrush association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Bog blueberry | 100 | 1 | 1 |
| Douglas spiraea | 100 | 1 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Hardstem bulrush | 100 | 60 | 60 |
| Water smartweed | 100 | 15 | 15 |
| Pond lily | 100 | 2 | 2 |

## :REEPING BENTGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

*grostis stolonifera-Argentina egedii*



AGSTS-AREGE
(Sampled: 1 recon plot)
WE0106

**nvironment.** This association is restricted to brackish areas in estuaries and deflation plains. opography is flat to slightly undulating, and the substrate is sand. Salinity originates from irregular orm surges and extreme high tides in areas adjacent to salt or brackish water. Drift logs are usually resent.

**egetation and ecology.** This common salt marsh association is not well represented on the Recreation rea, because of the relative scarcity of suitable sites. Vegetation in the single plot sampled was ominated by Pacific silverweed and creeping bentgrass, with 70 and 30 percent cover, respectively. otal cover was nearly 100 percent. In plots sampled elsewhere along the coast, creeping bentgrass has een reported with cover as high as 95 percent (Taylor and Frenkel 1979; Taylor 1980). Undulating pography and slight changes in elevation create a variety of salinity gradients, and composition varies cally. Creeping bentgrass is a Eurasian species, but is so widely distributed that many people have ssumed it to be native. How it has impacted native salt marsh associations is unknown. It may have olonized relatively bare mud flats, or it may have displaced native species.

**uccession.** Early seral. Based on topographic position and a small component of saltgrass, this ssociation appears to replace the saline saltgrass-Pacific silverweed association, and is subsequently eplaced in turn by the less saline Lyngby sedge-Pacific silverweed association.

**istribution and history.** This association is common in salt marshes along the coast between orthern California and southeastern Alaska. On the Recreation Area, stands were seen in the Tenmile nd Siltcoos estuaries, in North Slough, and at the extreme northern end of the South Jetty. This ssociation is not common on the Recreation Area, because so little estuarine area is present. Creeping entgrass has also been called *Agrostis alba*, and Pacific silverweed has been called *Potentilla pacifica*. reeping bentgrass is thought to have been introduced from Europe.

**Management.** Methods for eradicating creeping bentgrass in estuaries have not been studied. On the Recreation Area, off-road vehicles should be excluded from sensitive estuarine areas.

**Other studies.** Taylor and Frenkel (1979), Taylor (1980), Thomas (1980), Mitchell (1981), Thomas (1984), Frenkel and Boss (1988) and Frenkel and Morlan (1990) all described various expressions of this association. Duebendorfer (1992) included this species in his "brackish marsh" association.

Common plants of the creeping bentgrass-Pacific silverweed association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Pacific silverweed | 100 | 70 | 70 |
| Creeping bentgrass | 100 | 30 | 30 |
| Saltgrass | 100 | 4 | 4 |
| Salt rush | 100 | 3 | 3 |
| Lyngby sedge | 100 | 2 | 2 |
| Tufted hairgrass | 100 | 1 | 1 |
| Gumweed | 100 | 1 | 1 |
| Slough sedge | 100 | 1 | 1 |

## ,YNGBY SEDGE-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

*'arex lyngbyei-Argentina egedii*

CALY3-AREGE
(Sampled: 4 recon plots)
WE0105

**ɔnvironment.** This association is restricted to brackish marshes in estuaries and deflation plains ɔjacent to estuaries. Stands in estuaries occur at low to middle topographic position, in and just above ɪe intertidal zone, where mud flats are cut by numerous tidal streams and are free of sand burial. The ɹbstrate is sand and mud, with 0-25 percent exposed at low tide. Stands on deflation plains are not ɹbject to tidal influence, but occasional storm surges flood these areas with seawater, reworking ɛdiments and importing large drift logs from beaches. Exposed sand and mud may have saline or algal ɾusts when dry.

**'egetation and ecology.** Stands are exclusively herbaceous, with 75-90 percent cover by graminoids, ɲd 10-30 percent cover by herbs. Species diversity is low. Dominant species are Lyngby sedge with 5-90 percent cover, and Pacific silverweed with 10-25 percent cover. Other species present in small ɯounts are those belonging to associations with either greater or lesser salt tolerance, occurring either ɛlow or above this association's elevation in the salt marsh. Stands intergrade with freshwater ɜsociations with increasing distance from estuaries. Because of their small size, most estuaries on the .ecreation Area probably have had a history of variable salinity and freshwater mixing, with associated ɯrinking and expansion of salt-tolerant associations.

**uccession.** Early seral. Stands of this type are preceded by brackish-water associations of the intertidal ɔne. On the Recreation Area, are the creeping bentgrass-Pacific silverweed, and three-square bulrush ɜsociations. As infilling by sediments occurs, this association is replaced by the slightly drier Baltic ɪsh-Pacific silverweed association.

**ɔistribution and history.** This association is common in estuaries along the coast between northern 'alifornia and Alaska. Its occurrence in the Recreation Area is limited because few rivers and mud flats ccur within the administrative boundaries, and because sand burial is pervasive. The best examples ɲay be seen along North Slough in Coos Bay, on the Umpqua Spit, at the north end of South Jetty, and

in the small estuaries of Tenmile Creek and Siltcoos River. Hydrology in the marshes of North Slough has been disturbed by drainage ditches and the railroad bed. The estuaries were grazed by livestock earlier in this century. Pacific silverweed has also been called *Potentilla pacifica*.

**Management.** The estuaries of Tenmile Creek and Siltcoos River receive moderately high recreational use for wildlife viewing and hiking. Recreation pressure is highest at Siltcoos River because it is so easily accessible. Shifting sands at the mouth of these small estuaries create changeable conditions for tidal inundation and salt intrusion, making management of salt marsh difficult in these areas. Mechanical removal of sand at the mouth of the river would allow more penetration of salt into the estuaries, if such management becomes necessary.

**Other studies.** Frenkel and Morlan (1990), Viereck et al. (1992), Shephard (1995), and Thilenius (1995) described this association.

Common plants of the Lyngby sedge-Pacific silverweed association (n = 4 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Lyngby sedge | 100 | 68 | 45-90 |
| Pacific silverweed | 100 | 15 | 10-25 |
| Tufted hairgrass | 75 | 8 | 0-30 |
| Saltgrass | 75 | 4 | 0-10 |
| Spring-bank clover | 50 | 3 | 0-10 |
| Three-square bulrush | 50 | 2 | 0-4 |
| Creeping spikerush | 50 | 1 | 0-1 |
| Salt rush | 50 | 1 | 0-1 |

## TUFTED HAIRGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

*Deschampsia cespitosa* ssp. *cespitosa-Argentina egedii*

DECEC-AREGE
(Not sampled)
WE0104

This early seral association was seen on the Recreation Area, but never sampled. It occurs in high salt marsh, with intermittent tidal flooding. In plots sampled elsewhere along the coast Jefferson 1975; Frenkel et al. 1978), tufted hairgrass ranges from 20-50 percent cover, and Pacific silverweed has 30-60 percent cover. This association occurs in estuaries along the coast between southwestern Oregon and Alaska, becoming more common north of Tillamook Bay, Oregon. It is not extensive on the Recreation Area, because estuarine habitat is limited, and the association is near the southern end of its range. A single stand was seen in the Tenmile Creek estuary. Jefferson 1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978), and Boggs (1997) described this association. Pacific silverweed has also been called *Potentilla pacifica*.

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## SALTGRASS-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

*Distichlis spicata-Argentina egedii*

DISP-AREGE
(Sampled: 6 recon plots)
WE0107

**Environment.** This is the most salt-tolerant association present on the Recreation Area, and also one of the most limited in distribution. Although it is common in large estuaries elsewhere along the coast, the small estuaries of the Recreation Area are largely unsuitable for its formation, because of limitations in size and variable salinities. The association occurs on sand or mud in slight depressions in deflation plains adjacent to estuaries, usually cut with channels of tidal creeks. Ten to fifty percent of the substrate may be exposed. Occasional storm surges flood these areas with seawater, reworking sediments and importing large drift logs from beaches.

**Vegetation and ecology.** Trees and shrubs are absent. Stands sampled were dominated by graminoids with 85-95 percent cover. Cover may be as low as 40-50 percent in salt pannes. Herb content ranges from 1-15 percent cover. Abandoned tidal channels may contain salt pannes, depressions where seawater from extreme high tides or storms becomes stranded and evaporates, creating highly saline soils and algal crusts tolerated by only a few species of vascular plants. These are the most saline habitats on the Recreation Area. Because microtopography and salinity gradients are complex, composition is variable, and not all components are always present. On the Recreation Area, the dominant species at these sites is saltgrass, with 60-90 percent cover. Pickleweed, shadscale, arrowgrass and fleshy jaumea, typical components of this association elsewhere along the coast, occur here only sporadically, usually only in salt pannes. Pickleweed and arrowgrass may be present in small amounts, although they were absent from our plots. Pacific silverweed may be codominant, but is not always present. Lyngby sedge and three-square bulrush intergrade from lower-elevation brackish marsh, while Baltic rush, colonial bentgrass and tufted hairgrass intergrade from higher-elevation brackish marsh. Sites may be obliterated by storms or sedimentation.

**Succession.** Early seral. This is one of the first associations of vascular plants to appear on tidal mudflats in the Recreation Area. It colonizes areas dominated by algae. Stands are replaced by the creeping bentgrass-Pacific silverweed association on slightly higher topography.

**Distribution and history.** This association is common in salt marshes along the coast from northern California to British Columbia. On the Recreation Area, it is restricted to North Slough, the estuaries of Tenmile Creek and Siltcoos River, and the extreme northern end of the South Jetty peninsula, in the estuary of the Siuslaw River. It may also occur on the Umpqua Spit south of Threemile Creek. Saltgrass has also been called *Distichlis stricta*, and Pacific silverweed has been called *Potentilla pacifica*.

**Management.** When salt pannes dry out in summer, they may be vulnerable to damage by off-road vehicles. Shifting sands at the mouth of the small estuaries create changeable conditions for tidal inundation, making management of salt marsh unpredictable.

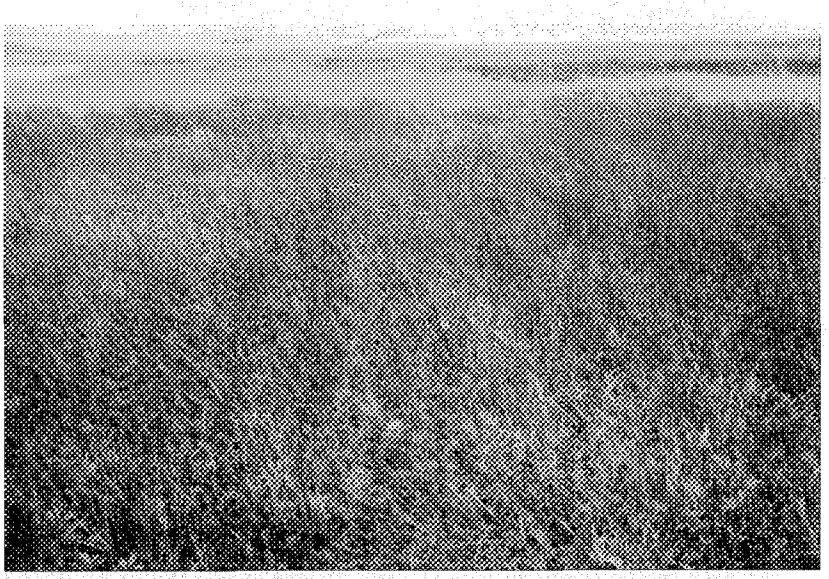
**Other studies.** This association and its many variations have been documented by Thum (1972), Jefferson (1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978), Taylor and Frenkel (1979), Taylor (1980), Mitchell (1981), Frenkel et al. (1981), Liverman (1982), Frenkel and Boss (1988), Newton (1989), Frenkel and Morlan (1990), and Peinado et al. (1994). Wiedemann (1984) described a creeping spikerush-saltgrass association from deflation plains, where ocean water occasionally surges over foredunes. Duebendorfer (1992) described a similar "salt marsh" association dominated by saltgrass, pickleweed and arrowgrass. The saltgrass series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the saltgrass-Pacific silverweed association (n = 6 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Saltgrass | 100 | 73 | 60-90 |
| Pacific silverweed | 100 | 12 | Tr-45 |
| Lyngby sedge | 83 | 12 | 0-45 |
| Three-square bulrush | 50 | 8 | 0-40 |
| Salt rush | 50 | 1 | 0-2 |
| Spring-bank clover | 50 | 1 | 0-1 |
| Shadscale | 50 | 1 | 0-1 |
| Baltic rush | 33 | 3 | 0-15 |
| Colonial bentgrass | 33 | 1 | 0-5 |
| Creeping spikerush | 33 | 1 | 0-3 |
| Tufted hairgrass | 33 | 1 | 0-2 |
| Sea milkwort | 17 | 3 | 0-15 |
| Lilaeopsis | 17 | 3 | 0-15 |
| Pickleweed | 17 | 1 | 0-7 |
| Creeping buttercup | 17 | 1 | 0-5 |
| Slough sedge | 17 | 1 | 0-3 |
| Seaside arrowgrass | 17 | Tr | 0-2 |
| Meadow barley | 17 | Tr | 0-1 |
| Graceful arrowgrass | 17 | Tr | 0-1 |
| Brass buttons | 17 | Tr | 0-1 |

## BALTIC RUSH-PACIFIC SILVERWEED TIDAL HERBACEOUS VEGETATION

*uncus balticus-Argentina egedii*



JUBA-AREGE
(Sampled: 1 recon plot)
WE0102

**Environment.** This association is a component of "salt meadow" vegetation occurring just above the ntertidal zone in salt marshes, where limited freshwater influence is present. On the Recreation Area, is restricted to brackish marshes in estuaries and deflation plains adjacent to estuaries. Stands in stuaries occur at middle to upper topographic position, above the intertidal zone, where they may be undated occasionally by extreme high tides. The substrate is sand and mud. Stands on deflation plains re not subject to tidal influence, but occasional storm surges flood these areas with seawater, reworking f sediments, and importation of large drift logs from beaches.

**Vegetation and ecology.** Only one plot was sampled on the Recreation Area, but it is similar to other tands sampled elsewhere along the coast. Tree and shrub layers are absent. The herb layer is species-oor (Table 5), but total vegetative cover is nearly 100 percent. It is dominated by Baltic rush with 40-0 percent cover, and Pacific silverweed with 25-60 percent cover. Lyngby sedge, tufted hairgrass and olonial bentgrass may be conspicuous or even codominant in some stands. Species from intergrading ow salt marsh include pickleweed, arrowgrass and lilaeopsis.

**uccession.** Early seral. Associations preceding this are those of more saline conditions in the intertidal one. On the Recreation Area, it replaces the Lyngby sedge-Pacific silverweed association. In reshwater conditions, it is in turn replaced by the creeping spikerush-Nevada rush association. If sand nfiltration occurs, making sites slightly drier, stands convert to the sickle-leaved rush-salt rush ssociation.

**Distribution and history.** This association is common in salt marshes along the coast from northern California to Washington. On the Recreation Area, occurrences are limited because of the lack of uitable habitat. Small examples occur along North Slough in Coos Bay, on the Umpqua Spit and in ne estuaries of Tenmile Creek and Siltcoos River. Pacific silverweed has also been called *Potentilla acifica.*

**Management.** Stands are small and no recreation conflicts were noted in the field. Off-road vehicles could threaten some stands if estuary areas become accessible to these vehicles.

**Other studies.** Frenkel et al. (1978), Mitchell (1981), Frenkel et al. (1981), Frenkel and Boss (1988), and Frenkel and Morlan (1990) described this association.

Common plants of the Baltic rush-Pacific silverweed association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Pacific silverweed | 100 | 60 | 60 |
| Baltic rush | 100 | 40 | 40 |
| Saltgrass | 100 | 25 | 25 |
| Lyngby sedge | 100 | 2 | 2 |
| Tufted hairgrass | 100 | 1 | 1 |
| Tall fescue | 100 | 1 | 1 |
| Gumweed | 100 | 1 | 1 |
| Pickleweed | 100 | 1 | 1 |

## THREE-SQUARE BULRUSH TIDAL HERBACEOUS VEGETATION

*Schoenoplectus americanus*

SCAM6
(Sampled: 3 recon plots)
WE0101

**Environment.** This association occurs primarily in brackish marshes in estuaries, and deflation plains adjacent to estuaries. Stands in estuaries grow at low to middle elevations, in and just above the intertidal zone, where mud flats may be cut by numerous tidal streams and are free of sand burial. The substrate is sand and mud, with 30-70 percent exposed, or coated with a saline or algal crust when dry. Stands on deflation plains are not subject to tidal influence, but flooding in winter and drying in summer. Occasional storm surges cause extensive flooding of these areas by seawater, reworking sediments importing large drift logs from beaches.

**Vegetation and ecology.** Woody species are absent where this association occurs in estuaries, but Hooker willow may be present occasionally among stands of three-square bulrush on deflation plains. Total herb cover may range from 1-98 percent. It is dominated by three-square bulrush with cover ranging from 25-90 percent. Other species frequently present include Lyngby sedge, Pacific silverweed and lilaeopsis, with covers ranging from 5-40 percent each. The most brackish sites often contain arrowgrass and saltgrass. Three-square bulrush usually occurs on wetter sites than saltgrass, but it is much more tolerant of fresh water than is saltgrass. Stands on deflation plains frequently intergrade with other associations in response to microtopography and salinity gradients.

**Succession.** Early seral. Three-square bulrush may be the first vegetation to develop on sediments in the intertidal zone. Depending on microsite and salinity gradients, it is replaced by the Lyngby sedge-Pacific silverweed association.

**Distribution and history.** This association is common in estuaries along the coast between northern California and British Columbia. Its occurrence in the Recreation Area is limited, because so little habitat occurs within the administrative boundaries, and because sand burial is so pervasive. The best examples may be seen along North Slough in Coos Bay, on the Umpqua Spit, at the northern end of South Jetty, and in the estuaries of Tenmile Creek and Siltcoos River. Hydrology in the marshes of

North Slough has been disturbed by drainage ditches and the railroad bed. The estuaries may have been grazed earlier in this century. This species has also been called *Scirpus americanus*.

**Management.** The estuaries of Tenmile Creek and Siltcoos River receive moderately high use for wildlife viewing and hiking. Recreation pressure is greatest at Siltcoos River because it is so easily accessible. Shifting sands at the mouth of these estuaries create changeable conditions for tidal inundation, making management of salt marsh unpredictable. Off-road vehicles may churn up some sites when water levels drop in summer.

**Other studies.** Jefferson (1975), Stout (1976), Macdonald (1977), Frenkel et al. (1978) and Liverman (1982) described this association in brackish marshes. Thomas (1980, 1984) and Kunze (1994) described its occurrence in brackish marshes with greater freshwater influence. The bulrush series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the three-square bulrush association (n = 3 recon plots).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Hooker willow | 67 | 2 | 3 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Three-square bulrush | 100 | 45 | 25-65 |
| Creeping spikerush | 100 | 12 | 1-20 |
| Pacific silverweed | 100 | 10 | 1-20 |
| Slough sedge | 67 | 15 | 0-30 |
| Lilaeopsis | 67 | 2 | 0-5 |
| Lyngby sedge | 33 | 5 | 0-15 |
| Saltgrass | 33 | 1 | 0-2 |

## SEASHORE LUPINE HERBACEOUS VEGETATION

*Lupinus littoralis*

LULI2
(Sampled: 4 recon plots,
54 transect plots)
GR8212

**Environment.** This association is characteristic of open, dry, sparsely-vegetated dunes, and to a lesser extent dry deflation plains. The substrate is sand with little or no organic material. Sand movement is moderate to slight, causing both erosion and burial of stands. Insolation is intense, and summer drought pervasive. Many populations of seashore lupine become established during the summer on dune surfaces recently created by winter winds. The subsequent return of winter wind patterns often obliterates these newly-established populations.

**Vegetation and ecology.** Bare sand averages 51 percent and ranges from 5-97 percent. Tree and shrub layers are absent. The herb layer is depauperate to moderately diverse, with total cover averaging 39 percent, ranging from 3-75 percent. The dominant species is seashore lupine, with cover ranging from 3-75 percent, averaging 31 percent. The plots sampled had been invaded by European beachgrass, and many stands are being replaced by it throughout the Recreation Area. Other native components present in lesser numbers include species typical of open dunes, such as seashore bluegrass, red fescue, beach silvertop, coast strawberry, beach knotweed and yellow sandverbena. Some of these species form plant associations of their own, and sometimes intergrade with one another. Seashore lupine reproduces prolifically by seed, and can colonize bare dune surfaces readily.

**Succession.** Early seral. The seashore lupine association develops on bare sand where the movement of sand diminishes, sometimes only seasonally. On open dunes, in the absence of European beachgrass, it is replaced by the red fescue association. Where sand movement is reactivated, it is replaced by the European beachgrass association.

**Distribution and history.** This association occurs along the coast between southwestern Oregon and British Columbia. On the Recreation Area, it occurs in most places where there is open sand with somewhat reduced sand movement. Although many older stands are being overrun by European beachgrass, new stands are ubiquitous, and the species is prolific.

**Management.** This association is adapted to ongoing disturbance from shifting sands. Recreational activities may have local influence, but no long-term problems are apparent.

**Other studies.** Egler (1934) described a seashore bluegrass-seashore lupine association. Wiedemann (1966) and Wiedemann et al. (1969) included seashore lupine as part of a "dry meadow" association. Kunze (1983, 1985) described a seashore lupine-seashore bluegrass-coast strawberry association from dry deflation plains.

Common plants of the seashore lupine association (n = 4 recon plots).

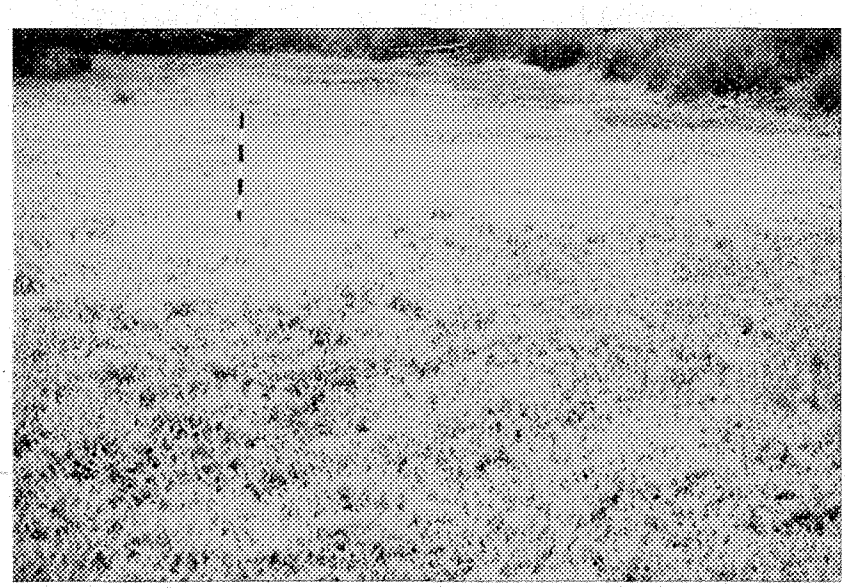
| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Seashore lupine | 100 | 31 | 3-75 |
| European beachgrass | 100 | 10 | 1-25 |
| Seashore bluegrass | 100 | 6 | 1-10 |
| Red fescue | 75 | 2 | 0-5 |
| False dandelion | 50 | 3 | 0-10 |
| Silver hairgrass | 50 | 1 | 0-1 |
| Beach silvertop | 50 | 1 | 0-1 |
| Little hairgrass | 50 | Tr | 0-1 |

# WATERPEPPER SEASONALLY FLOODED HERBACEOUS ALLIANCE

POHY2-LUPA

## WATERPEPPER- WATER PURSLANE HERBACEOUS VEGETATION

*Polygonum hydropiperoides-Ludwigia palustris*



POHY2-LUPA
(Not sampled)
WL9001

This early seral association was seen on the Recreation Area, but never sampled. It forms extensive stands in shallow lakes, as well as ponds on deflation plains, subject to drying in summer. The substrate is mud. Cover of waterpepper ranges from 25-95 percent, while cover of water purslane varies from 5-80 percent. The association is more typical of interior valleys in Oregon and Washington, but it occurs sporadically along the coast from southwestern Oregon to southwestern Washington. On the Recreation Area, it was seen on the floodplain of Tenmile Creek, and in the Lagoon area of Siltcoos River. Kunze (1994) described this association.

# FLOATING WATER-PENNYWORT SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

HYRA

## FLOATING WATER-PENNYWORT HERBACEOUS VEGETATION

*Hydrocotyl ranunculoides*

HYRA
(Not sampled)
WL0102

This early seral association was seen on the Recreation Area, but never sampled. It forms nearly monotypic stands that may cover the entire surface of shallow lakes, ponds, and pools in peatlands. Cover ranges from 60-95 percent. The association occurs along the coast between southwestern Oregon and southwestern Washington. It was seen once on the Recreation Area, where it forms extensive mats covering the surface of an unnamed lake just west of the railroad tracks along North Slough. This is the largest occurrence of its type known in the Pacific Northwest. It apparently has not been described before.

# WATER SMARTWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE



## WATER SMARTWEED HERBACEOUS VEGETATION

*Polygonum amphibium*

POAM8
(Not sampled)
WL9002

This early seral association was seen on the Recreation Area, but never sampled. It forms aquatic beds in lakes and ponds, where it may form extensive and sometimes dense floating mats. It also tolerates seasonal drying. Stands sampled elsewhere are usually monotypic, with 30-95 percent cover (Kunze 1994). This association is more common in the interior valleys of Oregon and Washington. On the Recreation Area, this association was seen along Tenmile Creek, Tahkenitch Creek, and in the Lagoon area along the Siltcoos River. Kunze (1994) described this association.

# POND LILY SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

NULUP

## POND LILY HERBACEOUS VEGETATION

*Nuphar lutea* ssp. *polysepala*

NULUP
(Sampled: 1 recon plot)
WL0101

**Environment.** This aquatic association is common in lakes and ponds occurring on deflation plains, floodplains, and along the edge of the dune sheet. Water is usually permanent, but may dry up in late summer, revealing the enormous fleshy rhizomes of pond lily. The substrate is muck.

**Vegetation and ecology.** The single plot sampled on the Recreation Area is typical of stands seen elsewhere along the coast. Small trees and Hooker willow, Sitka willow, or Douglas spiraea frequently occur around the lake margins or on emergent logs and small islands. The herb layer is dominated by beds of pond lily with 15-30 percent cover, the leaves floating on the surface or protruding 1-2 feet above the surface of the water. Stands are clonal, and may cover extensive areas in shallow lakes. They often intermix with other aquatic bed associations, such as those dominated by floating-leaved pondweed and water-shield. Bog buckbean, a clonal aquatic bed species more typical of montane mires and lakes, occurs with pond lily in Beale Lake. Graminoids, including northern mannagrass, threeway sedge, inflated sedge and slough sedge, may occur with total cover seldom greater than 5 percent. They are restricted to shallows or emergent substrates. Common bladderwort, an insectivorous species, is a frequent associate.

**Succession.** Early seral. The pond lily association is one of several aquatic bed associations that initiate transition from lacustrine habitats to palustrine habitats. It is preceded by benthic associations in deeper water, such as coontail, waterweed, or common bladderwort. Pond lily needs an accumulation of littoral sediments or organic material to create shallows suitable for growth. As water depths and the period of seasonal inundation diminish, it is replaced on the Recreation Area by either the simplestem bur-reed, hardstem bulrush, or inflated sedge associations.

**Distribution and history.** This association is common along the coast between northern California and Alaska. On the Recreation Area, good examples may be seen in the shallow lakes between Beale Lake

and Horsfall Lake, between the south loop of Eel Creek campground and Highway 101, and in sheltered arms of Tahkenitch Lake. This species has also been called *Nuphar polysepalum.*

**Management.** No special management is needed to maintain this association, other than maintenance of water levels. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. Like floating-leaved pondweed, pond lily can survive seasonal exposure of its roots when ponds dry up in late summer, but it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of all aquatic species in the Horsfall area will decline if pumping is really lowering the water table.

**Other studies.** Peck (1919) and Egler (1934) described pond lily associations in lakes and ponds along the coast of Oregon. Viereck et al. (1992), Kunze (1994), Shephard (1995) and Boggs (1998) described this association. The yellow pond-lily series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the pond lily association (n = 1 recon plot).

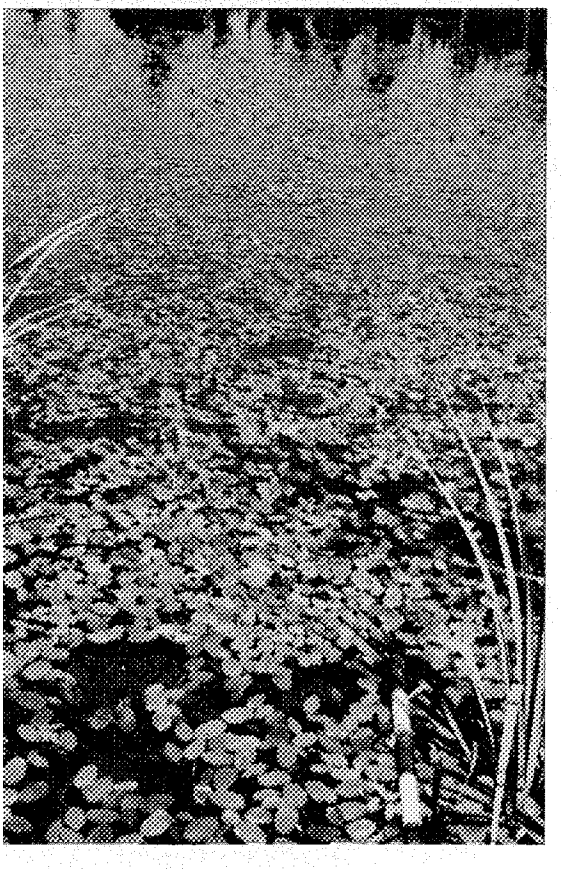
| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| SHRUBS AND WOODY GROUNDCOVER | | | |
| Douglas spiraea | 100 | 1 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | |
| Pond lily | 100 | 20 | 20 |
| Water clubrush | 100 | 5 | 5 |
| Inflated sedge | 100 | 2 | 2 |
| Threeway sedge | 100 | 2 | 2 |
| Northern mannagrass | 100 | 2 | 2 |
| Floating-leaved pondweed | 100 | 1 | 1 |

# FLOATING-LEAVED PONDWEED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

PONA4

## FLOATING-LEAVED PONDWEED HERBACEOUS VEGETATION

*Potamogeton natans*



PONA4
(Sampled: 1 recon plot)
WL0103

**Environment.** This aquatic bed association occurs around the margins of lakes and ponds on old deflation plains, among the dunes, and particularly on larger dune-blocked lakes along the east edge of the dune sheet. The substrate may be sand, silt, mud or fibrous peat. Stands are usually flooded year-round, but can tolerate seasonal drying if the substrate remains wet. Water depth in flooded stands typically ranges from 1-6 feet.

**Vegetation and ecology.** This association is best expressed in monotypic stands occurring on the surfaces of lakes and ponds. Frequently, it intermixes with adjoining associations, and many ecologists have sampled these mixed stands rather than the monotypic stands. The single stand sampled on the Recreation Area occurred on a deflation plain, and had inclusions of emergent marsh species. Woody layers are absent. Total herb cover ranges from 20-85 percent, dominated by floating-leaved pondweed with cover from 20-70 percent. Other species frequently present are pond lily, water-shield, common bladderwort and hardstem bulrush.

**Succession.** Early seral. This floating-leaved association is preceded by benthic associations in deeper water, such as coontail, waterweed, or common bladderwort. On the Recreation Area, infilling of sediments in the littoral area leads to replacement of this association by either the hardstem bulrush, inflated sedge, or simplestem bur-reed associations.

**Distribution and history.** This association is common along the coast between northern California and Alaska. On the Recreation Area, good examples may be seen in the shallow lakes between Beale Lake and Horsfall Lake, and in sheltered arms of Tahkenitch Lake.

**Management.** No special management is needed to maintain this association, other than maintenance of water levels. Stands are too wet for recreational use. Groundwater pumping at the southern end of the Recreation Area may be affecting the water table in that area. Like pond lily, floating-leaved pondweed can survive seasonal exposure of its roots when ponds dry up in late summer, but it may not survive extended exposure caused by premature drawdown of lake levels. Diversity of all aquatic species in the Horsfall area will decline if pumping is really lowering the water table.

**Other studies.** Peck (1919) described a colony of floating-leaved pondweed, similar to those occurring elsewhere on the coast. This association was described by Kunze (1994) and Boggs (1998), and is included in the "pondweeds with floating leaves" series of Sawyer and Keeler-Wolf (1995).

Common plants of the floating-leaved pondweed association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Floating-leaved pondweed | 100 | 60 | 60 |
| Simplestem bur-reed | 100 | 35 | 35 |
| Creeping spikerush | 100 | 5 | 5 |
| Horsetail | 100 | 2 | 2 |
| Marsh speedwell | 100 | 1 | 1 |
| Pacific silverweed | 100 | 1 | 1 |

# IMPLESTEM BUR-REED SEMIPERMANENTLY FLOODED HERBACEOUS ALLIANCE

SPAN2

## IMPLESTEM BUR-REED HERBACEOUS VEGETATION

*parganium angustifolium*

SPAN2
(Sampled: 1 recon plot)
WL0104

**nvironment.** This association occurs in freshwater emergent marshes, on deflation plains and around ıe margins of lakes and ponds further inland. Along larger tidal rivers, it forms marshes above the ıfluence of brackish water. The substrate is peaty muck. Stands are seasonally or perennially flooded. /ater levels may drop to expose the roots, but the substrate is always wet.

**egetation and ecology.** Only one stand was sampled on the Recreation Area, at the margin of a pond ı a deflation plain. Woody layers were absent in the plot, but both Hooker willow and Douglas spiraea ere present around the margins, with an average height of 4 feet. Simplestem bur-reed dominated the erb layer, with 45 percent cover. Growth is clonal, the plants spreading by rhizomes. Slough sedge as present with 10 percent cover. Species from earlier seral stages, such as pond lily or floating-leaved ondweed, may be present. These sites are feeding areas for beaver.

**uccession.** Early seral. In the Recreation Area, this type is preceded by aquatic bed associations ominated by either floating-leaved pondweed or pond lily. Stands may be replaced by either the slough dge or Douglas spiraea associations.

**istribution and history.** This association is common along the coast between northern California and ritish Columbia, and it is also common inland. On the Recreation Area, stands can be seen south of iltcoos estuary, in the Lagoon area of the Siltcoos River lagoon, along Tenmile Creek, and near Beale ake. This species has also been called *Sparganium emersum*.

**lanagement.** Recreational impacts are minimal, because stands are too wet for casual entry. laintenance of water supply and beaver populations will be adequate to sustain this association.

**Other studies.** Christy (1993), Christy and Putera (1993), and Kunze (1994) listed a similar association from freshwater intertidal areas on the lower Columbia River. Kunze (1994) also described a broad-fruited bur-reed association (*Sparganium eurycarpum*) with similar composition, hydrology and substrate, but this species has not been reported from the Recreation Area. The bur-reed series of Sawyer and Keeler-Wolf (1995) includes this association.

Common plants of the simplestem bur-reed association (n = 1 recon plot).

| | Const. | Ave. cov. (%) | Range cov. (%) |
|---|---|---|---|
| HERBS, FERNS AND GRAMINOIDS | | | |
| Simplestem bur-reed | 100 | 45 | 45 |
| Slough sedge | 100 | 10 | 10 |
| Pacific silverweed | 100 | 1 | 1 |
| Marsh cinquefoil | 100 | 1 | 1 |
| Creeping spikerush | 100 | 1 | 1 |

## SOUTH AMERICAN WATERWEED PERMANENTLY FLOODED HERBACEOUS ALLIANCE

EGDE

### SOUTH AMERICAN WATERWEED HERBACEOUS VEGETATION

*Egeria densa*

EGDE
(Not sampled)
WL0106

This early seral association was seen on the Recreation Area, but not sampled. Its old name is *Elodea densa*. It forms extensive monotypic beds of submersed, dark green to blackish shoots in lakes, ponds and streams. Cover ranges from 60-95 percent. Introduced for the aquarium trade, South American waterweed has escaped and spread throughout the Pacific Northwest, northward to British Columbia. It replaces the native Canadian waterweed, and populations often become dense enough to obstruct boat passage. On the Recreation Area, extensive stands may be seen in Siltcoos River, the adjacent Lagoon, and in Tahkenitch Creek along the Tahkenitch trail. Dispersal is accomplished by fragments adhering to recreational boats, and populations are almost always present in lakes that have boat ramps. This weedy association apparently has not been described before.

# ?ARROT-FEATHER PERMANENTLY FLOODED HERBACEOUS ALLIANCE

MYAQ2

## ?ARROT-FEATHER HERBACEOUS VEGETATION

*Ayriophyllum aquaticum*

MYAQ2
(Not sampled)
WL0105

This early seral association was seen on the Recreation Area, but not sampled. Its old name is *Ayriophyllum braziliensis*. Parrot-feather forms dense, monotypic beds of submerged and emergent, ime-green shoots on the surface of lakes, ponds and pools. Cover ranges from 40-95 percent. ntroduced as an ornamental and for the aquarium trade, parrot-feather has escaped and is spreading ggressively throughout the Pacific Northwest (Sytsma and Anderson 1989). Beds may become so thick iat they form floating mats used by waterfowl for nesting platforms, and they may also obstruct boat assage in lake channels. If left undisturbed, continued accumulation of biomass may develop floating iats of peat that support fen vegetation of sphagnum moss, sedges, shore pine and stunted Sitka spruce. )n the Recreation Area, extensive beds of parrot-feather may be seen in the Lagoon area of Siltcoos :iver, as well as along the river itself. This weedy association apparently has not been described before.

# COMMON BLADDERWORT PERMANENTLY FLOODED HERBACEOUS ALLIANCE

UTMA

## COMMON BLADDERWORT HERBACEOUS VEGETATION

*Utricularia macrorhiza*

UTMA
(Not sampled)
WL0107

This early seral association was seen on the Recreation Area, but not sampled. It forms nearly monotypic beds, submerged in lakes and ponds. This large insectivorous species is characterized by its bladders blackened with the remains of aquatic invertebrates. Cover ranges from 40-95 percent. The association occurs in lakes and ponds throughout the Pacific Northwest. On the Recreation Area, good examples occur in the shallow lakes between Hauser and Horsfall. Boggs (1998) described this association in Alaska. This species has also been called *Utricularia vulgaris*.

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## Appendix 1. Summary data for recon vegetation plots, Oregon Dunes National Recreation Area, by National Vegetation Classification System class and association. Minimum constancy = 0.10, minimum average cover = 0.10, Tr = < 1.0.

Site and vegetation variables for which data were collected in transect plots and recon plots.

| Data Type | Transect plots | Recon Plots |
|---|---|---|
| Elevation (ft) | x | x |
| Aspect | x | x |
| Slope (°) | x | x |
| Landform (mapping units of Pinto et al. 1972) | x | |
| Macroposition (vertical, horizontal) | x | x |
| Microposition (vertical, horizontal) | x | x |
| Macrorelief (horizontal, vertical) | x | x |
| Microrelief (horizontal, vertical) | x | x |
| Topographic moisture | | x |
| Depth to sand (in) | | x |
| Total basal area, live ($ft^2$) | | x |
| Total basal area, dead ($ft^2$) | | x |
| Average shrub height (ft) | | x |
| Percent cover, layer (tree, shrub, herbs, fern, graminoid, moss, lichen, litter, bare ground) | x | x |
| Percent cover, species (trees, shrubs, herbs) | x | x |
| Site tree data, by species: | | |
| DBH | | x |
| height (ft) | | x |
| age (yr, projected or actual count) | x | |
| current growth (last 10 yr growth in 20ths of an inch) | x | |

Environmental variables on the Recreation Area were sampled more intensively in recon plots than in transect plots, because plot size was so much larger, and physical parameters more varied. Macroposition described position of the plot relative to a large geomorphic feature such as a ridge, with a horizontal axis along the contour line, and a vertical axis between the top and bottom of the slope (vertical). Microposition described position of the plot within about 100 feet, with similar vertical and horizontal axes. Macrorelief described the convexity or concavity of the surface at large, with vertical and horizontal axes, while microrelief did the same for the surface within the boundary of the plot. Topographic moisture identified relative dryness or wetness of the plot, based on whether incident water would tend to pool within the plot, or flow out of it, depending on microtopography. Depth to sand identified the thickness of any organic matter on the surface of the ground. Percent cover was estimated in increments of 1 percent between 0 and 10, and increments of 5 percent between 10 and 100. Total cover for vegetation layers combined estimates of cover for all species in each layer. We sampled three layers -- trees, shrubs and herbs -- from which names of dominant species were chosen. The ground layer was not used to name associations, although total cover of mosses and lichens was recorded. Total cover for the tree layer was estimated separately for mature trees (> 20 ft high) and regenerating trees (< 20 ft high). Total cover for the shrub layer was likewise estimated separately for tall shrubs (> 6 ft high) and low shrubs (< 6 ft high). For site tree data, 1-3 individuals of each species present were measured. Tree height was measured with a range finder and clinometer. Age and current growth were determined by counting increment cores. Basal area was measured with prisms using basal area factors of 20 or 40, depending on density of stems.

## FOREST

| Environment | ALRU/RUSP/CAOB3 2 Plots MEAN | S.D. | CHLA/VAOV2-LYAM3 11 Plots MEAN | S.D. | PICOC-PSME/MYCA-VAOV2 15 Plots MEAN | S.D. |
|---|---|---|---|---|---|---|
| Aspect | 70 | 66 | 30 | 75 | 69 | 39 |
| Slope | 2 | 1 | 25 | 25 | 32 | 28 |
| Vertical microtopography | 2 | 0 | 3 | 1 | 2 | 1 |
| Horizontal microtopography | 3 | 1 | 2 | 1 | 3 | 1 |
| Overstory trees | 75 | 14 | 64 | 21 | 62 | 16 |
| Understory trees | 3 | 2 | 5 | 6 | 2 | 3 |
| High shrubs | 2 | 1 | 82 | 14 | 79 | 24 |
| Low shrubs | 2 | 1 | 5 | 8 | 8 | 10 |
| Herb | 5 | 7 | 0 | 0 | 1 | 1 |
| Moss | 3 | 4 | 27 | 22 | 5 | 5 |
| Bare sand | 0 | 0 | 0 | 0 | 0 | 1 |
| **Species** | **CON** | **AVE** | **CON** | **AVE** | **CON** | **AVE** |
| OVERSTORY TREES | | | | | | |
| Madrone | . | . | 18 | 0 | . | . |
| Port Orford cedar | . | . | 100 | 48 | . | . |
| Red alder | 100 | 60 | . | . | . | . |
| Shore pine | . | . | 55 | 5 | 100 | 43 |
| Sitka spruce | 50 | 8 | 73 | 11 | 33 | 1 |
| Douglas fir | . | . | 82 | 10 | 100 | 22 |
| Western hemlock | 50 | 2 | 45 | 2 | 20 | 1 |
| UNDERSTORY TREES | | | | | | |
| Port Orford cedar | . | . | 73 | 3 | . | . |
| Scouler willow | . | . | 18 | 3 | . | . |
| Crabapple | 50 | 8 | 9 | Tr | . | . |
| Sitka spruce | 100 | 1 | 36 | 1 | 33 | 1 |
| Shore pine | . | . | 9 | 0 | 33 | 1 |
| Western hemlock | 50 | 1 | 36 | 1 | 33 | 0 |
| Douglas fir | . | . | 45 | 1 | 33 | 1 |
| Cascara | 100 | 5 | 18 | 0 | 13 | 0 |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Red elderberry | 50 | 1 | . | . | . | . |
| Douglas spiraea | 50 | 3 | . | . | 7 | Tr |
| Hairy manzanita | . | . | 18 | 1 | 33 | 1 |
| Hooker willow | 50 | 3 | . | . | . | . |
| Black twinberry | 100 | 2 | . | . | . | . |
| Bearberry | . | . | . | . | 40 | 0 |
| Labrador tea | . | . | . | . | 7 | 0 |
| Scots broom | . | . | . | . | 60 | 1 |
| Salmonberry | 100 | 1 | . | . | . | . |
| Trailing blackberry | 50 | 1 | 9 | Tr | . | . |
| Thimbleberry | 50 | 1 | . | . | . | . |
| Wax myrtle | . | . | 82 | 7 | 73 | 7 |
| Evergreen huckleberry | 50 | 0 | 100 | 63 | 100 | 52 |
| Red huckleberry | 50 | 0 | 36 | 1 | 13 | 0 |
| Salal | 50 | 1 | 91 | 9 | 100 | 21 |
| Western rhododendron | . | . | 36 | 8 | 80 | 22 |
| Silk tassel | . | . | . | . | 7 | 0 |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Small-fruited bulrush | 50 | 1 | . | . | . | . |
| Lady fern | 50 | 1 | . | . | . | . |
| Clover | . | . | 9 | Tr | . | . |
| Slough sedge | 100 | 80 | . | . | . | . |

| | | | | | | |
|---|---|---|---|---|---|---|
| Skunk cabbage | 50 | 2 | . | . | . | . |
| Toothed Australian fireweed | . | . | 9 | Tr | . | . |
| Licorice fern | 50 | 1 | 27 | 0 | . | . |
| Red fescue | . | . | . | . | 7 | Tr |
| Candystick | . | . | . | . | 20 | 0 |
| Western rattlesnake-plantain | . | . | 9 | Tr | 7 | Tr |
| Sword fern | 100 | 2 | 27 | 0 | . | . |
| False lily-of-the-valley | 50 | 2 | . | . | 20 | 0 |
| Deer fern | . | . | 27 | 0 | . | . |
| Ground-cone | . | . | 9 | Tr | 40 | 0 |
| Bracken fern | . | . | 64 | 1 | 93 | 4 |
| Gnome plant | . | . | 9 | Tr | 7 | Tr |
| Scouler's polypody | . | . | . | . | 7 | Tr |

| | PICOC/CAOB3 | | PICOC/CYSC4/AMAR4 | | PISI-PICOC/VAOV2 | |
|---|---|---|---|---|---|---|
| | 6 Plots | | 14 Plots | | 12 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 11 | 39 | 70 | 59 | 27 | 56 |
| Slope | 0 | 0 | 5 | 6 | 13 | 21 |
| Vertical microtopography | 2 | 1 | 2 | 1 | 3 | 1 |
| Horizontal microtopography | 2 | 1 | 2 | 1 | 3 | 1 |
| Overstory trees | 63 | 16 | 26 | 28 | 47 | 30 |
| Understory trees | 1 | 1 | 9 | 12 | 17 | 32 |
| High shrubs | 22 | 18 | 39 | 29 | 61 | 32 |
| Low shrubs | 6 | 6 | 11 | 18 | 12 | 13 |
| Herb | 39 | 34 | 34 | 33 | 1 | 1 |
| Moss | 27 | 35 | 25 | 38 | 21 | 22 |
| Bare sand | 0 | 1 | 4 | 6 | 0 | 1 |
| **Species** | **CON** | **AVE** | **CON** | **AVE** | **CON** | **AVE** |
| OVERSTORY TREES | | | | | | |
| Shore pine | 100 | 63 | 71 | 25 | 83 | 24 |
| Sitka spruce | 17 | 1 | 43 | 1 | 83 | 25 |
| Douglas fir | . | . | 7 | 0 | 25 | 2 |
| Western hemlock | . | . | . | . | 8 | 0 |
| Western red cedar | . | . | . | . | 8 | Tr |
| UNDERSTORY TREES | | | | | | |
| Crabapple | 17 | 0 | . | . | 8 | 0 |
| Sitka spruce | 17 | 0 | 64 | 5 | 58 | 5 |
| Shore pine | 50 | 1 | 71 | 4 | 42 | 13 |
| Western hemlock | . | . | . | . | 8 | Tr |
| Douglas fir | . | . | 14 | 0 | 8 | Tr |
| Cascara | . | . | 14 | Tr | 8 | 0 |
| Western red cedar | . | . | . | . | 8 | Tr |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Douglas spiraea | 17 | 0 | . | . | . | . |
| Hooker willow | 50 | 5 | . | . | 8 | 1 |
| Black twinberry | 50 | 1 | . | . | 8 | 0 |
| Bog blueberry | 50 | 2 | . | . | . | . |
| Cultivated cranberry | 17 | 0 | . | . | . | . |
| Bearberry | . | . | 7 | 1 | 33 | 2 |
| Labrador tea | 17 | 0 | 7 | Tr | 8 | 0 |
| Scots broom | 33 | 1 | 100 | 36 | . | . |
| Salmonberry | . | . | . | . | 8 | Tr |
| Chaparral broom | . | . | 21 | 0 | . | . |
| Trailing blackberry | . | . | 7 | Tr | 8 | 0 |
| Wax myrtle | 83 | 9 | 14 | 2 | 83 | 17 |
| Sitka willow | . | . | . | . | 8 | 1 |
| Evergreen huckleberry | 100 | 6 | 50 | 4 | 100 | 32 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Red huckleberry | . | . | . | . | 8 | Tr |
| Salal | 67 | 2 | 29 | 1 | 100 | 25 |
| Western rhododendron | . | . | . | . | 17 | 2 |
| Fool's huckleberry | . | . | 7 | Tr | . | . |
| Silk tassel | . | . | . | . | 17 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Slough sedge | 100 | 48 | . | . | 17 | 0 |
| Toothed Australian fireweed | . | . | 14 | 1 | . | . |
| Tufted hairgrass | 33 | 3 | . | . | . | . |
| Hemlock water-parsnip | 17 | 1 | . | . | . | . |
| Creeping spikerush | 17 | 1 | . | . | . | . |
| Early blue violet | 33 | 0 | . | . | . | . |
| Creeping buttercup | 17 | 0 | . | . | . | . |
| Kings gentian | 17 | 0 | . | . | . | . |
| Western witchgrass | 17 | 0 | . | . | . | . |
| Elegant hairgrass | 17 | 0 | . | . | . | . |
| Spring-bank clover | 17 | 0 | . | . | . | . |
| Northern bugleweed | 33 | 2 | . | . | . | . |
| Marsh speedwell | 33 | 0 | . | . | . | . |
| Hooded ladies-tresses | 17 | 0 | . | . | . | . |
| Sand dune sedge | 17 | 0 | . | . | . | . |
| Western water-milfoil | 17 | 0 | . | . | . | . |
| Nevada rush | 17 | 1 | . | . | . | . |
| Shore sedge | 17 | 0 | . | . | . | . |
| Salt rush | 33 | 2 | 7 | 0 | . | . |
| Pacific silverweed | 33 | 4 | . | . | 8 | Tr |
| California aster | 17 | 0 | 14 | Tr | . | . |
| Licorice fern | 17 | 0 | 36 | 0 | 8 | Tr |
| Red fescue | . | . | 14 | 0 | 8 | Tr |
| False dandelion | 17 | 0 | 71 | 1 | 8 | Tr |
| Sticky chickweed | . | . | 7 | Tr | . | . |
| Doubtful chickweed | . | . | 7 | Tr | . | . |
| Cut-leaved Australian fireweed | . | . | 14 | 0 | . | . |
| Woodland groundsel | . | . | 29 | 0 | . | . |
| Sheep sorrel | . | . | 36 | 0 | . | . |
| Seashore lupine | . | . | 14 | 0 | . | . |
| Green sedge | . | . | 7 | Tr | . | . |
| Hairy hawkbit | . | . | 7 | Tr | . | . |
| Yarrow | . | . | 29 | 0 | . | . |
| White-flowered hawkweed | . | . | 36 | 0 | . | . |
| Sweet vernal grass | . | . | 7 | 0 | . | . |
| Velvet grass | . | . | 21 | 1 | . | . |
| Silver hairgrass | . | . | 43 | 5 | . | . |
| Six-weeks fescue | . | . | 7 | 1 | . | . |
| Pale montia | . | . | 7 | Tr | . | . |
| Coast strawberry | . | . | 36 | 0 | . | . |
| Chickweed | . | . | 7 | Tr | . | . |
| Seaside tansy | . | . | 7 | Tr | . | . |
| Tansy ragwort | . | . | 7 | Tr | . | . |
| Purple cudweed | . | . | 7 | Tr | . | . |
| Western rattlesnake-plantain | 17 | 0 | . | . | 17 | Tr |
| European beachgrass | . | . | 100 | 36 | 8 | 1 |
| Little hairgrass | . | . | 71 | 11 | 17 | 0 |
| Pearly everlasting | . | . | 29 | 0 | . | . |
| Sword fern | . | . | 64 | 1 | 17 | 0 |
| Bird-foot trefoil | . | . | . | . | 8 | Tr |
| Bog St. Johnswort | . | . | . | . | 8 | Tr |
| Cut-leaved water-horehound | . | . | . | . | 8 | Tr |
| Pacific reedgrass | . | . | . | . | 8 | Tr |
| Pyrola | . | . | . | . | 8 | Tr |
| False lily-of-the-valley | . | . | . | . | 33 | 0 |
| Deer fern | . | . | 7 | Tr | 8 | Tr |
| Bracken fern | . | . | . | . | 42 | 1 |
| Swamp bedstraw | 17 | 0 | . | . | . | . |
| Gnome plant | . | . | . | . | 8 | Tr |

| | | | | | | |
|---|---|---|---|---|---|---|
| Snome plant | . | . | . | . | 8 | Tr |
| Scouler's polypody | . | . | . | . | 17 | 0 |

| | PISI/GASH | | PISI/GASH-RUSP | | PISI/VAOV2 | |
|---|---|---|---|---|---|---|
| | 1 Plots | | 4 Plots | | 14 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 0 | 0 | 87 | 44 | 15 | 55 |
| Slope | 25 | 0 | 6 | 3 | 24 | 27 |
| Vertical microtopography | 4 | 0 | 3 | 1 | 2 | 1 |
| Horizontal microtopography | 1 | 0 | 3 | 1 | 2 | 1 |
| Overstory trees | 85 | 0 | 91 | 5 | 57 | 19 |
| Understory trees | 0 | 0 | 2 | 1 | 4 | 6 |
| High shrubs | 1 | 0 | 24 | 13 | 82 | 16 |
| Low shrubs | 5 | 0 | 15 | 8 | 4 | 3 |
| Herb | 1 | 0 | 2 | 1 | 2 | 3 |
| Moss | 15 | 0 | 40 | 21 | 26 | 21 |
| Bare sand | 0 | 0 | 0 | 0 | 0 | 1 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| Red alder | . | . | . | . | 7 | 1 |
| Shore pine | . | . | . | . | 36 | 2 |
| Sitka spruce | 100 | 85 | 100 | 81 | 100 | 50 |
| Douglas fir | . | . | . | . | 43 | 5 |
| Western hemlock | . | . | 100 | 11 | 21 | 1 |
| Western red cedar | . | . | 100 | 10 | 21 | 4 |
| UNDERSTORY TREES | | | | | | |
| Sitka spruce | . | . | 25 | 0 | 57 | 1 |
| Shore pine | . | . | . | . | 21 | 0 |
| Western hemlock | . | . | 50 | 1 | 21 | 1 |
| Douglas fir | . | . | . | . | 14 | Tr |
| Cascara | 100 | 0 | 75 | 9 | 29 | 3 |
| Western red cedar | . | . | 50 | 1 | 7 | 1 |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Black twinberry | . | . | . | . | 29 | 1 |
| Scots broom | . | . | . | . | 7 | 1 |
| Salmonberry | . | . | 100 | 18 | 7 | 1 |
| Trailing blackberry | . | . | . | . | 36 | 0 |
| Thimbleberry | . | . | 75 | 2 | . | . |
| Wax myrtle | . | . | . | . | 64 | 8 |
| Evergreen huckleberry | 100 | 1 | 100 | 5 | 100 | 54 |
| Red huckleberry | . | . | 100 | 5 | . | . |
| Salal | 100 | 5 | 100 | 19 | 100 | 26 |
| Western rhododendron | . | . | . | . | 43 | 3 |
| Cool's huckleberry | . | . | 75 | 3 | . | . |
| Silk tassel | . | . | . | . | 36 | 4 |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Clough sedge | . | . | . | . | 7 | 1 |
| Skunk cabbage | . | . | 25 | 1 | . | . |
| Licorice fern | . | . | . | . | 14 | Tr |
| European beachgrass | . | . | . | . | 7 | 1 |
| Little hairgrass | . | . | . | . | 7 | Tr |
| Pearly everlasting | . | . | . | . | 7 | Tr |
| Sword fern | . | . | 100 | 6 | 21 | 0 |
| False lily-of-the-valley | . | . | . | . | 64 | 1 |
| Deer fern | . | . | 100 | 9 | . | . |
| Ground-cone | . | . | . | . | 7 | 0 |
| Bracken fern | . | . | . | . | 79 | 1 |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Swamp bedstraw | 100 | 1 | 25 | 0 | . | . |
| Evergreen violet | 100 | 1 | . | . | . | . |
| Field woodrush | 100 | 1 | . | . | . | . |
| Candyflower | 100 | 1 | 25 | 0 | . | . |
| Fairy lantern | 100 | 0 | 75 | 1 | . | . |
| Small-flowered woodrush | . | . | 50 | 0 | . | . |
| Oval-leaved mitrewort | . | . | 25 | 1 | . | . |
| Gnome plant | . | . | 25 | 0 | 14 | Tr |
| Scouler's polypody | . | . | . | . | 7 | Tr |
| Common horsetail | . | . | . | . | 7 | Tr |

| | PSME/RHMA3-VAOV2 | | TSHE/RHMA3-VAOV2 | |
|---|---|---|---|---|
| | 11 Plots | | 16 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. |
| Aspect | 22 | 73 | 52 | 49 |
| Slope | 34 | 27 | 37 | 21 |
| Vertical microtopography | 2 | 1 | 2 | 1 |
| Horizontal microtopography | 2 | 1 | 2 | 1 |
| Overstory trees | 65 | 17 | 73 | 19 |
| Understory trees | 1 | 2 | 2 | 3 |
| High shrubs | 94 | 3 | 83 | 21 |
| Low shrubs | 2 | 2 | 7 | 11 |
| Herb | 0 | 0 | 2 | 4 |
| Moss | 12 | 16 | 22 | 11 |
| Bare sand | 0 | 1 | 0 | 0 |
| Species | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | |
| Red alder | . | . | 6 | 0 |
| Shore pine | 73 | 3 | 13 | 0 |
| Sitka spruce | 36 | 3 | 63 | 11 |
| Douglas fir | 100 | 60 | 88 | 34 |
| Western hemlock | . | . | 100 | 28 |
| Western red cedar | 18 | 3 | 44 | 10 |
| UNDERSTORY TREES | | | | |
| Sitka spruce | 9 | 0 | 6 | Tr |
| Shore pine | 9 | 0 | 6 | Tr |
| Western hemlock | . | . | 56 | 1 |
| Douglas fir | 36 | 1 | 19 | 1 |
| Cascara | 45 | 1 | 56 | 2 |
| Western red cedar | 9 | 0 | 19 | 0 |
| SHRUBS AND WOODY GROUNDCOVER | | | | |
| Scots broom | . | . | 6 | Tr |
| Salmonberry | . | . | 6 | 0 |
| Trailing blackberry | 9 | 0 | 6 | Tr |
| Wax myrtle | 82 | 6 | 31 | 2 |
| Evergreen huckleberry | 100 | 67 | 100 | 52 |
| Red huckleberry | 9 | 0 | 56 | 1 |
| Salal | 100 | 14 | 100 | 22 |
| Western rhododendron | 91 | 41 | 100 | 39 |
| Silk tassel | 36 | 1 | . | . |
| Ocean spray | 36 | 2 | 38 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | | |
| Licorice fern | 9 | Tr | 19 | 0 |
| Candystick | . | . | 6 | Tr |
| Western rattlesnake-plantain | 9 | Tr | . | . |
| Sword fern | 45 | 1 | 38 | 1 |
| False lily-of-the-valley | 9 | Tr | 25 | 1 |

| | | | | |
|---|---|---|---|---|
| Ground-cone | 18 | 0 | 25 | 0 |
| Bracken fern | 64 | 1 | 69 | 1 |
| Gnome plant | 27 | 0 | 19 | Tr |
| Scouler's polypody | 9 | Tr | 31 | 1 |
| Dwarf mistletoe | . | . | 6 | Tr |
| Western trillium | . | . | 6 | Tr |

## WOODLAND

| Environment | PICOC/ARCO3 5 Plots MEAN | S.D. | PICOC/ARUV 11 Plots MEAN | S.D. |
|---|---|---|---|---|
| Aspect | 245 | 34 | 57 | 69 |
| Slope | 23 | 23 | 20 | 29 |
| Vertical microtopography | 3 | 1 | 3 | 1 |
| Horizontal microtopography | 3 | 2 | 3 | 1 |
| Overstory trees | 34 | 15 | 38 | 28 |
| Understory trees | 4 | 4 | 7 | 7 |
| High shrubs | 70 | 22 | 11 | 10 |
| Low shrubs | 16 | 17 | 33 | 22 |
| Herb | 0 | 1 | 2 | 3 |
| Moss | 13 | 17 | 26 | 24 |
| Bare sand | 1 | 1 | 5 | 5 |
| **Species** | **CON** | **AVE** | **CON** | **AVE** |
| OVERSTORY TREES | | | | |
| Douglas fir | 40 | 3 | 9 | Tr |
| Shore pine | 100 | 31 | 91 | 31 |
| Sitka spruce | . | . | 9 | Tr |
| UNDERSTORY TREES | | | | |
| Douglas fir | 40 | 1 | 18 | Tr |
| Shore pine | 80 | 3 | 100 | 7 |
| Sitka spruce | . | . | 18 | Tr |
| Western hemlock | . | . | 9 | Tr |
| Cascara | . | . | 9 | Tr |
| SHRUBS AND WOODY GROUNDCOVER | | | | |
| Western rhododendron | 80 | 2 | . | . |
| Evergreen huckleberry | 100 | 36 | 91 | 3 |
| Hairy manzanita | 100 | 39 | 91 | 5 |
| Salal | 100 | 17 | 91 | 2 |
| Wax myrtle | 40 | 5 | 36 | 1 |
| Scots broom | 40 | 1 | 45 | 4 |
| Bearberry | 60 | 1 | 100 | 28 |
| Ocean spray | . | . | 9 | Tr |
| HERBS, FERNS AND GRAMINOIDS | | | | |
| Ground-cone | 40 | Tr | . | . |
| Gnome plant | 20 | Tr | . | . |
| Pinesap | 20 | Tr | . | . |
| Hooded ladies-tresses | 20 | Tr | 9 | Tr |
| Bracken fern | 60 | 1 | 36 | 1 |
| Sickle-leaved rush | 20 | Tr | 18 | Tr |
| Silver hairgrass | 20 | Tr | 36 | Tr |
| Seashore lupine | 20 | Tr | 64 | 1 |
| Candystick | 20 | Tr | 73 | 1 |
| Little hairgrass | 20 | Tr | 82 | 1 |
| Slough sedge | . | . | 9 | Tr |
| Western rattlesnake-plantain | . | . | 9 | Tr |
| Seashore bluegrass | . | . | 36 | 1 |
| Pinedrops | . | . | 9 | Tr |

| | | | | |
|---|---|---|---|---|
| Sheep sorrel | . | . | 9 | Tr |
| Red fescue | . | . | 82 | 1 |
| Pearly everlasting | . | . | 9 | Tr |
| False dandelion | . | . | 64 | 1 |
| European beachgrass | . | . | 18 | 1 |
| Common groundsel | . | . | 9 | Tr |
| Salt rush | . | . | 27 | Tr |

## SHRUBLAND

| | LUAR/AMAR4 | | SAHO-MAFU/CAOB3-LYAM3 | | SAHO/CAOB3-AREGE | |
|---|---|---|---|---|---|---|
| | 2 Plots | | 2 Plots | | 18 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 50 | 48 | 0 | 0 | 3 | 15 |
| Slope | 5 | 7 | 1 | 0 | 0 | 0 |
| Vertical microtopography | 4 | 0 | 2 | 0 | 2 | 1 |
| Horizontal microtopography | 4 | 0 | 2 | 0 | 2 | 1 |
| Overstory trees | 0 | 0 | 3 | 4 | 4 | 9 |
| Understory trees | 2 | 0 | 0 | 0 | 2 | 8 |
| High shrubs | 40 | 14 | 63 | 46 | 37 | 31 |
| Low shrubs | 18 | 4 | 13 | 4 | 20 | 20 |
| Herb | 10 | 0 | 30 | 28 | 71 | 10 |
| Moss | 1 | 0 | 12 | 11 | 8 | 16 |
| Bare sand | 6 | 6 | 0 | 0 | 8 | 11 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| Red alder | . | . | 100 | 9 | . | . |
| Sitka spruce | . | . | 50 | 2 | 22 | 1 |
| Shore pine | . | . | 50 | 2 | 28 | 3 |
| UNDERSTORY TREES | | | | | | |
| Douglas fir | 50 | 1 | . | . | . | . |
| Shore pine | 100 | 2 | . | . | 33 | 2 |
| Sitka spruce | . | . | . | . | 17 | Tr |
| Western red cedar | . | . | . | . | 6 | Tr |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Chaparral broom | 50 | 1 | . | . | . | . |
| Tree lupine | 100 | 55 | . | . | . | . |
| Scots broom | 50 | 8 | . | . | 11 | Tr |
| Sitka willow | 50 | 1 | 50 | 8 | . | . |
| Black twinberry | 50 | 1 | 50 | 1 | 17 | 1 |
| Evergreen huckleberry | 50 | 1 | 100 | 1 | 28 | 1 |
| Wax myrtle | 50 | 1 | 50 | 1 | 39 | 7 |
| Labrador tea | . | . | 100 | 10 | 6 | Tr |
| Salal | . | . | 100 | 3 | 39 | 3 |
| Hooker willow | 50 | 1 | 100 | 55 | 100 | 42 |
| Bog blueberry | . | . | . | . | 17 | 1 |
| Trailing blackberry | . | . | . | . | 11 | Tr |
| Cultivated cranberry | . | . | . | . | 6 | Tr |
| Douglas spiraea | . | . | 50 | 1 | 6 | Tr |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Orchard-grass | 50 | 2 | . | . | . | . |
| Six-weeks fescue | 50 | 1 | . | . | . | . |
| Dogtail | 50 | 1 | . | . | . | . |
| American dunegrass | 50 | 3 | . | . | . | . |
| Pearly everlasting | 100 | 4 | . | . | . | . |
| Sheep sorrel | 100 | 1 | . | . | . | . |
| Perennial sow-thistle | 50 | 1 | . | . | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| arentucellia | 50 | 1 | . | . | . | . |
| each knotweed | 50 | 1 | . | . | . | . |
| ut-leaved Australian fireweed | 50 | Tr | . | . | . | . |
| eashore lupine | 50 | 3 | . | . | . | . |
| uropean beachgrass | 100 | 40 | . | . | . | . |
| arrow | 50 | 3 | . | . | . | . |
| ilver hairgrass | 100 | 2 | . | . | . | . |
| oast strawberry | 100 | 3 | . | . | . | . |
| entgrass | 50 | 1 | . | . | . | . |
| elvet grass | 100 | 1 | . | . | 6 | Tr |
| alse dandelion | 100 | 3 | . | . | 17 | Tr |
| ittle hairgrass | 100 | 2 | 50 | 1 | . | . |
| icorice fern | 50 | 1 | 100 | 2 | . | . |
| word fern | 50 | 2 | 100 | 1 | 6 | Tr |
| kunk cabbage | . | . | 100 | 28 | . | . |
| usick's sedge | . | . | 50 | 1 | . | . |
| alt rush | 50 | 1 | . | . | 50 | 2 |
| itka sedge | . | . | 50 | 23 | . | . |
| eer fern | . | . | 100 | 1 | . | . |
| ird-foot trefoil | 50 | 1 | . | . | 61 | 5 |
| arsh cinquefoil | . | . | 50 | 2 | 11 | Tr |
| og St. Johnswort | . | . | 50 | 1 | 33 | 2 |
| oothed Australian fireweed | 50 | 2 | 50 | 1 | 11 | Tr |
| acific silverweed | . | . | . | . | 94 | 23 |
| uropean centaury | . | . | . | . | 6 | Tr |
| hite-flowered hawkweed | . | . | . | . | 17 | Tr |
| orthern bugleweed | . | . | . | . | 33 | 2 |
| lough sedge | . | . | 100 | 40 | 100 | 50 |
| ufted hairgrass | . | . | . | . | 6 | Tr |
| atson's willow-herb | . | . | . | . | 11 | Tr |
| ed fescue | . | . | . | . | 6 | 1 |
| ilaeopsis | . | . | . | . | 11 | 1 |
| ound-leaved sundew | . | . | . | . | 11 | Tr |
| alifornia aster | . | . | . | . | 44 | 1 |
| ickle-leaved rush | . | . | . | . | 39 | 1 |
| arsh speedwell | . | . | . | . | 67 | 1 |
| ady fern | . | . | 100 | 2 | . | . |
| hore sedge | . | . | . | . | 17 | 1 |
| loating-leaved pondweed | . | . | . | . | 6 | Tr |
| iant helleborine | . | . | . | . | 33 | Tr |
| weet vernal grass | . | . | . | . | 6 | Tr |
| olden-eyed grass | . | . | . | . | 39 | 1 |
| og clubmoss | . | . | . | . | 11 | Tr |
| ings gentian | . | . | . | . | 11 | 1 |
| hree-square bulrush | . | . | . | . | 6 | Tr |
| evada rush | . | . | . | . | 39 | 4 |
| yrola | . | . | . | . | 11 | Tr |
| pring-bank clover | . | . | . | . | 44 | 1 |
| implestem bur-reed | . | . | . | . | 6 | Tr |
| aintbrush orthocarpus | . | . | . | . | 6 | Tr |
| reen sedge | . | . | . | . | 33 | 1 |
| reeping buttercup | . | . | . | . | 50 | 1 |
| wamp bedstraw | . | . | . | . | 28 | Tr |
| ooded ladies-tresses | . | . | . | . | 6 | Tr |
| orsetail | . | . | . | . | 11 | Tr |
| apered rush | . | . | . | . | 6 | Tr |
| oad rush | . | . | . | . | 6 | Tr |
| reeping spikerush | . | . | . | . | 17 | Tr |

| | SPDO | |
|---|---|---|
| | 1 Plots | |
| Environment | MEAN | S.D. |
| Aspect | 200 | 0 |
| Slope | 0 | 0 |
| Vertical microtopography | 2 | 0 |
| Horizontal microtopography | 2 | 0 |
| Overstory trees | 0 | 0 |
| Understory trees | 0 | 0 |
| High shrubs | 50 | 0 |
| Low shrubs | 10 | 0 |
| Herb | 10 | 0 |
| Moss | 0 | 0 |
| Bare sand | 0 | 0 |
| Species | CON | AVE |
| OVERSTORY TREES | | |
| None | | |
| UNDERSTORY TREES | | |
| None | | |
| SHRUBS AND WOODY GROUNDCOVER | | |
| Hooker willow | 100 | 2 |
| Douglas spiraea | 100 | 60 |
| HERBS, FERNS AND GRAMINOIDS | | |
| Toothed Australian fireweed | 100 | 10 |
| Slough sedge | 100 | 20 |
| Lady fern | 100 | 2 |
| Hardstem bulrush | 100 | 3 |

## DWARF-SHRUBLAND

| | VAUL/CAOB3 | | VAUL/DECEC | |
|---|---|---|---|---|
| | 10 Plots | | 3 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. |
| Aspect | 0 | 0 | 20 | 68 |
| Slope | 0 | 0 | 0 | 0 |
| Vertical microtopography | 2 | 1 | 3 | 1 |
| Horizontal microtopography | 2 | 1 | 3 | 1 |
| Overstory trees | 2 | 6 | 0 | 0 |
| Understory trees | 3 | 5 | 0 | 0 |
| High shrubs | 20 | 25 | 2 | 3 |
| Low shrubs | 59 | 26 | 15 | 26 |
| Herb | 37 | 33 | 12 | 11 |
| Moss | 11 | 17 | 0 | 0 |
| Bare sand | 0 | 1 | 0 | 0 |
| Species | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | |
| Shore pine | 20 | 2 | 33 | 2 |
| UNDERSTORY TREES | | | | |
| Sitka spruce | 10 | Tr | . | . |
| Shore pine | 70 | 2 | 33 | Tr |

| | | | | |
|---|---|---|---|---|
| rabapple | 40 | 1 | 33 | 1 |
| ascara | . | . | 33 | Tr |
| SHRUBS AND WOODY GROUNDCOVER | | | | |
| abrador tea | 50 | 1 | . | . |
| cots broom | 10 | Tr | . | . |
| vergreen huckleberry | 40 | 1 | . | . |
| ed huckleberry | 10 | Tr | . | . |
| ultivated cranberry | 30 | 17 | . | . |
| og blueberry | 100 | 54 | 33 | 13 |
| alal | 50 | 1 | 33 | Tr |
| ooker willow | 90 | 13 | 67 | 2 |
| ouglas spiraea | 30 | 2 | 33 | 2 |
| ax myrtle | 30 | 2 | 33 | Tr |
| HERBS, FERNS AND GRAMINOIDS | | | | |
| ut-leaved water-horehound | 20 | Tr | . | . |
| ickle-leaved rush | 20 | Tr | . | . |
| lue-eyed grass | 10 | Tr | . | . |
| oastline bluegrass | 10 | Tr | . | . |
| ings gentian | 20 | Tr | . | . |
| ird-foot trefoil | 10 | 1 | . | . |
| eal-all | 20 | 1 | . | . |
| oad rush | 10 | 1 | . | . |
| iant helleborine | 10 | Tr | . | . |
| arly blue violet | 30 | Tr | . | . |
| eashore lupine | 10 | Tr | . | . |
| ivid sedge | 10 | 1 | . | . |
| eathery grape-fern | 10 | Tr | . | . |
| estern witchgrass | 10 | Tr | . | . |
| hite-flowered hawkweed | 10 | Tr | . | . |
| alifornia aster | 40 | 2 | . | . |
| pring-bank clover | 30 | Tr | . | . |
| acific reedgrass | 20 | Tr | . | . |
| orthern bugleweed | 40 | 1 | . | . |
| onkey flower | 10 | Tr | . | . |
| reeping spikerush | 10 | Tr | . | . |
| and dune sedge | 20 | Tr | . | . |
| olden-eyed grass | 10 | Tr | . | . |
| alt rush | 60 | 2 | 33 | Tr |
| reeping buttercup | 50 | Tr | 33 | 2 |
| arsh speedwell | 90 | 2 | 67 | 1 |
| acific silverweed | 80 | 9 | 67 | 1 |
| lough sedge | 100 | 27 | 100 | 7 |
| alse dandelion | 30 | 1 | 33 | Tr |
| evada rush | 10 | 1 | 33 | 1 |
| ufted hairgrass | 10 | Tr | 100 | 38 |
| merican wintercress | . | . | 33 | Tr |
| ommon horsetail | . | . | 33 | Tr |
| estern water-hemlock | . | . | 33 | Tr |
| urly dock | . | . | 33 | Tr |
| oothed Australian fireweed | . | . | 67 | 2 |
| word fern | . | . | 33 | Tr |
| nflated sedge | . | . | 33 | 1 |
| owland cudweed | . | . | 33 | Tr |
| ommon bladderwort | . | . | 33 | 1 |
| orthern bedstraw | . | . | 33 | Tr |
| atson's willow-herb | . | . | 33 | Tr |
| arrow | . | . | 33 | Tr |
| og St. Johnswort | . | . | 33 | 1 |
| early everlasting | . | . | 33 | Tr |
| ield mint | . | . | 67 | Tr |
| ater smartweed | . | . | 33 | 1 |
| ster | . | . | 33 | 1 |
| ommon witchgrass | . | . | 33 | Tr |

## HERBACEOUS VEGETATION

| Environment | AGSTS-AREGE 1 Plots MEAN | S.D. | AMAR4 16 Plots MEAN | S.D. | CALY3-AREGE 4 Plots MEAN | S.D. |
|---|---|---|---|---|---|---|
| Aspect | 0 | 0 | 4 | 45 | 0 | 0 |
| Slope | 0 | 0 | 2 | 4 | 0 | 1 |
| Vertical microtopography | 2 | 0 | 2 | 2 | 2 | 0 |
| Horizontal microtopography | 2 | 0 | 3 | 2 | 2 | 0 |
| Overstory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| Understory trees | 0 | 0 | 1 | 1 | 0 | 0 |
| High shrubs | 0 | 0 | 2 | 4 | 0 | 0 |
| Low shrubs | 0 | 0 | 3 | 6 | 0 | 0 |
| Herb | 70 | 0 | 37 | 37 | 35 | 45 |
| Moss | 0 | 0 | 0 | 1 | 0 | 0 |
| Bare sand | 1 | 0 | 26 | 34 | 6 | 13 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| Sitka spruce | . | . | 6 | Tr | . | . |
| UNDERSTORY TREES | | | | | | |
| Sitka spruce | . | . | 19 | Tr | . | . |
| Shore pine | . | . | 31 | Tr | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Chaparral broom | . | . | 6 | Tr | . | . |
| Tree lupine | . | . | 6 | Tr | . | . |
| Black twinberry | . | . | 6 | Tr | . | . |
| Bearberry | . | . | 13 | 1 | . | . |
| Wax myrtle | . | . | 13 | 1 | . | . |
| Salal | . | . | 19 | Tr | . | . |
| Scots broom | . | . | 31 | 1 | . | . |
| Evergreen huckleberry | . | . | 6 | Tr | . | . |
| Hooker willow | . | . | 13 | 1 | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Licorice fern | . | . | 6 | Tr | . | . |
| Sword fern | . | . | 13 | Tr | . | . |
| Dogtail | . | . | 6 | Tr | . | . |
| Deer fern | . | . | 6 | Tr | . | . |
| Ripgut brome | . | . | 6 | Tr | . | . |
| Seaside dock | . | . | . | . | 25 | 1 |
| Mayweed chamomile | . | . | . | . | 25 | Tr |
| Fleshy jaumea | . | . | . | . | 25 | Tr |
| American wintercress | . | . | . | . | 25 | Tr |
| Leathery grape-fern | . | . | 13 | Tr | . | . |
| Pond water-starwort | . | . | . | . | 25 | Tr |
| Toothed Australian fireweed | . | . | 19 | Tr | . | . |
| Seaside plantain | . | . | . | . | 25 | Tr |
| Seaside arrowgrass | . | . | . | . | 25 | Tr |
| Shadscale | . | . | . | . | 25 | 1 |
| Hemlock water-parsnip | . | . | . | . | . | . |
| Skunk cabbage | . | . | . | . | . | . |
| Tall mannagrass | . | . | . | . | . | . |
| Tufted hairgrass | 100 | 1 | . | . | 75 | 8 |
| Creeping bentgrass | 100 | 30 | . | . | 25 | Tr |
| Lyngby sedge | 100 | 2 | . | . | 100 | 68 |
| Sea pea | . | . | 25 | 8 | . | . |
| American dunegrass | . | . | 31 | 4 | . | . |
| Meadow barley | . | . | . | . | 25 | 1 |
| Saltgrass | 100 | 4 | . | . | 75 | 4 |

| | | | | | | |
|---|---|---|---|---|---|---|
| arrow | . | . | 38 | Tr | . | . |
| umweed | 100 | 1 | . | . | . | . |
| olonial bentgrass | . | . | . | . | 25 | 5 |
| urly dock | . | . | . | . | . | . |
| early everlasting | . | . | 69 | 1 | . | . |
| alt rush | 100 | 3 | 31 | 2 | 50 | 1 |
| oodland groundsel | . | . | 25 | Tr | . | . |
| easide tansy | . | . | 19 | Tr | . | . |
| pring-bank clover | . | . | 13 | Tr | 50 | 3 |
| hite-flowered hawkweed | . | . | 38 | Tr | . | . |
| evada rush | . | . | 6 | Tr | 25 | Tr |
| ticky chickweed | . | . | 13 | Tr | . | . |
| ix-weeks fescue | . | . | 19 | Tr | . | . |
| alifornia aster | . | . | 6 | Tr | . | . |
| lough sedge | 100 | 1 | 13 | 1 | 25 | 1 |
| alse dandelion | . | . | 81 | 2 | . | . |
| ickle-leaved rush | . | . | 6 | Tr | . | . |
| elvet grass | . | . | 6 | Tr | . | . |
| ilver hairgrass | . | . | 50 | 1 | . | . |
| heep sorrel | . | . | 25 | Tr | . | . |
| warf orthocarpus | . | . | 6 | Tr | . | . |
| and dune sedge | . | . | 6 | Tr | . | . |
| otton-batting plant | . | . | 6 | Tr | . | . |
| aintbrush orthocarpus | . | . | . | . | 25 | Tr |
| acific silverweed | 100 | 70 | . | . | 100 | 15 |
| atson's willow-herb | . | . | 6 | Tr | . | . |
| ittle hairgrass | . | . | 50 | 2 | . | . |
| oast strawberry | . | . | 56 | 2 | . | . |
| uropean beachgrass | . | . | 100 | 51 | . | . |
| ed fescue | . | . | 31 | 1 | 25 | Tr |
| olden-eyed grass | . | . | 6 | Tr | . | . |
| uropean centaury | . | . | 13 | Tr | . | . |
| each knotweed | . | . | 13 | Tr | . | . |
| hree-square bulrush | . | . | . | . | 50 | 2 |
| urple cudweed | . | . | 13 | Tr | . | . |
| arsh speedwell | . | . | 6 | Tr | . | . |
| ird-foot trefoil | . | . | 6 | Tr | . | . |
| eashore lupine | . | . | 69 | 2 | . | . |
| eashore bluegrass | . | . | 13 | 1 | . | . |
| each silvertop | . | . | 6 | Tr | . | . |
| reeping spikerush | . | . | . | . | 50 | 1 |
| arsh cinquefoil | . | . | 6 | Tr | . | . |

| | CAOB3 | | CAOB3-AREGE | | CAEX5 | |
|---|---|---|---|---|---|---|
| | 1 Plots | | 15 Plots | | 3 Plots | |
| nvironment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| spect | 200 | 0 | 0 | 30 | 0 | 0 |
| lope | 0 | 0 | 0 | 0 | 0 | 0 |
| ertical microtopography | 2 | 0 | 3 | 1 | 2 | 1 |
| orizontal microtopography | 2 | 0 | 3 | 1 | 2 | 1 |
| verstory trees | 0 | 0 | 1 | 1 | 0 | 0 |
| nderstory trees | 0 | 0 | 5 | 15 | 0 | 0 |
| igh shrubs | 0 | 0 | 6 | 9 | 0 | 0 |
| ow shrubs | 0 | 0 | 6 | 18 | 0 | 0 |
| erb | 5 | 0 | 69 | 31 | 38 | 50 |
| oss | 0 | 0 | 4 | 9 | 0 | 0 |
| are sand | 0 | 0 | 6 | 9 | 0 | 0 |
| pecies | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| hore pine | . | . | 27 | Tr | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| UNDERSTORY TREES | | | | | | |
| Sitka spruce | . | . | 20 | Tr | . | . |
| Shore pine | . | . | 40 | 1 | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Chaparral broom | . | . | 7 | Tr | . | . |
| Tree lupine | . | . | 7 | Tr | . | . |
| Wax myrtle | . | . | 33 | 1 | . | . |
| Salal | . | . | 27 | 3 | . | . |
| Scots broom | . | . | 13 | Tr | . | . |
| Evergreen huckleberry | . | . | 20 | Tr | . | . |
| Hooker willow | . | . | 87 | 4 | 33 | Tr |
| Douglas spiraea | . | . | . | . | 67 | 1 |
| Bog blueberry | . | . | 13 | Tr | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Leathery grape-fern | . | . | 13 | Tr | . | . |
| Pond water-starwort | 100 | 1 | . | . | . | . |
| Northern bedstraw | 100 | 1 | . | . | . | . |
| Toothed Australian fireweed | 100 | 2 | 13 | Tr | . | . |
| Field mint | 100 | 1 | . | . | 33 | Tr |
| Adders-tongue | . | . | 7 | Tr | . | . |
| Bractless hedge-hyssop | . | . | 7 | Tr | . | . |
| Speedwell | . | . | 7 | Tr | . | . |
| Western witchgrass | . | . | 13 | Tr | . | . |
| Heal-all | . | . | 7 | Tr | . | . |
| Whorled water-pennywort | . | . | 7 | Tr | . | . |
| Swamp bedstraw | . | . | 20 | Tr | . | . |
| Buttercup | . | . | 7 | Tr | . | . |
| Hemlock water-parsnip | . | . | . | . | 33 | Tr |
| Skunk cabbage | . | . | . | . | 33 | Tr |
| Tall mannagrass | . | . | . | . | 33 | 2 |
| Reed canary grass | . | . | 7 | Tr | . | . |
| American dunegrass | . | . | 7 | Tr | . | . |
| Yarrow | . | . | 20 | Tr | . | . |
| Curly dock | . | . | 7 | Tr | . | . |
| Sea watch | . | . | 7 | Tr | . | . |
| Kings gentian | . | . | 13 | 1 | . | . |
| Salt rush | . | . | 60 | 2 | . | . |
| Seaside tansy | . | . | 7 | Tr | . | . |
| Spring-bank clover | . | . | 53 | 1 | . | . |
| White-flowered hawkweed | . | . | 13 | Tr | . | . |
| Creeping buttercup | . | . | 60 | 4 | . | . |
| Nevada rush | . | . | 33 | 2 | . | . |
| Early blue violet | . | . | 7 | Tr | . | . |
| Meadow fescue | . | . | . | . | . | . |
| Six-weeks fescue | . | . | 7 | Tr | . | . |
| California aster | . | . | 53 | 1 | . | . |
| Slough sedge | 100 | 90 | 100 | 55 | 100 | 3 |
| False dandelion | . | . | 40 | Tr | . | . |
| Sickle-leaved rush | . | . | 60 | 5 | . | . |
| Velvet grass | . | . | 7 | Tr | . | . |
| Silver hairgrass | . | . | 7 | Tr | . | . |
| Green sedge | . | . | 20 | 1 | . | . |
| Northern bugleweed | . | . | 20 | 3 | . | . |
| Pacific silverweed | . | . | 93 | 25 | . | . |
| Watson's willow-herb | . | . | 20 | Tr | . | . |
| Little hairgrass | . | . | 13 | Tr | . | . |
| Shore sedge | . | . | 20 | 1 | 33 | Tr |
| Seaside lotus | . | . | 20 | 1 | . | . |
| Coast strawberry | . | . | 7 | Tr | . | . |
| European beachgrass | . | . | 7 | Tr | . | . |
| Pyrola | . | . | 7 | Tr | . | . |
| Bog St. Johnswort | . | . | 13 | 2 | . | . |
| Water smartweed | 100 | 1 | . | . | . | . |
| Red fescue | . | . | 7 | Tr | . | . |

| | | | | | | |
|---|---|---|---|---|---|---|
| Golden-eyed grass | . | . | 13 | Tr | . | . |
| Hardstem bulrush | 100 | 1 | . | . | . | . |
| Giant helleborine | . | . | 7 | Tr | . | . |
| European centaury | . | . | 13 | Tr | . | . |
| Gilaeopsis | . | . | 33 | 1 | . | . |
| Hooded ladies-tresses | . | . | 7 | Tr | . | . |
| Purple cudweed | . | . | 7 | Tr | . | . |
| Northern mannagrass | . | . | . | . | 67 | 1 |
| Inflated sedge | . | . | . | . | 67 | 48 |
| Marsh speedwell | . | . | 53 | 1 | 100 | 1 |
| Bird-foot trefoil | . | . | 20 | 3 | . | . |
| Hairy hawkbit | . | . | 7 | Tr | . | . |
| Pond lily | . | . | . | . | 100 | 9 |
| Parentucellia | . | . | 7 | Tr | . | . |
| Creeping spikerush | . | . | 27 | 3 | 33 | 2 |
| Floating-leaved pondweed | . | . | . | . | 33 | Tr |
| Blue-eyed grass | . | . | 7 | Tr | . | . |

| | DISP-AREGE 6 Plots | | LEMOM2 4 Plots | | ELPA3-JUNE 11 Plots | |
|---|---|---|---|---|---|---|
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 0 | 0 | 3 | 57 | 3 | 36 |
| Slope | 0 | 1 | 15 | 29 | 0 | 0 |
| Vertical microtopography | 2 | 0 | 1 | 1 | 2 | 1 |
| Horizontal microtopography | 2 | 0 | 1 | 1 | 2 | 1 |
| Overstory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| Understory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| High shrubs | 0 | 0 | 1 | 1 | 0 | 1 |
| Low shrubs | 0 | 0 | 1 | 1 | 4 | 7 |
| Herb | 47 | 44 | 67 | 46 | 68 | 26 |
| Moss | 0 | 0 | 0 | 0 | 8 | 19 |
| Bare sand | 6 | 8 | 5 | 10 | 13 | 18 |
| **Species** | **CON** | **AVE** | **CON** | **AVE** | **CON** | **AVE** |
| OVERSTORY TREES | | | | | | |
| None | | | | | | |
| UNDERSTORY TREES | | | | | | |
| Oregon ash | . | . | 25 | Tr | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Black twinberry | . | . | 50 | 1 | . | . |
| Trailing blackberry | . | . | 25 | Tr | . | . |
| Salmonberry | . | . | 25 | 1 | . | . |
| Wax myrtle | . | . | . | . | 9 | Tr |
| Salal | . | . | . | . | 9 | Tr |
| Hooker willow | . | . | . | . | 73 | 3 |
| Labrador tea | . | . | . | . | 9 | Tr |
| Douglas spiraea | . | . | 25 | Tr | 9 | Tr |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Toothed Australian fireweed | . | . | 25 | 1 | . | . |
| Seaside plantain | . | . | . | . | 9 | Tr |
| Seaside arrowgrass | 17 | Tr | . | . | 9 | Tr |
| Shadscale | 50 | 1 | . | . | . | . |
| Tall mannagrass | . | . | . | . | 9 | Tr |
| Tufted hairgrass | 33 | 1 | 50 | 1 | . | . |
| Creeping bentgrass | 17 | 1 | . | . | 9 | Tr |
| Sea milkwort | 17 | 3 | . | . | . | . |
| Lyngby sedge | 83 | 12 | . | . | 9 | Tr |
| Sea pea | . | . | 100 | 31 | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Reed canary grass | . | . | . | . | 9 | Tr |
| American dunegrass | . | . | 100 | 69 | . | . |
| Meadow barley | 17 | Tr | 25 | Tr | . | . |
| Saltgrass | 100 | 73 | . | . | 18 | Tr |
| Brass buttons | 17 | Tr | . | . | 9 | Tr |
| Graceful arrowgrass | 17 | Tr | . | . | 9 | Tr |
| Yarrow | . | . | 75 | 1 | . | . |
| Gumweed | . | . | 25 | Tr | . | . |
| Canada thistle | . | . | 25 | Tr | . | . |
| Bittersweet nightshade | . | . | 25 | Tr | . | . |
| Searocket | . | . | 25 | Tr | . | . |
| Common groundsel | . | . | 25 | Tr | . | . |
| Tansy ragwort | . | . | 25 | 3 | . | . |
| Coastline bluegrass | . | . | 25 | Tr | . | . |
| Colonial bentgrass | 33 | 1 | 50 | 3 | 9 | Tr |
| Curly dock | . | . | 50 | 1 | . | . |
| Pearly everlasting | . | . | 25 | Tr | . | . |
| Sea watch | . | . | 25 | 1 | . | . |
| Salt rush | 50 | 1 | 75 | 5 | 64 | 2 |
| Different-leaved water-starwort | . | . | . | . | 9 | Tr |
| Tapered rush | . | . | . | . | 18 | 2 |
| Common cattail | . | . | . | . | 9 | 2 |
| Common horsetail | . | . | . | . | 9 | Tr |
| Toad rush | . | . | . | . | 9 | Tr |
| Mexican plantain | . | . | . | . | 9 | Tr |
| Parrot feather | . | . | . | . | 9 | Tr |
| Spring-bank clover | 50 | 1 | . | . | 18 | Tr |
| Creeping buttercup | 17 | 1 | . | . | 64 | 9 |
| Nevada rush | 17 | Tr | . | . | 82 | 22 |
| Dune bentgrass | . | . | . | . | 9 | Tr |
| Meadow fescue | . | . | 25 | Tr | . | . |
| California aster | . | . | 25 | Tr | 27 | Tr |
| Slough sedge | 17 | 1 | . | . | 73 | 3 |
| Rush | 17 | Tr | . | . | . | . |
| False dandelion | . | . | 25 | Tr | 9 | Tr |
| Low clubrush | . | . | . | . | 18 | Tr |
| English plantain | . | . | 25 | Tr | . | . |
| Sickle-leaved rush | . | . | . | . | 55 | 8 |
| Velvet grass | . | . | 50 | 2 | 9 | Tr |
| Sheep sorrel | . | . | 25 | 1 | . | . |
| Green sedge | . | . | . | . | 27 | Tr |
| Northern bugleweed | . | . | . | . | 9 | Tr |
| Pacific silverweed | 100 | 12 | 50 | 11 | 82 | 3 |
| Watson's willow-herb | . | . | . | . | 9 | Tr |
| Shore sedge | . | . | . | . | 73 | 11 |
| Baltic rush | 33 | 3 | . | . | . | . |
| Coast strawberry | . | . | . | . | 9 | Tr |
| European beachgrass | . | . | 50 | 7 | . | . |
| Bog St. Johnswort | . | . | . | . | 9 | 4 |
| Water smartweed | . | . | . | . | 9 | Tr |
| Red fescue | . | . | 50 | 1 | 9 | Tr |
| Golden-eyed grass | . | . | . | . | 27 | Tr |
| Giant helleborine | . | . | . | . | 9 | Tr |
| Pickleweed | 17 | 1 | . | . | . | . |
| Round-leaved sundew | . | . | . | . | 9 | Tr |
| Lilaeopsis | 17 | 3 | . | . | 91 | 14 |
| Hooded ladies-tresses | . | . | . | . | 9 | Tr |
| Three-square bulrush | 50 | 8 | . | . | 27 | 3 |
| Marsh speedwell | . | . | . | . | 18 | Tr |
| Bird-foot trefoil | . | . | 25 | 1 | 18 | 1 |
| Procumbent pearlwort | . | . | . | . | 18 | Tr |
| Parentucellia | . | . | . | . | 9 | Tr |
| Creeping spikerush | 33 | 1 | . | . | 91 | 29 |

| nvironment | FERU2 9 Plots MEAN | S.D. | FERU2-JULE 6 Plots MEAN | S.D. | FERU2-PTAQ 3 Plots MEAN | S.D. |
|---|---|---|---|---|---|---|
| spect | 34 | 62 | 0 | 0 | 243 | 27 |
| lope | 10 | 11 | 0 | 0 | 49 | 19 |
| ertical microtopography | 3 | 1 | 2 | 1 | 2 | 1 |
| orizontal microtopography | 3 | 2 | 2 | 1 | 2 | 1 |
| verstory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| nderstory trees | 1 | 1 | 1 | 1 | 5 | 7 |
| igh shrubs | 0 | 0 | 0 | 0 | 0 | 0 |
| ow shrubs | 0 | 1 | 4 | 6 | 3 | 4 |
| erb | 10 | 12 | 71 | 28 | 8 | 10 |
| oss | 5 | 15 | 1 | 1 | 0 | 0 |
| are sand | 65 | 26 | 9 | 13 | 60 | 21 |
| pecies | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| one | | | | | | |
| UNDERSTORY TREES | | | | | | |
| ouglas fir | 11 | Tr | . | . | . | . |
| itka spruce | . | . | 33 | Tr | . | . |
| hore pine | 44 | 1 | 33 | Tr | 67 | 4 |
| ascara | . | . | 17 | Tr | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| earberry | 33 | Tr | 17 | Tr | 33 | 2 |
| ax myrtle | . | . | 67 | 1 | . | . |
| alal | . | . | 67 | 3 | . | . |
| cots broom | . | . | 50 | 1 | 33 | Tr |
| vergreen huckleberry | . | . | 50 | 1 | . | . |
| ooker willow | . | . | 33 | 1 | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| ufted hairgrass | . | . | 50 | 7 | . | . |
| reeping bentgrass | . | . | 17 | 3 | . | . |
| ea pea | . | . | 17 | Tr | . | . |
| merican dunegrass | . | . | 33 | Tr | . | . |
| eadow barley | . | . | 33 | 1 | . | . |
| altgrass | . | . | 17 | 2 | . | . |
| arrow | 22 | 1 | 33 | 2 | . | . |
| umweed | . | . | 50 | 5 | . | . |
| olonial bentgrass | . | . | 17 | 1 | . | . |
| urly dock | . | . | 17 | Tr | . | . |
| early everlasting | 44 | Tr | 17 | Tr | . | . |
| ea watch | . | . | 17 | Tr | . | . |
| alt rush | 11 | Tr | 100 | 10 | . | . |
| easide tansy | . | . | 17 | Tr | . | . |
| pring-bank clover | . | . | 50 | 1 | . | . |
| reeping buttercup | . | . | 17 | Tr | . | . |
| evada rush | . | . | 50 | 8 | . | . |
| ticky chickweed | . | . | 17 | Tr | . | . |
| easide tansy | 11 | Tr | . | . | . | . |
| each pea | 11 | Tr | . | . | . | . |
| une bentgrass | 11 | 1 | 17 | Tr | . | . |
| ix-weeks fescue | . | . | 17 | 1 | . | . |
| alifornia aster | . | . | 50 | 1 | . | . |
| lough sedge | . | . | 50 | 1 | . | . |
| alse dandelion | 67 | 1 | 83 | 4 | 33 | 1 |
| nglish plantain | . | . | 50 | 1 | . | . |
| ickle-leaved rush | . | . | 33 | 3 | . | . |
| elvet grass | . | . | 50 | 6 | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Silver hairgrass | 11 | Tr | 50 | 1 | . | . |
| Sheep sorrel | . | . | 50 | 2 | 33 | Tr |
| Roughstalk bluegrass | . | . | 17 | 4 | . | . |
| Bluejoint reedgrass | . | . | 17 | Tr | . | . |
| Dwarf orthocarpus | . | . | 33 | Tr | . | . |
| Sand dune sedge | . | . | 17 | 7 | . | . |
| Green sedge | . | . | 17 | Tr | . | . |
| Paintbrush orthocarpus | . | . | 33 | Tr | . | . |
| Pacific silverweed | . | . | 50 | 1 | . | . |
| Little hairgrass | 22 | 1 | 67 | 4 | . | . |
| Seaside lotus | . | . | 33 | 2 | . | . |
| Coast strawberry | 44 | Tr | 50 | 2 | . | . |
| European beachgrass | 11 | Tr | . | . | . | . |
| Bog St. Johnswort | . | . | 17 | Tr | . | . |
| Red fescue | 100 | 18 | 100 | 23 | 100 | 6 |
| Golden-eyed grass | . | . | 17 | Tr | . | . |
| Bracken fern | . | . | . | . | 100 | 25 |
| Giant helleborine | . | . | 17 | Tr | . | . |
| European centaury | . | . | 67 | 1 | . | . |
| Beach knotweed | 89 | 1 | 33 | Tr | 33 | Tr |
| Round-leaved sundew | . | . | 17 | Tr | . | . |
| Purple cudweed | . | . | 33 | Tr | . | . |
| Bird-foot trefoil | . | . | 17 | 1 | . | . |
| Procumbent pearlwort | . | . | 33 | 1 | . | . |
| Seashore lupine | 44 | 5 | 33 | 4 | 67 | 15 |
| Bog clubmoss | . | . | 17 | Tr | . | . |
| Hairy hawkbit | 11 | Tr | . | . | . | . |
| Sweet vernal grass | . | . | 17 | 3 | . | . |
| Seashore bluegrass | 67 | 3 | . | . | 100 | 1 |
| Beach silvertop | 56 | 1 | . | . | 67 | 1 |
| Parentucellia | . | . | 33 | 1 | . | . |

| | JUBA-AREGE | | JUFA-JULE | | | |
|---|---|---|---|---|---|---|
| | 1 Plots | | 10 Plots | | JULE 7 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 0 | 0 | 3 | 35 | 9 | 29 |
| Slope | 1 | 0 | 0 | 0 | 0 | 0 |
| Vertical microtopography | 2 | 0 | 2 | 1 | 2 | 1 |
| Horizontal microtopography | 2 | 0 | 2 | 1 | 2 | 1 |
| Overstory trees | 0 | 0 | 0 | 0 | 3 | 5 |
| Understory trees | 0 | 0 | 2 | 3 | 2 | 2 |
| High shrubs | 0 | 0 | 9 | 16 | 2 | 2 |
| Low shrubs | 0 | 0 | 22 | 22 | 5 | 7 |
| Herb | 60 | 0 | 55 | 26 | 69 | 21 |
| Moss | 0 | 0 | 7 | 12 | 1 | 1 |
| Bare sand | 0 | 0 | 9 | 14 | 19 | 21 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| Shore pine | . | . | 10 | Tr | 57 | 3 |
| UNDERSTORY TREES | | | | | | |
| Sitka spruce | . | . | 20 | Tr | 29 | Tr |
| Shore pine | . | . | 70 | 2 | 71 | 2 |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Wax myrtle | . | . | 40 | 4 | 14 | Tr |
| Salal | . | . | 50 | 2 | 29 | Tr |
| Scots broom | . | . | 20 | Tr | 71 | 2 |
| Evergreen huckleberry | . | . | 50 | 1 | 14 | Tr |
| Hooker willow | . | . | 100 | 20 | 57 | 3 |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Labrador tea | . | . | 20 | 2 | 14 | Tr |
| Red elderberry | . | . | 10 | Tr | . | . |
| Silk tassel | . | . | . | . | 14 | 1 |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Tufted hairgrass | 100 | 1 | . | . | . | . |
| Creeping bentgrass | 100 | 5 | . | . | . | . |
| Lyngby sedge | 100 | 2 | . | . | . | . |
| Saltgrass | 100 | 25 | . | . | . | . |
| Yarrow | . | . | . | . | 14 | Tr |
| Sumweed | 100 | 1 | . | . | . | . |
| Colonial bentgrass | . | . | . | . | 14 | 1 |
| Pearly everlasting | . | . | 10 | Tr | 14 | Tr |
| Kings gentian | . | . | 10 | Tr | . | . |
| Salt rush | . | . | 90 | 12 | 100 | 12 |
| Seaside tansy | . | . | 10 | Tr | 14 | Tr |
| Spring-bank clover | . | . | 40 | 4 | 14 | Tr |
| White-flowered hawkweed | . | . | 20 | Tr | 14 | Tr |
| Creeping buttercup | . | . | 50 | 3 | 14 | Tr |
| Nevada rush | . | . | 50 | 5 | 29 | 6 |
| Sticky chickweed | . | . | . | . | 14 | Tr |
| Early blue violet | . | . | 10 | Tr | . | . |
| Meadow fescue | . | . | . | . | 14 | Tr |
| Six-weeks fescue | . | . | . | . | 43 | 6 |
| California aster | . | . | 60 | 1 | 57 | 1 |
| Slough sedge | . | . | 90 | 4 | 86 | 7 |
| Rush | . | . | . | . | 14 | 5 |
| False dandelion | . | . | 100 | 2 | 100 | 9 |
| Low clubrush | . | . | 10 | Tr | . | . |
| English plantain | . | . | . | . | 14 | Tr |
| Sickle-leaved rush | . | . | 100 | 23 | 43 | Tr |
| Velvet grass | . | . | 20 | Tr | 43 | 4 |
| Silver hairgrass | . | . | . | . | 57 | 4 |
| Sheep sorrel | . | . | 10 | Tr | 57 | 1 |
| Dwarf orthocarpus | . | . | . | . | 14 | Tr |
| Sand dune sedge | . | . | . | . | 14 | Tr |
| Cotton-batting plant | . | . | . | . | 14 | Tr |
| Green sedge | . | . | 60 | 1 | . | . |
| Northern bugleweed | . | . | 30 | 1 | 14 | Tr |
| Paintbrush orthocarpus | . | . | 40 | 1 | 29 | 1 |
| Pacific silverweed | 100 | 60 | 70 | 3 | 14 | 1 |
| Watson's willow-herb | . | . | 40 | 1 | 29 | Tr |
| Little hairgrass | . | . | 30 | 1 | 86 | 11 |
| Shore sedge | . | . | 50 | 1 | 14 | Tr |
| Baltic rush | 100 | 40 | . | . | . | . |
| Seaside lotus | . | . | 20 | 4 | 29 | 4 |
| Coast strawberry | . | . | 50 | 1 | 57 | 1 |
| European beachgrass | . | . | 10 | Tr | 43 | 3 |
| Pyrola | . | . | 20 | Tr | . | . |
| Bog St. Johnswort | . | . | 40 | 2 | 14 | Tr |
| Red fescue | . | . | 20 | Tr | 43 | 1 |
| Golden-eyed grass | . | . | 80 | 2 | 29 | Tr |
| Giant helleborine | . | . | 50 | 1 | . | . |
| Pickleweed | 100 | 1 | . | . | . | . |
| European centaury | . | . | 60 | 1 | 71 | 2 |
| Round-leaved sundew | . | . | 30 | 1 | . | . |
| Lilaeopsis | . | . | 30 | 1 | . | . |
| Hooded ladies-tresses | . | . | 30 | Tr | 14 | Tr |
| Purple cudweed | . | . | 40 | 1 | 71 | 2 |
| Marsh speedwell | . | . | 40 | 1 | 29 | Tr |
| Bird-foot trefoil | . | . | 40 | 5 | 43 | 1 |
| Procumbent pearlwort | . | . | 20 | 1 | 43 | 1 |
| Seashore lupine | . | . | 20 | 1 | 71 | 6 |
| Bog clubmoss | . | . | 30 | 1 | . | . |
| Tall fescue | 100 | 1 | . | . | . | . |
| Hairy hawkbit | . | . | 30 | 1 | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Sweet vernal grass | . | . | 20 | Tr | 29 | 2 |
| Parentucellia | . | . | 40 | 1 | 29 | Tr |
| Monkey flower | . | . | 20 | Tr | 14 | Tr |
| Creeping spikerush | . | . | 20 | 1 | . | . |
| Field chickweed | . | . | . | . | 14 | Tr |
| Elegant hairgrass | . | . | . | . | 14 | Tr |
| Fescue | . | . | . | . | 14 | 2 |
| Bromegrass | . | . | . | . | 29 | 3 |
| Little quaking-grass | . | . | . | . | 29 | 1 |
| Marsh cinquefoil | . | . | 10 | Tr | . | . |

| | LULI2 | | NULUP | | POMA26 | |
|---|---|---|---|---|---|---|
| | 4 Plots | | 1 Plots | | 1 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 38 | 55 | 0 | 0 | 0 | 0 |
| Slope | 24 | 25 | 0 | 0 | 0 | 0 |
| Vertical microtopography | 3 | 1 | 2 | 0 | 2 | 0 |
| Horizontal microtopography | 4 | 1 | 2 | 0 | 2 | 0 |
| Overstory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| Understory trees | 0 | 0 | 0 | 0 | 1 | 0 |
| High shrubs | 0 | 0 | 0 | 0 | 0 | 0 |
| Low shrubs | 0 | 0 | 1 | 0 | 0 | 0 |
| Herb | 41 | 35 | 20 | 0 | 1 | 0 |
| Moss | 0 | 0 | 0 | 0 | 0 | 0 |
| Bare sand | 54 | 42 | 0 | 0 | 90 | 0 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| None | | | | | | |
| UNDERSTORY TREES | | | | | | |
| None | | | | | | |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Douglas spiraea | . | . | 100 | 1 | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Pearly everlasting | 25 | Tr | . | . | . | . |
| Woodland groundsel | 25 | Tr | . | . | . | . |
| White-flowered hawkweed | 25 | Tr | . | . | . | . |
| Slough sedge | . | . | 100 | 1 | . | . |
| False dandelion | 50 | 3 | . | . | . | . |
| Silver hairgrass | 50 | 1 | . | . | . | . |
| Little hairgrass | 50 | Tr | . | . | . | . |
| Coast strawberry | 25 | Tr | . | . | . | . |
| European beachgrass | 100 | 10 | . | . | 100 | 3 |
| Red fescue | 75 | 2 | . | . | 100 | 1 |
| Beach knotweed | 25 | Tr | . | . | . | . |
| Northern mannagrass | . | . | 100 | 2 | . | . |
| Inflated sedge | . | . | 100 | 2 | . | . |
| Marsh speedwell | . | . | 100 | 1 | . | . |
| Seashore lupine | 100 | 31 | . | . | 100 | 1 |
| Hairy hawkbit | 25 | Tr | . | . | . | . |
| Seashore bluegrass | 100 | 6 | . | . | 100 | 15 |
| Beach silvertop | 50 | 1 | . | . | 100 | 1 |
| Pond lily | . | . | 100 | 20 | . | . |
| Creeping spikerush | . | . | 100 | 1 | . | . |
| Fowl bluegrass | 25 | 1 | . | . | . | . |
| Yellow abronia | 25 | Tr | . | . | . | . |
| Floating-leaved pondweed | . | . | 100 | 1 | . | . |
| Threeway sedge | . | . | 100 | 2 | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Knotweed | . | . | 100 | 1 | . | . |
| Water clubrush | . | . | 100 | 5 | . | . |
| Marsh cinquefoil | . | . | 100 | 1 | . | . |

| | PONA4 | | SCACA | | SCAM6 | |
|---|---|---|---|---|---|---|
| | 1 Plots | | 1 Plots | | 3 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Aspect | 0 | 0 | 200 | 0 | 0 | 0 |
| Slope | 0 | 0 | 0 | 0 | 0 | 0 |
| Vertical microtopography | 3 | 0 | 2 | 0 | 1 | 1 |
| Horizontal microtopography | 3 | 0 | 2 | 0 | 1 | 1 |
| Overstory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| Understory trees | 0 | 0 | 0 | 0 | 0 | 0 |
| High shrubs | 0 | 0 | 0 | 0 | 0 | 0 |
| Low shrubs | 0 | 0 | 0 | 0 | 2 | 2 |
| Herb | 80 | 0 | 15 | 0 | 63 | 54 |
| Moss | 0 | 0 | 0 | 0 | 0 | 0 |
| Bare sand | 20 | 0 | 0 | 0 | 28 | 41 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| None | | | | | | |
| UNDERSTORY TREES | | | | | | |
| None | | | | | | |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Hooker willow | . | . | . | . | 67 | 2 |
| Douglas spiraea | . | . | 100 | 1 | . | . |
| Bog blueberry | . | . | 100 | 1 | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Lyngby sedge | . | . | . | . | 33 | 5 |
| Saltgrass | . | . | . | . | 33 | 1 |
| Salt rush | . | . | . | . | 33 | Tr |
| Spring-bank clover | . | . | . | . | 33 | 1 |
| Slough sedge | . | . | . | . | 67 | 15 |
| Pacific silverweed | 100 | 1 | . | . | 100 | 10 |
| Shore sedge | . | . | . | . | 33 | Tr |
| Coast strawberry | . | . | . | . | 33 | Tr |
| Water smartweed | . | . | 100 | 15 | . | . |
| Hardstem bulrush | . | . | 100 | 60 | . | . |
| Beach knotweed | . | . | . | . | 33 | 1 |
| Lilaeopsis | . | . | . | . | 67 | 2 |
| Three-square bulrush | . | . | . | . | 100 | 45 |
| Marsh speedwell | 100 | 1 | . | . | . | . |
| Bird-foot trefoil | . | . | . | . | 33 | 1 |
| Pond lily | . | . | 100 | 2 | . | . |
| Parentucellia | . | . | . | . | 33 | Tr |
| Creeping spikerush | 100 | 5 | . | . | 100 | 12 |
| Floating-leaved pondweed | 100 | 60 | . | . | . | . |
| Blue-eyed grass | . | . | . | . | 33 | 1 |
| Horsetail | 100 | 2 | . | . | . | . |
| Marsh cinquefoil | . | . | . | . | 33 | 3 |
| Simplestem bur-reed | 100 | 35 | . | . | . | . |

## Appendix 1. Summary data for recon vegetation plots, continued.

| | SPAN2 | |
|---|---|---|
| | 1 Plots | |
| Environment | MEAN | S.D. |
| Aspect | 0 | 0 |
| Slope | 0 | 0 |
| Vertical microtopography | 2 | 0 |
| Horizontal microtopography | 2 | 0 |
| Overstory trees | 0 | 0 |
| Understory trees | 0 | 0 |
| High shrubs | 5 | 0 |
| Low shrubs | 5 | 0 |
| Herb | 10 | 0 |
| Moss | 0 | 0 |
| Bare sand | 0 | 0 |
| Species | CON | AVE |
| OVERSTORY TREES | | |
| None | | |
| UNDERSTORY TREES | | |
| None | | |
| SHRUBS AND WOODY GROUNDCOVER | | |
| None | | |
| HERBS, FERNS AND GRAMINOIDS | | |
| Slough sedge | 100 | 10 |
| Pacific silverweed | 100 | 1 |
| Creeping spikerush | 100 | 1 |
| Marsh cinquefoil | 100 | 1 |
| Simplestem bur-reed | 100 | 45 |

**Appendix 2. Summary data for transect vegetation plots, Oregon Dunes National Recreation Area, by National Vegetation Classification System class and association. Minimum constancy = 0.10, minimum average cover = 0.10, Tr = < 1.0.**

## HERBACEOUS VEGETATION

| | AMAR4 | | LEMOM2 | | ELPA3-JUNE | |
|---|---|---|---|---|---|---|
| | 80 Plots | | 1 Plots | | 30 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Microposition | 10 | 8 | 16 | 0 | 11 | 8 |
| Moss | 6 | 5 | . | . | . | . |
| Bare sand | 41 | 30 | 70 | 0 | 89 | 5 |
| Lichen | 10 | 15 | . | . | . | . |
| Litter | 19 | 23 | . | . | 6 | 6 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| Shore pine | 4 | Tr | . | . | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Tree lupine | 8 | 5 | . | . | . | . |
| Wax myrtle | 1 | Tr | . | . | . | . |
| Hooker willow | 1 | Tr | . | . | 7 | Tr |
| Salal | 6 | Tr | . | . | . | . |
| Evergreen huckleberry | 1 | Tr | . | . | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| Woodland groundsel | 1 | Tr | . | . | . | . |
| Toothed Australian fireweed | 11 | 1 | . | . | . | . |
| American dunegrass | 8 | Tr | 100 | 30 | . | . |
| Silver hairgrass | 5 | Tr | . | . | . | . |
| European beachgrass | 100 | 18 | . | . | . | . |
| Lilaeopsis | . | . | . | . | 10 | Tr |
| Creeping spikerush | . | . | . | . | 100 | 11 |
| Shore sedge | . | . | . | . | 37 | 1 |
| Pearly everlasting | 35 | 2 | . | . | . | . |
| Pacific silverweed | 1 | Tr | . | . | 43 | 1 |
| California aster | 19 | 1 | . | . | . | . |
| Coast strawberry | 45 | 3 | . | . | . | . |
| Paintbrush orthocarpus | 1 | Tr | . | . | . | . |
| Slough sedge | 6 | Tr | . | . | 7 | 1 |
| Nevada rush | 5 | Tr | . | . | 67 | 8 |
| Yarrow | 13 | Tr | . | . | . | . |
| Doubtful chickweed | 1 | Tr | . | . | . | . |
| False dandelion | 48 | 2 | . | . | . | . |
| Watson's willow-herb | 1 | Tr | . | . | . | . |
| Sheep sorrel | 20 | Tr | . | . | . | . |
| Red fescue | 5 | Tr | . | . | . | . |
| Spring-bank clover | 3 | Tr | . | . | . | . |
| Bird-foot trefoil | . | . | . | . | 10 | Tr |
| Parentucellia | 1 | Tr | . | . | . | . |
| Elegant hairgrass | 3 | Tr | . | . | . | . |
| Monkey flower | 1 | Tr | . | . | . | . |
| Seaside lotus | 3 | Tr | . | . | . | . |
| Toad rush | 3 | Tr | . | . | . | . |
| Sickle-leaved rush | 1 | Tr | . | . | . | . |
| Little hairgrass | 29 | 3 | . | . | . | . |
| Purple cudweed | 4 | Tr | . | . | . | . |
| Salt rush | 20 | 1 | . | . | . | . |
| Beach knotweed | 1 | Tr | . | . | . | . |
| Dune bentgrass | 1 | Tr | . | . | . | . |
| European centaury | 6 | Tr | . | . | . | . |
| Seaside tansy | 1 | Tr | . | . | . | . |

## Appendix 2. Summary data for transect vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| Hairy hawkbit | 3 | Tr | . | . | . | . |
| Seashore lupine | 33 | 5 | . | . | . | . |

| | FERU2 | | JUFA-JULE | | JULE | |
|---|---|---|---|---|---|---|
| | 8 Plots | | 29 Plots | | 29 Plots | |
| Environment | MEAN | S.D. | MEAN | S.D. | MEAN | S.D. |
| Microposition | 27 | 9 | 10 | 8 | 11 | 8 |
| Moss | . | . | . | . | 27 | 30 |
| Bare sand | 91 | 5 | 46 | 32 | 42 | 37 |
| Lichen | . | . | 3 | 0 | 10 | 11 |
| Litter | 2 | 1 | 11 | 11 | 16 | 14 |
| Species | CON | AVE | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | | | |
| None | | | | | | |
| SHRUBS AND WOODY GROUNDCOVER | | | | | | |
| Wax myrtle | . | . | . | . | 3 | Tr |
| Hooker willow | . | . | 69 | 6 | 3 | Tr |
| Salal | . | . | . | . | 21 | 3 |
| Evergreen huckleberry | . | . | 3 | Tr | 17 | 1 |
| Scots broom | . | . | 10 | Tr | 14 | 2 |
| HERBS, FERNS AND GRAMINOIDS | | | | | | |
| European beachgrass | . | . | 7 | Tr | 17 | 1 |
| Shore sedge | . | . | 3 | Tr | . | . |
| Pearly everlasting | . | . | 3 | Tr | 10 | Tr |
| Pacific silverweed | 13 | Tr | 7 | Tr | . | . |
| California aster | . | . | 21 | Tr | 10 | Tr |
| Coast strawberry | . | . | 14 | Tr | 45 | 1 |
| Paintbrush orthocarpus | . | . | 7 | Tr | . | . |
| Slough sedge | . | . | 17 | 1 | 7 | 1 |
| Nevada rush | . | . | 79 | 3 | 17 | Tr |
| Yarrow | . | . | . | . | 21 | Tr |
| Doubtful chickweed | . | . | . | . | 3 | Tr |
| False dandelion | . | . | 55 | 1 | 59 | 4 |
| Watson's willow-herb | . | . | 17 | Tr | 3 | Tr |
| Sheep sorrel | . | . | 7 | Tr | 52 | 1 |
| Red fescue | 100 | 7 | 7 | Tr | 10 | 1 |
| Bractless hedge-hyssop | . | . | 10 | Tr | . | . |
| Green sedge | . | . | 10 | Tr | . | . |
| Creeping buttercup | . | . | 31 | Tr | . | . |
| Golden-eyed grass | . | . | 31 | Tr | . | . |
| Bog St. Johnswort | . | . | 10 | Tr | . | . |
| Giant helleborine | . | . | 10 | Tr | . | . |
| Hooded ladies-tresses | . | . | 10 | Tr | . | . |
| Sand dune sedge | . | . | 7 | Tr | . | . |
| Spring-bank clover | . | . | 14 | Tr | 10 | Tr |
| Bird-foot trefoil | . | . | 45 | 5 | . | . |
| Parentucellia | . | . | 31 | 1 | 7 | Tr |
| Elegant hairgrass | . | . | 3 | Tr | 3 | Tr |
| Monkey flower | . | . | 10 | Tr | 7 | Tr |
| Seaside lotus | . | . | 17 | 2 | 14 | Tr |
| Toad rush | . | . | 10 | Tr | 14 | Tr |
| Procumbent pearlwort | . | . | 34 | Tr | 3 | Tr |
| Sickle-leaved rush | . | . | 83 | 3 | 14 | Tr |
| Little hairgrass | . | . | 34 | 1 | 59 | 9 |
| Purple cudweed | . | . | 34 | Tr | 28 | 1 |
| Salt rush | 13 | Tr | 83 | 2 | 86 | 12 |
| Beach knotweed | 13 | Tr | . | . | 3 | Tr |
| Dune bentgrass | 13 | Tr | 41 | 1 | 7 | Tr |

## ppendix 2. Summary data for transect vegetation plots, continued.

| | | | | | | |
|---|---|---|---|---|---|---|
| uropean centaury | . | . | 38 | Tr | 34 | 1 |
| easide tansy | . | . | 3 | Tr | . | . |
| airy hawkbit | 13 | Tr | 55 | 4 | 38 | 1 |
| eashore lupine | 25 | 1 | 34 | 7 | 48 | 1 |
| elvet grass | . | . | . | . | 3 | Tr |
| weet vernal grass | . | . | . | . | 3 | Tr |
| ix-weeks fescue | . | . | . | . | 14 | Tr |
| each silvertop | 25 | Tr | . | . | 3 | Tr |
| warf orthocarpus | . | . | . | . | 3 | Tr |
| eashore bluegrass | 38 | 1 | . | . | . | . |

| | LULI2 | | POMA26 | |
|---|---|---|---|---|
| | 54 Plots | | 20 Plots | |
| nvironment | MEAN | S.D. | MEAN | S.D. |
| icroposition | 11 | 8 | 16 | 9 |
| oss | 14 | 18 | . | . |
| are sand | 50 | 33 | 88 | 6 |
| ichen | 3 | 0 | . | . |
| itter | 14 | 19 | 3 | 2 |
| pecies | CON | AVE | CON | AVE |
| OVERSTORY TREES | | | | |
| hore pine | 4 | 1 | . | . |
| itka spruce | 2 | Tr | . | . |
| SHRUBS AND WOODY GROUNDCOVER | | | | |
| ooker willow | 4 | Tr | . | . |
| alal | 2 | Tr | . | . |
| HERBS, FERNS AND GRAMINOIDS | | | | |
| ilver hairgrass | 2 | Tr | . | . |
| uropean beachgrass | 33 | 2 | . | . |
| early everlasting | 17 | 1 | . | . |
| acific silverweed | . | . | 10 | Tr |
| alifornia aster | 7 | Tr | . | . |
| oast strawberry | 22 | 1 | . | . |
| lough sedge | 4 | Tr | . | . |
| evada rush | 15 | Tr | . | . |
| arrow | 6 | Tr | . | . |
| alse dandelion | 57 | 1 | . | . |
| heep sorrel | 11 | Tr | . | . |
| ed fescue | 35 | 2 | 10 | Tr |
| ird-foot trefoil | 11 | Tr | . | . |
| legant hairgrass | 4 | Tr | . | . |
| rocumbent pearlwort | 2 | Tr | . | . |
| ickle-leaved rush | 7 | Tr | . | . |
| ittle hairgrass | 56 | 3 | . | . |
| urple cudweed | 6 | Tr | . | . |
| alt rush | 44 | 2 | . | . |
| each knotweed | 13 | Tr | . | . |
| une bentgrass | 28 | 1 | . | . |
| uropean centaury | 22 | Tr | . | . |
| easide tansy | 6 | Tr | . | . |
| airy hawkbit | 44 | 1 | . | . |
| eashore lupine | 100 | 25 | 35 | Tr |
| each silvertop | 7 | Tr | 30 | Tr |
| warf orthocarpus | 2 | Tr | . | . |
| eashore bluegrass | 2 | Tr | 100 | 10 |

## Appendix 3. Checklist of vascular plants of the Oregon Dunes National Recreation Area.

This list was compiled by numerous contributors, especially David Danley, Katie Grenier, Sheila Logan, Dan Segotta, Shelly Smith, John Christy, and Jimmy Kagan. Nomenclature follows the PLANTS database (USDA, NRCS 1997).

| TREES | | PLANTS code |
|---|---|---|
| *Alnus rubra* | Red alder | ALRU |
| *Arbutus menziesii* | Madrone | ARME |
| *Chamaecyparis lawsoniana* | Port Orford cedar | CHLA |
| *Fraxinus latifolia* | Oregon ash | FRLA |
| *Picea sitchensis* | Sitka spruce | PISI |
| *Pinus attenuata* | Knobcone pine | PIAT |
| *Pinus contorta* | Shore pine | PICO |
| *Pinus nigra* | Black pine | PINI |
| *Pinus pinaster* | Cluster pine | PIPI6 |
| *Pinus radiata* | Monterey pine | PIRA2 |
| *Pinus sylvestris* | Scots pine | PISY |
| *Pseudotsuga menziesii* | Douglas fir | PSME |
| *Sequoia sempervirens* | Coast redwood | SESE3 |
| *Thuja plicata* | Western red cedar | THPL |
| *Tsuga heterophylla* | Western hemlock | TSHE |

| SHRUBS AND WOODY VINES | | |
|---|---|---|
| *Acer circinatum* | Vine maple | ACCI |
| *Arceuthobium* sp. | Dwarf mistletoe | ARCEU |
| *Arctostaphylos columbiana* | Hairy manzanita | ARCO3 |
| *Arctostaphylos uva-ursi* | Bearberry, kinnikinnik | ARUV |
| *Baccharis pilularis* | Chaparral broom | BAPI |
| *Crataegus douglasii* | Black hawthorn | CRDO2 |
| *Cytisus scoparius* | Scots broom | CYSC4 |
| *Cytisus striatus* | Broom | CYST7 |
| *Frangula purshiana* | Cascara | FRPU7 |
| *Garrya elliptica* | Silk tassel | GAEL |
| *Gaultheria shallon* | Salal | GASH |
| *Hedera helix* | English ivy | HEHE |
| *Holodiscus discolor* | Ocean spray | HODI |
| *Ilex aquifolium* | English holly | ILAQ80 |
| *Ledum glandulosum* | Labrador tea | LEGL |
| *Lonicera involucrata* | Black twinberry | LOIN5 |
| *Lupinus arboreus* | Tree lupine | LUAR |
| *Malus fusca* | Crabapple | MAFU |
| *Menziesia ferruginea* | Fool's huckleberry | MEFE |
| *Myrica californica* | Wax myrtle | MYCA |
| *Prunus virginiana* | Chokecherry | PRVI |
| *Rhododendron macrophyllum* | Western rhododendron | RHMA3 |
| *Ribes sanguineum* | Red flowering currant | RISA |
| *Rosa gymnocarpa* | Baldhip rose | ROGY |
| *Rubus discolor* | Himalayan blackberry | RUDI2 |
| *Rubus laciniatus* | Evergreen blackberry | RULA |
| *Rubus parviflorus* | Thimbleberry | RUPA |
| *Rubus spectabilis* | Salmonberry | RUSP |

| | | |
|---|---|---|
| *ubus ursinus* | Trailing blackberry | RUUR |
| *alix hookeriana* | Coast willow | SAHO |
| *alix scouleriana* | Scouler willow | SASC |
| *alix sitchensis* | Sitka willow | SASI2 |
| *ambucus racemosa* ssp. *pubens* var. *arborescens* | Red elderberry | SARAA |
| *piraea douglasii* | Douglas spiraea | SPDO |
| *Ilex europaeus* | Gorse | ULEU |
| *'accinium macrocarpon* | Eastern cranberry | VAMA |
| *'accinium ovatum* | Evergreen huckleberry | VAOV2 |
| *'accinium oxycoccos* | Wild cranberry | VAOX |
| *'accinium parvifolium* | Red huckleberry | VAPA |
| *'accinium uliginosum* | Bog blueberry | VAUL |

## 'ERNS AND CLUBMOSSES

| | | |
|---|---|---|
| *.thyrium filix-femina* | Lady fern | ATFI |
| *.zolla mexicana* | Mexican water-fern | AZME |
| *'lechnum spicant* | Deer fern | BLSP |
| *'otrychium multifidum* | Leathery grape-fern | BOMU |
| *'quisetum arvense* | Common horsetail | EQAR |
| *soetes nuttallii* | Nuttall's quillwort | ISNU |
| *.ycopodiella inundata* | Bog clubmoss | LYIN2 |
| *)phioglossum vulgatum* | Adders-tongue | OPVU |
| *'olypodium glycyrrhiza* | Licorice fern | POGL8 |
| *'olypodium scouleri* | Scouler's polypody | POSC4 |
| *'olystichum munitum* | Sword fern | POMU |
| *'teridium aquilinum* | Bracken fern | PTAQ |

## ;RASSES

| | | |
|---|---|---|
| *.grostis capillaris* | Colonial bentgrass | AGCA5 |
| *.grostis pallens* | Dune bentgrass | AGPA8 |
| *.grostis stolonifera* | Creeping bentgrass | AGSTS |
| *.ira caryophyllea* | Silver hairgrass | AICA |
| *.ira elegans* | Elegant hairgrass | AIEL4 |
| *.ira praecox* | Little hairgrass | AIPR |
| *.mmophila arenaria* | European beachgrass | AMAR4 |
| *.nthoxanthum odoratum* | Sweet vernal grass | ANOD |
| *'riza minor* | Little quaking-grass | BRMI2 |
| *'romus diandrus* | Ripgut brome | BRDI3 |
| *'romus hordeaceus* | Soft brome | BRHOH |
| *'alamagrostis canadensis* | Bluejoint reedgrass | CACAC10 |
| *'alamagrostis nutkaensis* | Pacific reedgrass | CANU |
| *'ynosurus echinatus* | Dogtail | CYEC |
| *)actylis glomerata* | Orchard-grass | DAGL |
| *)eschampsia cespitosa* ssp. *cespitosa* | Tufted hairgrass | DECEC |
| *)ichanthelium acuminatum* var. *fasciculatum* | Western witchgrass | DIACF |
| *)istichlis spicata* | Saltgrass | DISP |
| *'estuca rubra* | Red fescue | FERU2 |
| *'lyceria borealis* | Northern mannagrass | GLBO |
| *'lyceria elata* | Tall mannagrass | GLEL |
| *Holcus lanatus* | Velvet grass | HOLA |
| *Hordeum brachyantherum* | Meadow barley | HOBR2 |

| | | |
|---|---|---|
| *Leymus mollis* | American dunegrass | LEMOM2 |
| *Lolium arundinaceum* | Tall fescue | LOAR10 |
| *Panicum capillare* | Common witchgrass | PACA6 |
| *Paspalum distichum* | Knotgrass | PADI6 |
| *Phalaris arundinacea* | Reed canary grass | PHAR3 |
| *Poa annua* | Annual bluegrass | POAN |
| *Poa confinis* | Coastline bluegrass | POCO2 |
| *Poa trivialis* | Roughstalk bluegrass | POTR2 |
| *Poa macrantha* | Seashore bluegrass | POMA26 |
| *Poa pratensis* | Kentucky bluegrass | POPR |
| *Torreyochloa pallida* var. *pauciflora* | Alkaligrass | TOPAP3 |
| *Vulpia bromoides* | Six-weeks fescue | VUBR |

**SEDGES, SPIKERUSHES AND BULRUSHES**

| | | |
|---|---|---|
| *Bolboschoenus maritimus* | Seacoast bulrush | BOMA7 |
| *Carex aquatilis* var. *dives* | Sitka sedge | CAAQD |
| *Carex cusickii* | Cusick's sedge | CACU5 |
| *Carex exsiccata* | Inflated sedge | CAEX5 |
| *Carex lenticularis* | Shore sedge | CALE8 |
| *Carex livida* | Livid sedge | CALI |
| *Carex lyngbyei* | Lyngby sedge | CALY3 |
| *Carex macrocephala* | Large-headed sedge | CAMA10 |
| *Carex obnupta* | Slough sedge | CAOB3 |
| *Carex pansa* | Sand dune sedge | CAPA16 |
| *Carex viridula* ssp. *viridula* | Green sedge | CAVIV |
| *Dulichium arundinaceum* | Threeway sedge | DUAR3 |
| *Eleocharis acicularis* | Needle sedge | ELAC |
| *Eleocharis palustris* | Creeping spikerush | ELPA3 |
| *Schoenoplectus acutus* var. *acutus* | Hardstem bulrush | SCACA |
| *Schoenoplectus americanus* | Three-square bulrush | SCAM6 |
| *Schoeoplectus subterminalis* | Water clubrush | SCSU10 |
| *Scirpus cernuus* | Low clubrush | SCCE |
| *Scirpus microcarpus* | Small-fruited bulrush | SCMI2 |

**RUSHES AND WOODRUSHES**

| | | |
|---|---|---|
| *Juncus acuminatus* | Tapered rush | JUAC |
| *Juncus balticus* | Baltic rush | JUBA |
| *Juncus bufonius* | Toad rush | JUBU |
| *Juncus ensifolius* | Dagger-leaved rush | JUEN |
| *Juncus falcatus* | Sickle-leaved rush | JUFA |
| *Juncus lesueurii* | Salt rush | JULE |
| *Juncus nevadensis* | Nevada rush | JUNE |
| *Luzula campestris* | Field woodrush | LUCA2 |
| *Luzula parviflora* | Small-flowered woodrush | LUPA4 |

**HERBS**

| | | |
|---|---|---|
| *Abronia latifolia* | Yellow sandverbena | ABLA2 |
| *Abronia umbellata* ssp. *breviflora* | Pink sandverbena | ABUMB |
| *Achillea millefolium* | Yarrow | ACMI2 |

## ppendix 3. Checklist of vascular plants, continued.

| | | |
|---|---|---|
| *lotropa virgata* | Candystick | ALVI2 |
| *nbrosia chamissonis* | Silver burweed | AMCH4 |
| *iagallis minima* | Chaffweed | ANMI4 |
| *iaphalis margaritacea* | Pearly everlasting | ANMA |
| *igelica lucida* | Sea watch | ANLU |
| *ithemis cotula* | Mayweed chamomile | ANCO2 |
| *uilegia formosa* | Red columbine | AQFO |
| *gentina egedii* | Pacific silverweed | AREGE |
| *ter chilensis* | California aster | ASCH2 |
| *riplex patula* | Shadscale | ATPA4 |
| *rbarea orthoceras* | American wintercress | BAOR |
| *dens cernua* | Nodding beggars-tick | BICE |
| *asenia schreberi* | Water-shield | BRSC |
| *schniakia hookeri* | Ground-cone | BOHO |
| *kile edentula* | American searocket | CAED |
| *kile maritima* | European searocket | CAMA |
| *llitriche heterophylla* | Different-leaved water-starwort | CAHE3 |
| *llitriche stagnalis* | Pond water-starwort | CAST |
| *missonia contorta* | Beach evening-primrose | CACO34 |
| *rdionema ramosissimum* | Sand mat | CARA3 |
| *stilleja ambigua* ssp. *ambigua* | Paintbrush orthocarpus | CAAMA3 |
| *ntaurium erythraea* | European centaury | CEER5 |
| *rastium arvense* | Field chickweed | CEAR4 |
| *rastium dubium* | Doubtful chickweed | CEDU2 |
| *rastium glomeratum* | Sticky chickweed | CEGL2 |
| *cuta douglasii* | Western water-hemlock | CIDO |
| *rsium arvense* | Canada thistle | CIAR4 |
| *aytonia sibirica* var. *sibirica* | Candyflower | CLSIS |
| *aytonia spathulata* | Pale montia | CLSP10 |
| *marum palustre* | Marsh cinquefoil | COPA28 |
| *nium maculatum* | Poison hemlock | COMAP |
| *rdylanthus maritimus* ssp. *palustris* | Salt-marsh bird's-beak | COMA |
| *tula coronopifolia* | Brass buttons | COCO7 |
| *scuta salina* | Salt-marsh dodder | CUSA |
| *ucus carota* | Wild carrot | DACA6 |
| *isporum smithii* | Fairy lantern | DISM2 |
| *rosera rotundifolia* | Round-leaved sundew | DRRO |
| *eria densa* | South American waterweed | EGDE |
| *ilobium angustifolium* | Fireweed | EPAN2 |
| *ilobium ciliatum* ssp. *watsonii* | Watson's willow-herb | EPCIW |
| *ipactis gigantea* | Giant helleborine | EPGI |
| *igeron glaucus* | Seaside daisy | ERGL3 |
| *echtites glomerata* | Cut-leaved Australian fireweed | ERGL8 |
| *echtites minima* | Toothed Australian fireweed | ERMI6 |
| *agaria chiloensis* | Coast strawberry | FRCH |
| *alium boreale* | Northern bedstraw | GABO2 |
| *alium trifidum* | Swamp bedstraw | GATR2 |
| *amochaeta purpurea* | Purple cudweed | GAPU3 |
| *entiana sceptrum* | Kings gentian | GESC |
| *laux maritima* | Sea milkwort | GLMA |
| *lehnia littoralis* ssp. *leiocarpa* | Beach silver-top | GLLIL |
| *naphalium palustre* | Lowland cudweed | GNPA |
| *oodyera oblongifolia* | Western rattlesnake-plantain | GOOB2 |
| *ratiola ebracteata* | Bractless hedge-hyssop | GREB |
| *rindelia stricta* var. *stricta* | Gumweed | GRSTS2 |

## Appendix 3. Checklist of vascular plants, continued.

| | | |
|---|---|---|
| *Hemitomes congestum* | Gnome-plant | HECO6 |
| *Hieracium albiflorum* | White-flowered hawkweed | HIAL2 |
| *Hippuris vulgaris* | Common mare's-tail | HIVU2 |
| *Honckenya peploides* | Sea purslane | HOPE |
| *Hydrocotyle ranunculoides* | Floating water-pennywort | HYRA |
| *Hydrocotyle verticillata* | Whorled water-pennywort | HYVE2 |
| *Hypericum anagalloides* | Bog St. Johnswort | HYAN2 |
| *Hypochaeris radicata* | False dandelion | HYRA3 |
| *Iris pseudacorus* | Yellow iris | IRPS |
| *Iris tenax* | Oregon iris | IRTE |
| *Jaumea carnosa* | Fleshy jaumea | JACA4 |
| *Lathyrus japonicus* | Sea pea | LAJA |
| *Lathyrus littoralis* | Beach pea | LALI2 |
| *Lemna minor* | Duckweed | LEMI3 |
| *Leontodon hirtus* | Hairy hawkbit | LEHI4 |
| *Leucanthemum vulgare* | Oxe-eye daisy | LEVU |
| *Lilaeopsis occidentalis* | Lilaeopsis | LIOC |
| *Lotus corniculatus* | Bird-foot trefoil | LOCO6 |
| *Lotus formosissimus* | Seaside lotus | LOFO2 |
| *Ludwigia palustris* | Water purslane | LUPA |
| *Lupinus littoralis* | Seashore lupine | LULI2 |
| *Lupinus rivularis* | Streambank lupine | LURI |
| *Lycopus americanus* | Bugleweed | LYAM |
| *Lysichiton americanum* | Skunk cabbage | LYAM3 |
| *Lythrum salicaria* | Purple loosestrife | LYSA2 |
| *Maianthemum dilatatum* | False lily-of-the-valley | MADI |
| *Melilotus alba* | White sweet-clover | MEAL12 |
| *Mentha arvensis* | Field mint | MEAR4 |
| *Mentha pulegium* | Pennyroyal | MEPU |
| *Menyanthes trifoliata* | Bog buckbean | METR3 |
| *Mimulus guttatus* | Monkey flower | MIGU |
| *Mitella ovalis* | Oval-leaved mitrewort | MIOV |
| *Monotropa hypopithys* | Pinesap | MOHY3 |
| *Monotropa uniflora* | Indian pipe | MOUN3 |
| *Myriophyllum aquaticum* | Parrot-feather | MYAQ2 |
| *Myriophyllum hippuroides* | Western water-milfoil | MYHI |
| *Najas flexilis* | Wavy water-nymph | NAFL |
| *Nuphar lutea* ssp. *polysepala* | Pond lily | NULUP |
| *Nymphaea odorata* | American water-lily | NYOD |
| *Oenanthe sarmentosa* | Water-parsley | OESA |
| *Parentucellia viscosa* | Parentucellia | PAVI3 |
| *Plantago australis* ssp. *hirtella* | Mexican plantain | PLAUH |
| *Plantago lanceolata* | English plantain | PLLA |
| *Plantago major* | Common plantain | PLMA2 |
| *Plantago maritima* | Seaside plantain | PLMA3 |
| *Polygonum amphibium* | Water smartweed | POAM8 |
| *Polygonum hydropiperoides* | Waterpepper | POHY2 |
| *Polygonum paronychia* | Beach knotweed | POPA7 |
| *Potamogeton natans* | Floating-leaved pondweed | PONA4 |
| *Prunella vulgaris* | Heal-all | PRVU |
| *Pseudognaphalium stramineum* | Cotton-batting plant | PSST7 |
| *Pterospora andromedea* | Pinedrops | PTAN2 |
| *Pyrola asarifolia* | Pyrola | PYAS |
| *Ranunculus flammula* | Creeping buttercup | RAFL2 |
| *Ranunculus repens* | Creeping buttercup | RARE3 |

## ppendix 3. Checklist of vascular plants, continued.

| | | |
|---|---|---|
| *anunculus uncinatus* var. *parviflorus* | Little buttercup | RAUNP |
| *umex acetosella* | Sheep sorrel | RUAC3 |
| *umex crispus* | Curly dock | RUCR |
| *umex maritimus* | Seaside dock | RUMA4 |
| *uppia maritima* | Ditch-grass | RUMA5 |
| *ugina procumbens* | Procumbent pearlwort | SAPR |
| *ulicornia virginica* | Pickleweed | SAVI |
| *enecio jacobea* | Tansy ragwort | SEJA |
| *enecio sylvaticus* | Woodland groundsel | SESY |
| *enecio vulgaris* | Common groundsel | SEVU |
| *syrinchium angustifolium* | Blue-eyed grass | SIAN3 |
| *syrinchium californicum* | Golden-eyed grass | SICA8 |
| *um suave* | Hemlock water-parsnip | SISU2 |
| *olanum dulcamara* | Bittersweet nightshade | SODU |
| *olidago simplex* ssp. *simplex* var. *spathulata* | Sticky goldenrod | SOSIS4 |
| *onchus arvensis* | Perennial sow-thistle | SOAR2 |
| *parganium angustifolium* | Simplestem bur-reed | SPAN2 |
| *pergularia salina* var. *sali*na | Saltmarsh sandspurry | SPSAS |
| *piranthes romanzoffiana* | Hooded ladies-tresses | SPRO |
| *pirodela polyrhiza* | Great duckweed | SPPO8 |
| *tellaria* sp. | Chickweed | STELL |
| *anacetum camphoratum* | Seaside tansy | TACA2 |
| *rifolium microcephalum* | Small-head clover | TRMI4 |
| *rifolium wormskjoldii* | Spring-bank clover | TRWO2 |
| *riglochin concinnum* | Graceful arrowgrass | TRCO4 |
| *riglochin maritimum* | Seaside arrowgrass | TRMA4 |
| *riglochin striatum* | Three-ribbed arrowgrass | TRST6 |
| *rillium ovatum* | Western trillium | TROV2 |
| *riphysaria pusilla* | Dwarf orhocarpus | TRPU16 |
| *ypha latifolia* | Common cattail | TYLA |
| *tricularia gibba* | Humped bladderwort | UTGI |
| *tricularia macrorhiza* | Common bladderwort | UTMA |
| *tricularia minor* | Lesser bladderwort | UTMI |
| *eronica scutellata* | Marsh speedwell | VESC2 |
| *icia americana* | American vetch | VIAM |
| *icia nigricans* ssp. *gigantea* | Giant vetch | VINIG |
| *iola adunca* | Early blue violet | VIAD |
| *iola palustris* | Marsh violet | VIPA4 |
| *iola sempervirens* | Evergreen violet | VISE3 |
| *ostera japonica* | Dwarf eel-grass | ZOJA2 |

# INDEX TO PLANT ASSOCIATIONS



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