

Rare Plant Associations, Oregon Dunes National Recreation Area, Sutton Recreation Area, and Heceta Sand Dunes ACEC/ONA

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Summary

Nine of the ten rare plant associations identified in the dunes in 1993 are recommended for continued inclusion in conservation planning. Large-patch associations are currently in good condition, but small-patch associations are being infilled by a combination of plant succession and invasive species. Repeat photography using aerial and ground-based imagery is recommended as a way to gauge the rate of change in dune communities. Prescribed fire is recommended to monitor rejuvenation effects on two shore pine woodland associations that are most at risk of infilling. Vegetation mapping based on remote sensing will enable more accurate assessment of vegetation features, and facilitate modeling of management scenarios and effects of sea level rise, earthquakes, and tsunamis.

Background

In 2011, USFS requested the services of Portland State University's Oregon Biodiversity Information Center (ORBIC) to update its assessment of rare plant associations that occur on coastal sand dunes. The study area in this report includes dune habitats on the Siuslaw National Forest's Oregon Dunes National Recreation Area (NRA), the Sutton Recreation Area (RA) north of Florence, and BLM's Heceta Dunes Area of Critical Environmental Concern/ Outstanding Natural Area (ACEC/ONA) adjacent to the Sutton unit. The report focuses on plant associations occurring on sand dunes and does not include rare plant or animal habitat issues.

Methods

Knowledge of locations for rare plant associations in the study area dates from the author's field experience as botanist for the Eugene BLM District in 1978-1979, and field work done for USFS and BLM between 1991 and 2012. The most comprehensive field work was done in 1993, when ORBIC sampled vegetation intensively throughout the NRA. This report is based on compilations from field work done between 1993 and 2012, including Christy (1994), Christy et al. (1998), and Christy (1999, 2000, 2006).

Mapping. An early GIS vegetation map for the NRA, based on Sheila Logan's field work of 1987, was too coarse for use in our 1993 field work, or for use in this report. In 1993, ORBIC did

not create digital maps of rare plant associations, but we mapped on paper the largest and highest-quality sites. A number of smaller occurrences were photographed but not mapped, so we are unsure of their exact locations, or if they still exist. However, we are confident that the largest and best-quality sites were captured in the current GIS mapping.

The GIS dataset used for this report was created using historical imagery from Google Earth, information from the 1993 field work (paper mapping, plot locations, field notes), and mapping from Christy (1999, 2000). Mapping was updated using NAIP imagery from 2005-2011, and field observations in 2012. Because property boundaries are not always easy to detect in the dunes, plots sampled inadvertently on lands other than USFS or BLM ownership were not included here, nor were associations developed in old plantations.

Limitations of the GIS dataset. The extent and distribution of rare plant associations in the GIS dataset must be used as an estimate only. It is restricted to occurrences observed between 1993 and 2012, and in its current form no doubt underestimates the actual extent of these plant associations. Challenges include (1) absence of current, comprehensive vegetation mapping for the NRA, (2) absence of mapping for larger stands sampled during reconnaissance work of 1993, (3) difficulty in differentiating admixtures of vegetation in aerial imagery (e.g., shore pine / bearberry vs. shore pine / hairy manzanita associations in uplands, and shore pine / slough sedge vs. Sitka spruce - shore pine / salal - evergreen huckleberry on deflation plain). A limited amount of speculative interpretation from NAIP imagery was required to delineate some stands, but extensive speculative mapping from imagery was avoided, and is not recommended without an accurate vegetation map for the study area.

Rare Plant Associations

Rare plant associations in the study area were first identified during field work in 1993, and reported in planning documents for the NRA (Christy 1994). At the time, ten rare associations were identified (Table 1). These are described in more detail in Appendix A and in Christy et al. (1998). Their current condition is described in the following section. Global ranks for two associations (red fescue, seashore bluegrass) were updated to G3, based on documented occurrences on Vancouver Island, British Columbia (Page 2003).

Table 1. Rare plant associations on coastal sand dunes on the Oregon Dunes NRA, Sutton RA, and Heceta ACEC/ONA, ordered by ORBIC global and state conservation ranks.	
Association	Rank
Port Orford cedar / evergreen huckleberry	G1S1
Shore pine / bearberry	G1S1
Shore pine / hairy manzanita	G1S1
Shore pine / slough sedge	G2S1
Bog blueberry / slough sedge	G2S2
Bog blueberry / tufted hairgrass - slough sedge	G2S2

Red fescue	G3S1
Seashore bluegrass	G3S1
Sitka spruce / slough sedge - skunk cabbage	G3S1
Red fescue - bracken fern	G3S3

ORBIC participates in an international system for ranking rare, threatened and endangered species and plant associations throughout the world. Ranks range from 1-5, based primarily on the number of known occurrences, but also assessing threats, sensitivity, area occupied, and other biological factors. "G" is the Global Rank, and "S" is the State ("Subnational") Rank. Details of the methodology are available on the [NatureServe Explorer](#).

- 1= Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences.
- 2 = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction or extirpation, typically with 6-20 occurrences.
- 3 = Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences.
- 4 = Not rare and apparently secure, but with cause for long-term concern, usually with more than 100 occurrences.
- 5 = Demonstrably widespread, abundant, and secure.

Rare plant associations are those with global ranks of G1 or G2, and state ranks of S1 or S2. Recently, federal agencies have begun to include species with ranks of S3 in their conservation planning, but there has been less interest in tracking rare plant associations, primarily because agency programs have tended to focus on species or suites of species instead of habitats.

Management Issues

Off-highway vehicle (OHV) use, invasive species and pathogens, plant succession, and lack of most landscape-scale disturbance processes on coastal dunes are the primary management issues that influence conservation and viability of rare habitats in the dunes (Christy et al. 1998).

OHV use. Recreational OHV use remains strong in parts of the study area where it is a permitted activity in designated management areas. Some sites appear to have increased OHV use since our 1993 field work, evidenced by proliferation of trails and extension of trails into formerly unroaded areas, including tree islands in the dune sheet. In areas closed to OHV use since 2006, vegetation is beginning to recover (Figures 1-4). Repeat photography in the Sutton RA-Heceta ACEC/ONA area indicates that some recovery of the fragile *Arctostaphylos* plant associations has occurred, at least locally. Although the 2012 photos were taken two months after the peak recreation season, and needle fall during that period may have created the illusion of reduced trail wear, the tracks were clearly narrower, and trailside mats of *Arctostaphylos uva-ursi* had expanded, sometimes extending into the tracks where none occurred in 2006.

Invasive species and pathogens. Port Orford cedar root disease, European beachgrass, and Scots broom are the primary problem species affecting rare plant associations in the study area (Table 2). Gorse is a potential problem species, and eastern cranberry has had a minor affect on one plant association.

Table 2. Primary invasive species or pathogens affecting rare plant associations on coastal sand dunes on the Oregon Dunes NRA, Sutton RA, and Heceta ACEC/ONA.	
Association	Species or pathogen
Bog blueberry / slough sedge	Eastern cranberry
Bog blueberry / tufted hairgrass - slough sedge	None at present
Port Orford cedar / evergreen huckleberry	Port Orford cedar root disease
Red fescue	European beachgrass
Red fescue - bracken fern	European beachgrass
Seashore bluegrass	European beachgrass
Shore pine / bearberry	Scots broom, gorse
Shore pine / hairy manzanita	Scots broom, gorse
Shore pine / slough sedge	None at present
Sitka spruce / slough sedge - skunk cabbage	None at present

1. Eastern cranberry, an escape from cultivation, can form monotypic stands in shallow lakes and ponds on the dune sheet. Among the ten plant associations considered here, it is limited to the bog blueberry / slough sedge association that occurs on deflation plain at the south end of the NRA. In this area, it is widespread in the herb layer, but does not seem to interfere with the major native species.

2. Port Orford cedar root disease (*Phytophthora lateralis*) is present and spreading at the south end of the study area, where the few known stands of the Port Orford cedar / evergreen huckleberry association exist.

3. European beachgrass invades the red fescue and seashore bluegrass associations, and works in concert with encroaching shrubs and trees to alter wind patterns that diminish sand deposition.

4. Scots broom occurs in open dune habitats throughout the study area. It was planted in early stabilization efforts, and has since dispersed by prolific seeding. It is common in sites dominated by European beachgrass and shore pine, and is also the primary invader of the shore pine / bearberry and shore pine / hairy manzanita plant associations (Figure 8).

5. Gorse is scarce in the study area, and both USFS and BLM have been effective at control measures. However, gorse remains a serious threat. It has the capacity to form extensive monotypic stands such as the one that occurred at the north end of the Sutton RA, before being greatly reduced by a fire in the late 1990's. Stands in the dune sheet on the southern Oregon coast, including Bandon State Park, have become so extensive as to be unmanageable.

Plant succession. Plant succession is a natural process on the dunes, and works in concert with sand movement and invasive species such as European beachgrass and Scots broom to change the composition and structure of plant associations over time. Putative successional patterns on the dunes were illustrated in Christy et al. (1998). Succession in the study area is ongoing and can be observed in most open habitats when comparing historical and current imagery (Figures 5, 6, 7, 9, 10). Of the ten rare plant associations, eight are early seral communities that can be affected by plant succession over periods as short as 10 years.

Landscape-scale disturbance processes. Landscape disturbance processes in the study area include ongoing or periodic events. Wind, salt spray, sea level rise, and human activities are ongoing processes. Fire, tsunamis, and earthquakes are periodic. These factors affect sand movement and formation of vegetation in the dunes. Among these processes, managers can only influence human activity and fire. Over the last century, fire suppression and introduction of European beachgrass and Scots broom have had a pervasive effect on stabilizing dune vegetation. In contrast, OHV activity has suppressed vegetation in some areas of the dunes, counterbalancing to a small degree the effects of stabilization. Removal of European beachgrass and portions of foredune in the Overlook area of the NRA, as well as in snowy plover habitat in the Bandon dunes, has also helped reverse stabilization at a local scale. However, no management strategies have had resounding success, particularly at a landscape scale. Another human activity, groundwater removal, may have potential impacts on deflation plain wetlands, particularly at the south end of the NRA.

Current Condition of Rare Plant Associations

Current conditions for the ten rare plant associations identified in Table 1 are described below, in alphabetical order. For more detailed descriptions of the associations, see Appendix A in this report, and Christy et al. (1998). Acreage figures in Table 3 were derived from the GIS dataset accompanying this report, with limitations as explained in the methods section.

Table 3. Acreage of rare plant associations on coastal sand dunes on the Oregon Dunes NRA, Sutton RA, and Heceta ACEC/ONA, based on NAIP imagery from 2005-2011. Ordered by acreage.	
Association	Acres
Shore pine / slough sedge	281
Red fescue	170
Shore pine / bearberry	111
Port Orford cedar / evergreen huckleberry	90
Shore pine / hairy manzanita	70
Seashore bluegrass	60
Sitka spruce / slough sedge - skunk cabbage	27
Bog blueberry / slough sedge	27

Red fescue - bracken fern	4
Bog blueberry / tufted hairgrass - slough sedge	3

1. Bog blueberry / slough sedge (G2S2, 27 acres)

This association, occurring south of the Horsfall Beach parking area, remains in good condition, although infill by Hooker willow, salal, and evergreen huckleberry continues through normal successional patterns. OHV activity is present but largely confined to trails. Invasive eastern cranberry (*Vaccinium macrocarpon*) has infiltrated much of the stand, but is not considered a threat because it does not appear to outcompete the primary native components. Hooker willow, shore pine, and Sitka spruce have increased cover to some extent as plant succession proceeds on the deflation plain. A smaller occurrence of this association was noted but not mapped in 1993 along lower Tenmile Creek west of Spinreel Campground. The site was not revisited in 2012, so its current condition is unknown.

2. Bog blueberry / tufted hairgrass - slough sedge (G2S2, 3 acres)

This association has the lowest acreage of any of the rare plant associations in the study area. Stands on the Sutton RA remain in good condition, but others near Beale and Threemile Lakes were not visited, so their current condition is unknown. It is a small-patch sized community adapted to a particular hydroperiod, and as such is difficult to manage for. All occurrences potentially are threatened by groundwater withdrawal, which may disrupt hydroperiod and enable upland plants to invade.

3. Port Orford cedar / evergreen huckleberry (G1S1, 90 acres)

Most of the known stands of this association at the south end of the NRA appear to be in good condition, except for previous damage from construction of the Trans-Pacific Parkway and adjacent industrial development on the North Spit. A number of trees on the North Spit have died from Port Orford cedar root disease, particularly along the railroad between the Trans-Pacific Parkway and Hauser. Control of the disease on the dunes is problematic because of the proximity of popular OHV staging areas in the Horsfall area, the Trans-Pacific Parkway, Highway 101, and rail lines. Closure of the area south of Horsfall Road to OHV use has not been entirely successful, and sanitation of OHVs to prevent the spread of *Phytophthora* spores is not being done. It is likely that eventually the disease will decimate these stands.

4. Red fescue (G3S1, 170 acres)

Since 1993, smaller stands of the red fescue association located near active dune movement, as well as those surrounded by shore pine on stabilized dunes, have been invaded by European beachgrass and shore pine, and some occurrences have ceased to be viable (Figures 5-7). This confirms earlier an supposition that stands of red fescue in the middle of the dune sheet, or in small-patch areas surrounded by woody vegetation, are more dynamic and shorter-lived than larger stands that occur in blowout troughs along the eastern edge of the dune sheet, where there

appears to be less disturbance. Stands in the latter position have fared better, and look much the same as they did in 1993 (Figures 9, 10).

5. Red fescue - bracken fern (G3S3, 4 acres)

Four occurrences of this association were mapped between 1993 and 2000, but none were revisited in 2012, so their current condition is unknown. It is a small-patch community that probably does not warrant further consideration in conservation planning because it is not a well-represented or well-characterized vegetation type. It would be better to treat it as a phase of the red fescue association that has been infiltrated by bracken clones. Though easily recognized in the field, we see no need to maintain it as a separate entity in the vegetation classification.

6. Seashore bluegrass (G3S1, 60 acres)

The largest stand of seashore bluegrass in the study area, located in the Sutton RA, remains in excellent condition and looks much as it did in 1999. The area was open to OHV traffic in 1999, but is now closed. Smaller occurrences were noted but not mapped in 1993 just west and north of Eel Creek Campground, and south of Hauser. These were not visited in 2012 and their condition is unknown. Stands east of the Heceta ACEC, last seen in 2006, were also not visited. This association is very difficult to map using NAIP imagery alone, and is mappable only when known occurrences can be distinguished from other features in the imagery.

7. Shore pine / bearberry (G1S1, 111 acres)

Some stands of this type had improved since 2006 with closure to OHV use, while others looked worse than in 1993 because of ongoing invasion by Scots broom. Broom is the primary invasive species occurring in this association, where it infiltrates open sites and shades out early seral formations of native plants, as well as altering soil chemistry by nitrogen fixation (Figure 8). Broom was present in 1993 also, but seems to have increased since then. Repeat photography would be the only reliable way of gauging its rate of change. In the GIS dataset, this association was difficult to differentiate from the shore pine / hairy manzanita association, so acreage figures are probably quite inaccurate. Remote sensing may be the best way to map stands of this type.

8. Shore pine / hairy manzanita (G1S1, 70 acres)

Stands of this association in the Sutton RA and around Eel Creek Campground looked about the same as they did in 1993 and 1999, but extensive stands elsewhere in the interior of the NRA were not revisited. In general, stands are prone to infilling by shore pine and Douglas fir, which has probably occurred, but we have no direct evidence to document change. Repeat photography would be the only reliable way of gauging its rate of change. In NAIP imagery, this association is difficult to differentiate from the shore pine / bearberry association, so acreage figures from the GIS dataset are not very accurate. Remote sensing may be the best way to map stands of this type.

9. Shore pine / slough sedge (G2S1, 281 acres).

This association, though unique, is fairly common in the study area and remains in excellent condition. It also occurs on the Bandon dune sheet. It develops on old deflation plain, and would be expected to increase with time as more deflation plain becomes vegetated. However, as young stands develop, older stands are replaced by the common and widespread Sitka spruce - shore pine / salal - evergreen huckleberry association. In NAIP imagery, this association is difficult to differentiate from the Sitka spruce - shore pine / salal - evergreen huckleberry association, so acreage figures from the GIS dataset are not very accurate. In 1993, smaller occurrences were noted but not mapped and along lower Tenmile Creek west of Spinreel Campground.

10. Sitka spruce / slough sedge - skunk cabbage (G3S1, 27 acres)

Remnant stands on USFS ownership north and south of Baker Beach Road, just south of Lily Lake near the north end of the Sutton RA, remain in good condition. Another occurrence in a 200-year-old stand of spruce along the Siltcoos River was not revisited, and its current condition is unknown. In 1991, smaller occurrences were noted but not mapped along the Threemile Lake Trail. This association is uncommon in the study area because of the lack of wet bottomlands and floodplains. Although young stands are not infrequent elsewhere on the coast, older stands are of conservation concern and are the focal age class on the dunes.

Summary and Recommendations

1. Infilling of vegetation. Plant succession and invasion by Scots broom and European beachgrass appear to be the major processes affecting rare plant associations on the dunes today. We do not have a handle on how quickly plant succession is occurring in these habitats. Page et al. (2011) estimated an overall loss of sparsely-vegetated dune communities in British Columbia from 10-90 percent, while figures for areas comparable to the NRA ranged from 20-60 percent, since 1930.

In general, large-patch plant associations on the dunes seem to be holding their own, but some small-patch associations have been infilled since 1993 by shore pine, Scots broom, and European beachgrass. This is part of normal plant succession, abetted by invasive species. Impacts from OHV use appeared to be minimal in the associations observed in 2012, and vegetation appears to be recovering from previous impacts in areas now closed to OHV use.

Reduced sand supply, though of issue in other dune habitats, does not appear to affect the ten plant associations under consideration here. Removal of European beachgrass and portions of foredune (e.g., Overlook area of the NRA, snowy plover habitat at Bandon dunes, Lee et al. 2010) has helped reverse stabilization at a local scale, but not with resounding success or influence at a landscape scale. While important for dune communities near the beach, this kind of restoration work has been too remote to have had an observable effect on the rare plant associations included in this report.

Large-scale burns may be the only effective way to reverse succession in the shore pine / bearberry association and shore pine / hairy manzanita association, which are the habitats most at risk from plant succession.

Recommendation 1: As done by Page et al. (2011), I recommend using repeat photography to identify the rate and agents of change in these communities, using historical aerial photography for selected areas, as well as repeat of ground-based photography.

Recommendation 2: Conduct a prescribed burn on a test plot of 25-50 acres, with long-term monitoring and management (e.g., removal of Scots broom recruitment), preferably isolated in the central part of the dune sheet, would be the best way to examine the effectiveness of a prescribed burn.

2. Vegetation mapping. We will not be able to refine acreage figures and assess the true extent of these rare plant associations without better vegetation mapping of the study area.

Recommendation: A cost-effective solution would be to map the area using remote sensing techniques with high-resolution NAIP imagery and Lidar, which was beyond the scope of this project. This would also enable modeling of vegetation change under different management regimes, and potential changes caused by sea level rise, earthquakes, and tsunamis.

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Figure 1. Ongoing use of OHV trails despite posted closure, Heceta Sand Dunes ACEC/ONA, August 2006. Two of three BLM boundary signs were knocked down.



Figure 2. Same site as Figure 1, October 2012. One BLM boundary sign remains.



Figure 3. Edge of OHV trail, Heceta Sand Dunes ACEC/ONA, August 2006.



Figure 4. Same site as Figure 3, October 2012. Width of trail has diminished since 2006.



Figure 5. Stand of red fescue association among shore pines, 0.5 mi N of Carter Lake, 1994.

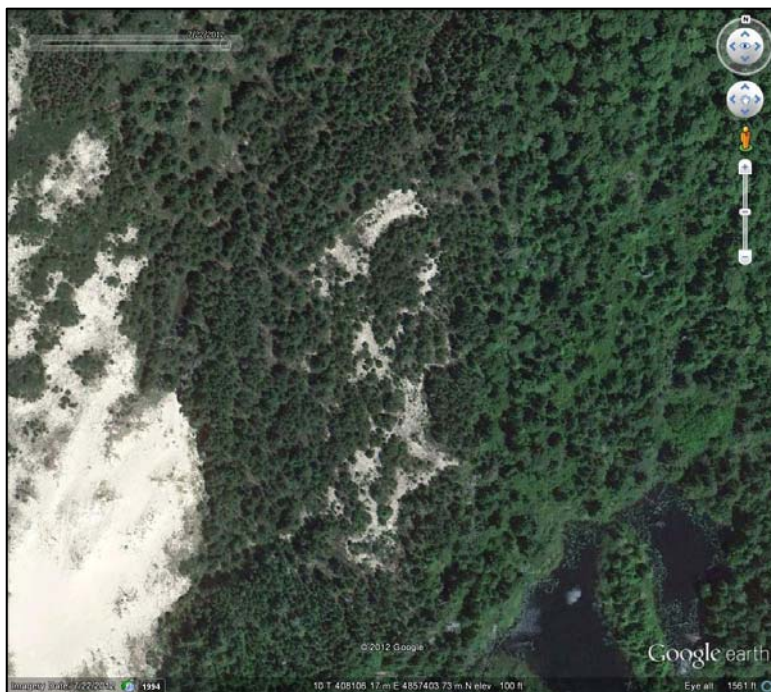


Figure 6. Same site as Figure 5, showing closure of stand and exclusion of red fescue by encroaching European beachgrass, shrubs, and shore pine.



Figure 7. Former high-quality stand of red fescue observed in 1993, being overrun by European beachgrass and shore pine, Eel Creek area, October 2012.



Figure 8. Infilling of shore pine / bearberry association by Scots broom, Eel Creek area, October 2012.



Figure 9. Red fescue association south of Eel Creek Campground, June 1993.



Figure 10. Same site as Figure 8, October 2012.

APPENDIX A. Descriptions of globally rare plant associations

The following descriptions of the ten rare plant associations were excerpted from Christy et al. (1998), with some edits and additions. See that work for additional details, photos, references, and stand tables showing frequency and percent cover of dominant species.

1. Bog blueberry / slough sedge

NVCS: *Vaccinium uliginosum* / *Carex obnupta*
ORBIC rank: G2S2

Environment. This wetland association occurs primarily on deflation plains. Stands are seasonally flooded 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.

Vegetation and ecology. This association occupies sites similar to those of the Hooker willow / slough sedge - Pacific silverweed association. It is dominated by bog blueberry and 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 - brown-headed 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 NRA, 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 NRA 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.

2. Bog blueberry / tufted hairgrass - slough sedge

Vaccinium uliginosum / *Deschampsia caespitosa* - *Carex obnupta*

ORBIC rank: G2S2

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 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 NRA 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 NRA 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 NRA, 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.

3. Port Orford cedar / evergreen huckleberry

Chamaecyparis lawsoniana / *Vaccinium ovatum*

ORBIC rank: G1S1

Environment. This unique association occurs on narrow, dry stabilized dune ridges, troughs and seasonally dry deflation plains at the southern end of the NRA, where less than 200 acres have been identified. All aspects and slopes are represented. Soils are poorly to moderately developed, from 4 to 12 inches deep.

Vegetation and ecology. Stands are dominated by a mixture of Port Orford cedar, Douglas fir and Sitka spruce. Cover of overstory trees varies from 20-90 percent, with an average of 64 percent. In this layer, Port Orford cedar is most abundant at 15-80 percent cover. Tree age varies from 150-350 years old, with diameters 12-30 inches. Live basal area for this association is the second largest recorded on the NRA, averaging 146 ft² per acre. Large, horizontal branches with Scouler's polypody create good nesting structure for marbled murrelets. Many large Port Orford cedars have charred bark, and ages of fire-sensitive trees present suggest that stands were last burned about 80-100 years ago. Port Orford cedar reproduction occurs mostly at the edges of stands, where there is much edge effect. Shore pine occurs at the edges of the stands but is senescent in the interior. The shrub layer, dominated by evergreen huckleberry, has 60-95 percent cover, averaging 82 percent cover. Shrub height averages 9 feet. Because of dense shading, the herb layer is depauperate. Moss cover averages 27 percent, with *Eurhynchium oregonum*, *Isotheceium myosuroides* and *Dicranum fuscescens* being the most common species. Lichens are scarce except for a few *Usnea* and *Lepraria* on the trees.

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. 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, and old-growth stands on sand dunes are exceedingly rare. On the NRA and in USFS ownership in Sections 32 and 33 just south of the NRA boundary, six old-growth stands are known, five between the Trans-Pacific Parkway and Horsfall Road, and one east of Beale Lake.

Management. Port Orford cedar is being decimated throughout its limited range by Port Orford cedar root disease (*Phytophthora lateralis*). The pathogen 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 *Phytophthora* 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 disease. 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 disease.

4. Red fescue

Festuca rubra

ORBIC rank: G3S1

Environment. The red fescue association once dominated well-drained, semi-stabilized dunes inland from deflation plains. The best remaining examples occur on partially-stabilized parabola dunes and slopes along the eastern edge of the dune sheet, adjacent to forest stands, where sites are somewhat sheltered from winds. All aspects and microtopography are represented.

Vegetation and ecology. The taxonomy of red fescue on coastal dunes is complex and remains unresolved, the plants variously having been called *Festuca rubra* var. *littoralis*, *Festuca rubra* ssp. *pruinosa*, and *Festuca ammobia*. Stands are typically species-poor, with individual fescue plants often spaced 1-4 feet apart. Bare sand varies from 20-90 percent, graminoid cover from 10-35 percent and herb cover from 1-30 percent. Beach knotweed and beach silvertop are conspicuous associates. On stable sites where other species have not invaded, red fescue can occasionally form a turf with seashore lupine codominant. Red fescue persists only on relatively inactive sand. Stands in most locations have been destroyed by recreational traffic, particularly off-road vehicles, while others have been overrun by European beachgrass.

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

Distribution and history. This association originally ranged along the coast from northern California to British Columbia. It is in decline throughout the region because of recreational traffic and invasion by European beachgrass. The species was used to a limited extent in stabilization plantings. Some of the best remaining sites on the NRA 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 NRA, and need protection. On dunes in northern California, the red fescue association has been identified 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.

5. Red fescue - bracken fern

NVCS: *Festuca rubra* var. *arenicola* - *Pteridium aquilinum*

ORBIC rank: G3S3

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 NRA, 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.

6. Seashore bluegrass

Poa macrantha (= *Poa douglasii* ssp. *macrantha*)

ORBIC rank: G3S1

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

Vegetation and ecology. *Poa macrantha* has also been called *Poa douglasii* ssp. *macrantha*. Stands are typically sparse and species-poor, with 80-98 percent bare sand. Red fescue, seashore lupine, beach knotweed and beach silvertop are frequent associates. Seashore bluegrass is adapted to moderate rates of sand burial, but cannot survive extensive sand movement. Stands in most locations have been overrun by European beachgrass.

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

Distribution and history. This association originally occurred along the coast between northern California and British Columbia. It is in decline throughout the region because of the widespread invasion of European beachgrass. Today, natural stands of this association are one of the rarest on the NRA, and need protection. One of the few remaining sites can be seen north of Eel Creek Campground.

Management. Stands tolerate dispersed foot traffic, but are intolerant of off-road vehicle traffic. Management should include protection and monitoring of the best remaining stands, with control of European beachgrass when needed.

7. Shore pine / bearberry

Pinus contorta var. *contorta* / *Arctostaphylos uva - ursi*
ORBIC rank: G1S1

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. In the Pacific Northwest, bearberry is also called kinnikinnick. Stands are dominated by conspicuous mats of bearberry, reindeer lichens and mosses. Common species of lichens and mosses include *Cladonia portentosa* ssp. *pacifica*, *Cladonia cervicornis* ssp. *verticillata*, *Racomitrium elongatum*, *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 on the NRA. 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 mral. 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 NRA 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.

Management. The fragile mats of lichens and bearberry in this association are readily destroyed by recreational vehicles and heavy foot traffic. 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. 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.

8. Shore pine / hairy manzanita

Pinus contorta var. *contorta* / *Arctostaphylos columbiana*
ORBIC rank: G1S1

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

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

Succession. Early to mid seral. Stands of this type replace the shore pine / bearberry association. Douglas fir had a greater current growth than shore pine, indicating that this association is mid-seral, and that Douglas fir will eventually replace shore pine. Depending on latitude, it is later

replaced by either the Port Orford cedar / evergreen huckleberry association, or the shore pine - Douglas fir / wax myrtle - evergreen huckleberry association.

Distribution and history. This association occurs discontinuously along the coast between northern California and Tillamook Bay, Oregon. It occurs throughout the NRA along the border between open dunes and forests. Typical examples can be seen around the Eel Creek Campground, and west of Hauser. It may now be in decline because of dune stabilization, and possibly the absence of stand-replacing fires.

Management. Stands are vulnerable to sand blowout that may follow fire or mechanical disturbance. Management should include protection and monitoring of several representative stands, with control of conifer invasion by cutting. This association is favored for collecting matsutake mushrooms, but mycorrhizal relationships and impacts from harvest and trampling are unknown. Because the ground layer is fragile, recreational vehicles should be excluded.

9. Shore pine / slough sedge

NVCS: *Pinus contorta* var. *contorta* / *Carex obnupta*
ORBIC rank: G2S1

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. Shore pines 40-130 years old dominate these stands, although most stands are 30-50 years old. Canopy cover is between 70-85 percent, and shore pine is the only reproducing conifer present. The sparse shrub layer, ranging from 1-25 percent cover, contains waxmyrtle, 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 NRA. 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 NRA, 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. It may be replaced by the shore pine / Labrador tea association, and eventually by the shore pine - Sitka spruce / evergreen huckleberry association, as seen at Goose Pasture.

Distribution and history. This association occurs sporadically along the coast between northern California and southwestern Washington. Old-growth stands are rare. Considerable acreage of this association in the 30-75 year age class appears to be developing on deflation plains, presumably an artifact of the expansion of these landforms after the advent of European beachgrass. On the NRA, 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. Stands off the NRA are being destroyed by residential 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.

10. Sitka spruce / slough sedge - skunk cabbage

Picea sitchensis / *Carex obnupta* - *Lysichiton americanus*
ORBIC rank: G3S1

Environment. Small examples of this association were seen on the NRA, but never sampled quantitatively. It occurs in depressions between old stabilized dunes, 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 and red alder, with western hemlock occurring on mounds. 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, and reduced crown spread are typical of swamp spruce. Large wads of Scouler's polypody, and thick mats of epiphytic mosses, particularly *Antitrichia curtispindula*, are typical on upper trunks and limbs. Canopy cover of spruce may be as low as 50 percent, and high light levels favor a dense growth of red alder and salmonberry, with salal occurring on mounds. The herb layer is a mix of slough sedge, skunk cabbage, and lady fern, with exposures of often deep, mucky soil between them. Windthrow is frequent, and creates 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 NRA, as there are few floodplains and few areas of perennially wet, organic soils. Small examples can be seen along Eel Creek and Siltcoos 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 be nesting sites for marbled murrelets. Sites may be vulnerable to catastrophic windthrow, and windfirm buffers could 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.