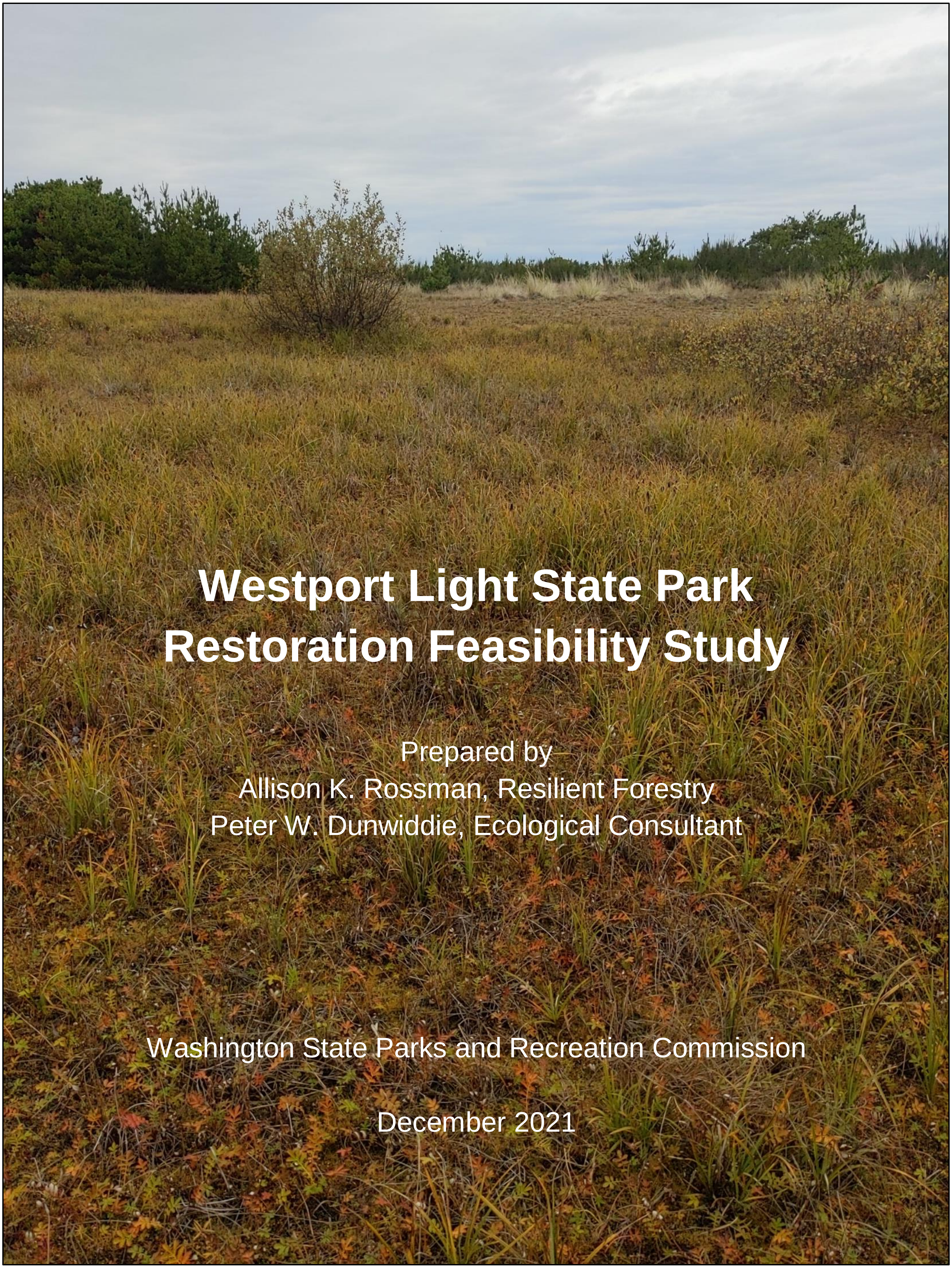

Westport Light State Park Restoration Feasibility Study

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Washington State Parks and Recreation Commission

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1. Executive Summary

Washington State Parks and Recreation Commission is preparing a Master Plan and considering the development of a golf course at Westport Light State Park. On their behalf, we assessed the feasibility of improving the ecological condition of the park in conjunction with golf course development. Our approach included extensively researching the site to develop a deep understanding of its ecological conditions, as well as visiting reference sites and similarly-situated golf courses to consider its potential condition and how ecological enhancements to the park could fit with a golf course. In this report we present our findings and professional assessment of the benefits and compatibilities of restoration opportunities.

Westport Light State Park is a mosaic of interdunal wetlands on the Washington coast with a history shaped by the accumulation, erosion, and stabilization of sand. Current patterns of vegetation at Westport are the result of the geomorphic, hydrologic, and disturbance history, as well as vegetation processes such as the expansion of European beachgrass (*Ammophila arenaria*) and shore pine (*Pinus contorta* var. *contorta*), and plant community succession. An attempt in 2006 to develop a golf course disturbed sizeable areas in the deflation plain behind the foredune, which were left to revegetate naturally. The uplands grew back mostly with non-natives while the wetlands revegetated largely with native shrubs, herbs, and grasses. Today, European beachgrass and Scotch broom dominate substantial portions of the uplands, but rare wetland communities are widespread.

These wetland communities occur primarily as small patches of both herbaceous- and shrub-dominated assemblages thatform an extensive, closely interspersed matrix of several types. Although most are relatively species-poor, all are extremely rare in western Washington and thus are of high ecological value. Communities described as *Juncus falcatus – Juncus (lesueurii, nevadensis*) (S1) and *Carex obnupta – Argentina egedii* ssp*. egedii* (S2) Wet Meadows overlap considerably in species composition and likely represent variants of a single interdunal swale association that varies depending on small differences in depth and duration of inundation. The shrub communities dominated by willow and spiraea are included under the *Salix hookeriana / Carex obnupta – (Argentina egedii* spp*. egedii*) Shrub Swamp (S1?) type and are similarly rare in Washington and develop as the herbaceous assemblages succeed as woody species establish and expand.

The primary restoration opportunity is to enhance the rare wetland vegetation communities extant on the site by increasing their area, physical heterogeneity, and species diversity. Due to restrictions on wetland impacts, the golf course would likely occupy most existing uplands in the park. This results in compatible restoration opportunities in wetland areas, but restricts opportunities to restore rare coastal dune community types in the uplands.

Opportunities to establish rare species in conjunction with the course are limited. Most rare species that are suited to growing in habitats that occur at Westport are adapted to open sand and upland dunes rather than wetlands. Therefore, opportunities are limited by the paucity of upland habitats that are large enough to sustain functional communities. In addition, the large expanses of open, blowing sand that sustain most such upland habitats are incompatible with an adjacent to a golf course.

In addition to direct impacts on upland habitats directly resulting from the golf course footprint, there can be negative ecological consequences associated with the construction and maintenance of a course. Measures must be taken to prevent the runoff of fertilizers and pesticides from infiltrating the sandy soils on the site and spreading into adjacent wetlands, which could be especially vulnerable due to their close proximity to the course. If not sufficiently abated, these chemicals could be a substantial threat to the naturally nutrient-poor wetland communities.

Westport Light State Park is a unique ecosystem where fully understanding its history and current physical and biological conditions is essential to assessing the potential for restoration. Historical maps and aerial imagery attest to the extensive and rapid changes that the interdunal ecosystem at Westport has undergone at scales from seasons to centuries. Such dynamism can be expected to continue and even increase with climate change, which amplifies the need to restore and manage ecosystems that are resilient and flexible. Features expected to be long-lived, especially those located in close proximity to the ocean shoreline, are likely to become problematic over the long-term as the physical and biological landscape at Westport continues to change in the coming decades.

2. Objective

The objective of this report is to assess the feasibility of restoring or creating beneficial ecological features that could be implemented with the construction of a golf course at Westport Light State Park ("Westport"). Identifying potential restoration options depends not only on the existing condition of the site and design objectives of the developer and land owner, but also on the ecological, physical, and operational constraints that determine which options are possible to implement. In this report we describe our understanding of the current ecological condition of the site and its restoration potential, and then apply the lens of a golf course to evaluate which potential options are most compatible and would provide the greatest ecological benefits.

3. Our approach

Our strategy for developing and assessing restoration opportunities at Westport was to (1) develop a deep understanding of the current and historical ecological condition of the park, (2) learn how the current condition compares to the potential condition and consider how ecological improvements could be achieved, and (3) assess the benefits of each restoration opportunity and the compatibility with golf course installation and maintenance on the site.

To (1) develop a deep understanding of the ecological condition of the park, we:

- Researched literature, reports, and historical documents about the vegetation, wildlife, geomorphology, and human history of the park.
- Used spatial data and historical imagery to understand outcomes of past development and the distribution of current vegetation communities.
- Conducted interviews with park managers and ecological experts to glean local knowledge and expertise.
- Visited Westport in the spring and fall to study vegetation communities in detail and map current distributions.

Figure 1. Early season visit to Westport with State Parks staff.

To (2) learn how the current condition of the park compares to its potential condition, we:

Figure 2. View of deflation plain wetlands from the top of high foredunes in Oregon Dunes Recreation Area.

- Examined references describing relevant vegetation communities and restoration efforts in similar ecosystems in Oregon and Washington.
- Visited comparable vegetation communities in and around the Oregon Dunes National Recreation Area with local experts and compared their composition, spatial distribution, and ecological function with those at Westport.
- Communicated with the Washington Natural Heritage Program staff about existing and potential rare species on the site

and the assessment of ecological condition, including an interview with Program Manager Joe Rocchio.
- Researched methods of assessing ecological value and how they may be applied at Westport.

To (3) assess the benefits of restoration and the compatibility with golf course development, we:
- Visited local and industry-leading examples of Scottish links golf courses (Chambers Bay Golf Course in Tacoma, Washington and Bandon Dunes Golf Resort in Bandon, Oregon) to observe the layout and condition of ecological features.
- Toured with the Director of Agronomy at Bandon Dunes to learn about the planning and maintenance of the course and natural areas.
- Communicated with our Parks collaborators to understand potential design constraints and priorities.
- Identified and applied metrics to evaluate the potential ecological benefits of restoration opportunities.
- Critically applied our knowledge of the Westport site to golf course parameters to assess compatibility and benefit of restoration opportunities.

Figure 3. Inspecting rare species within the layout of the Bandon Dunes Golf Resort, Oregon.

By becoming ecological experts on Westport and applying this knowledge to high-quality examples of comparable ecosystems and relevant golf course designs, we were able to accurately and realistically assess the potential for ecological restoration at Westport in conjunction with golf course installation. Throughout the process, we aimed to critically apply our professional knowledge of ecological function and creatively consider the compatibility of restoration with human development.

4. History and existing condition

4.1 Geography and dune geomorphology

Westport Light State Park is located on a peninsula on the west coast of Washington State, between Grays Harbor and the Pacific Ocean (Figure 4). The northwestern-most point of the peninsula is Point Chehalis, from which a 1.3-mile jetty extends into the ocean, with Half Moon Bay located just east of the jetty. The park occupies the northwestern portion of the peninsula, with the small town of Westport to the east. The Westport Lighthouse, built in 1898, is located just southeast of the park on Coast Guard property. A radio range station was constructed in the center of the northern half of the current park in the 1950s and was deconstructed in approximately 2007.

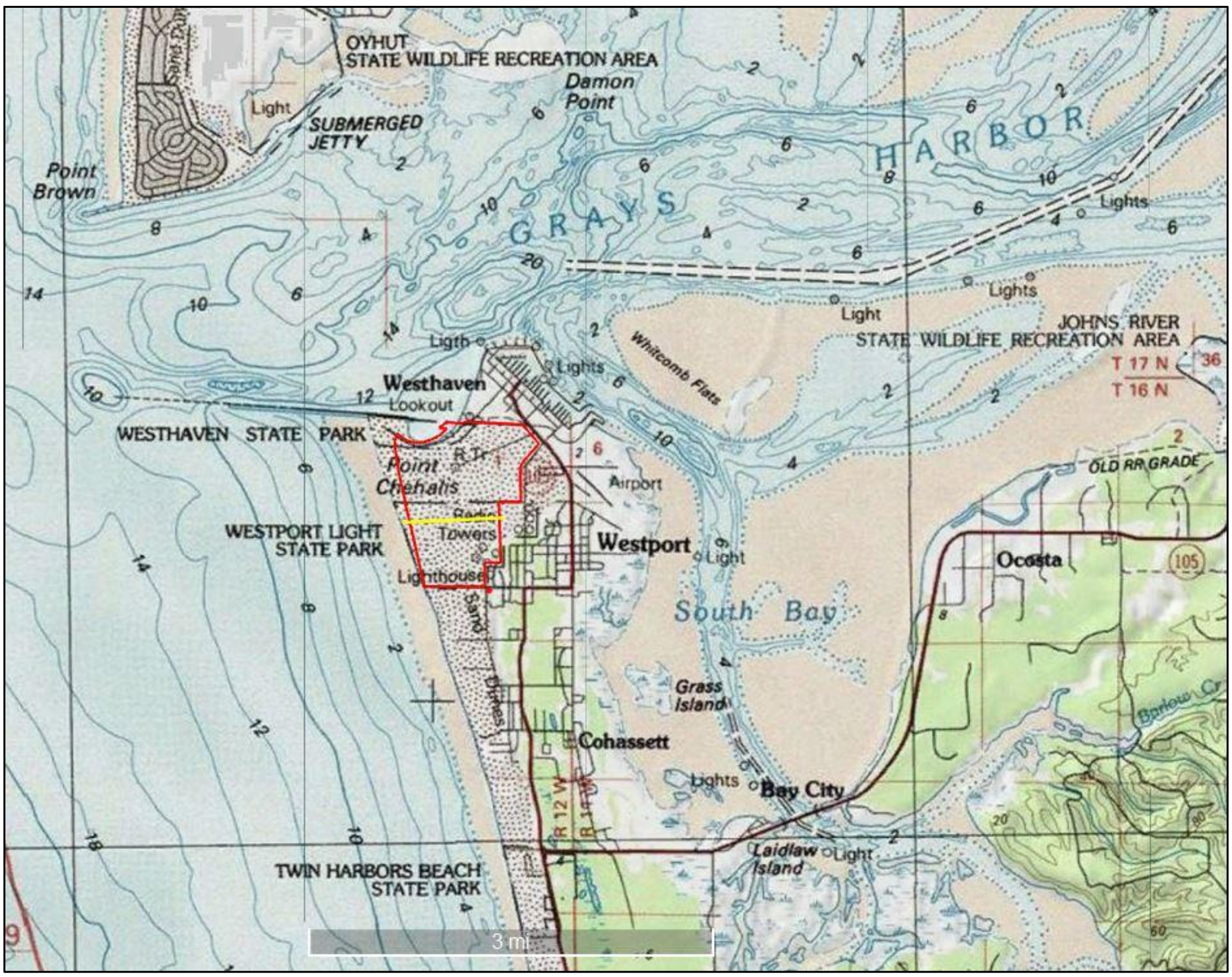

Figure 4. Westport Light State Park (red outline) and surrounding geography. Yellow line is the location of the topographic profile in Figure 5. Map data: Google, Earth Point, USGS.

Westport Light State Park ("Westport") is a sand dune system that has been extensively modified by both human and natural processes. A cross-sectional profile across the park illustrates fundamental aspects of the geomorphology and terrain that strongly influence the dynamics and vegetation on the site (Figure 5). From the ocean, an intertidal beach gradually rises in elevation to 16 feet where it abuts a bluff of sand 6 to 15 feet tall (22-31 feet ASL) (NAVD 88; Washington DNR Southwest WA OPSW 2019 Lidar project). The bluff is a foredune held in place primarily by European beachgrass (*Ammophila arenaria*), a species that was deliberately introduced to help stabilize the sand dunes that historically were much less densely vegetated and subject to movement. Small chunks of sand and roots fall from the foredune onto the beach as it erodes during storms and high tides. The foredune intercepts sand blowing in from the beach (Christy et al. 1998). Atop the foredune is a cement walking path that runs north-south through the park.

Figure 5. Topographic profile of a representative west-east transect across Westport Light State Park. Axes are in feet. Profile created from Southwest WA OPSW 2019 Lidar data (vertical datum NAVD 88) obtained from Washington DNR on 1/28/21. (Profile location shown on Figures 4 and 11.)

Behind the stabilized foredune is the deflation plain, an area where wind scours sand until the surface reaches the groundwater (Christy et al. 1998). At Westport, much of the deflation plan has reached this point, where the sand is continuously wet and not further susceptible to wind erosion. These depressions form a series of interdunal wetlands that become inundated annually with freshwater as the water table rises during the winter rainy season. On the west side of the park, the wetlands contain early-seral vegetation communities dominated by herbaceous or shrubby vegetation. The slightly higher areas between the wetlands are occupied by upland vegetation, which is dominated by stands of Scotch broom (*Cytisus scoparius*), shore pine (*Pinus contorta* var. *contorta*), and/or European beachgrass. Eastward, the deflation plain becomes increasingly forested with shore pine, the occasional Sitka spruce (*Picea sitchensis*), and various shrubs, until reaching Forrest Street and the boundary of the park.

4.2 The dynamic coastline

Erosion and accumulation, modified by human activities, are the themes of the dynamic coastline at Westport. Historical navigation charts reveal that in the latter half of the 19th century, Point Chehalis was a round headland with shifting sands and ocean depths that made nautical navigation difficult. During the late 1800s, the shoreline south of the point was rapidly moving westwards, shifting about 1 km between 1860 and 1886 (Figure 6). The Westhaven Jetty was constructed at Point Chehalis from 1898 to 1902 to maintain the depth of the channel between Grays Harbor and the Pacific Ocean (Kaminsky et al. 2010). It contributed to the accretion of sand in various places on the peninsula, including where the park lies today (Figure 6). During the decade following completion of the jetty, the shoreline continued to accrete rapidly by another 1 km (see 1898 and 1909 locations in Figure 6), but by 1926 it had retreated eastward again to approximately where it stands today.

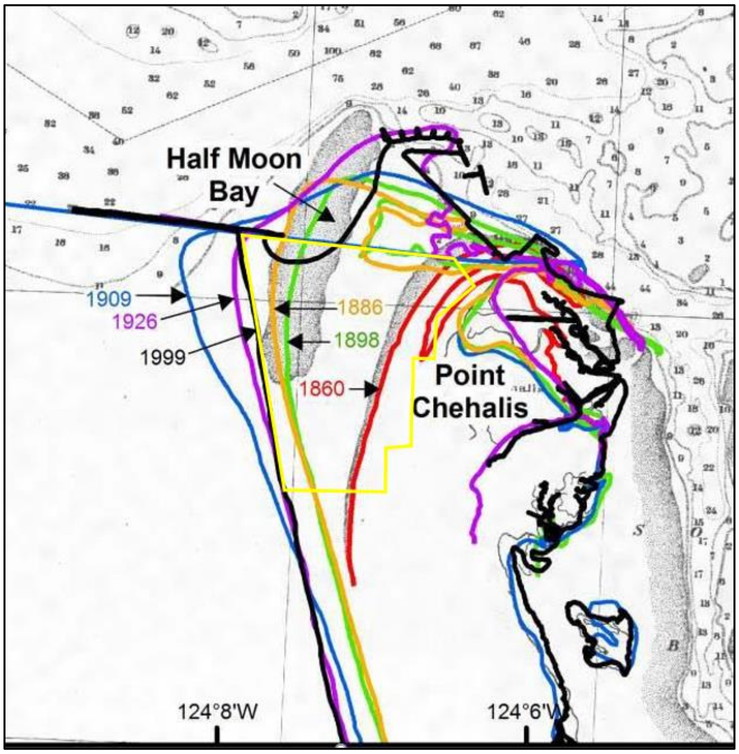

Figure 6. Coastline of the Point Chehalis peninsula in the late 19th and 20th centuries with the approximate boundary of Westport State Park shown in yellow. (From Kaminsky et al. 2010.)

Extensive efforts have been made over the last 150 years to stabilize the sand along the coast. European beachgrass was first introduced along the west coast for this purpose in the early 1900s (Seabloom and Weidermann 1994). Subsequently, American beachgrass (*Ammophila breviligulata*) was also introduced (ca. 1935) and has become the dominant beachgrass on some foredunes from the Columbia River north to Westport (Seabloom and Wiedemann 1994). Scotch broom and shore pine have also been planted extensively in some areas, including at Westport (Miles Wenzel *pers. comm.* 2-23-21), to further stabilize dunes and inhibit their movement into developed areas along the coast. While these plantings are unlikely to have significantly affected shoreline locations, they have altered the patterns of sand movement and the resulting topography of interdunal uplands and swales, as well as competed with the native species that previously occupied these habitats. We further discuss the impacts of these species in “Invasive Plants” below.

Human development and erosion have a shared history on the peninsula. Docks north of the town of Westport were installed by 1948, with a marina dredged and installed by 1966. Half Moon Bay began to erode during this time, and experienced considerable erosion between

1966 and 1970. In 1993, the land connection between the peninsula and the jetty breached. The Army Corps of Engineers repaired the breach by trucking in sand and have continued to conduct emergency repairs regularly (Miles Wenzel *pers. comm.* 2-23-21).

Shoreline locations documented from aerial imagery (from Earth Explorer and Google Earth) since the 1970s confirm that the shoreline along the entire western boundary of the park has continued to erode up to today (Figure 7). Retreat was particularly rapid towards the northern end between 1974 and 1985 (ca. 8m/yr), but was relatively stable at the southern park boundary. However, during the period from 1985-2016 the entire shoreline retreated about 2.5m/yr.

Figure 7. Shoreline retreat from 1974-2016 along the western boundary of Westport Light State Park. Red=1974, White=1985, Yellow=2016. Underlying imagery is from 1974 (USGS Earth Explorer).

4.3 Previous golf course development

In 2006, developer Mox Chehalis, LLC began constructing a golf course on the northern half of what is now Westport Light State Park, prior to the 2015 purchase of the land by Washington State Parks. In a short period of time, extensive impacts were made to the site. The developer cut and chipped shore pine, ground stumps, placed fill in and adjacent to wetlands, excavated and regraded existing wetlands, scraped surfaces, drove wheeled vehicles over extensive areas, and dug irrigation ponds (Figure 8; USACE 2008). Today, some poles marking the greens and silt fencing remain in place. The two irrigation ponds are still intact. Areas that were cleared of trees or filled with excavated sand are dominated by Scotch broom and European beachgrass.

When it was proposed, the development was highly controversial among Grays Harbor conservation groups, such as Friends of Grays Harbor (FOGH). As described in their 63-page objection to the public notice issued by the U.S. Army Corps of Engineers, FOGH's concerns included inadequate wetland protection, inaccuracy in the wetland delineation, impacts to recreation, the effects of chemical runoff on water quality in the wetlands and in Grays Harbor, and many others.

The developer proceeded to begin construction without the necessary permits from the U.S. Army Corps of Engineers (USACE 2008). Between 2006 and 2010, letters were sent and investigations were undertaken that revealed the extent of the violations (Figure 9). A restoration plan to remediate the unauthorized wetland filling and excavation was created in 2008. In 2010, the violation was resolved with a deed restriction (i.e., restriction on development) on large portions of the remaining shore pine forest (USACE 2010). The golf course was not completed, and there is no evidence that planting or other vegetation restoration per the restoration plan was carried out. While flora in wetland areas appears to have regrown with mostly native species, most upland areas are dominated by non-native Scotch broom and European beachgrass (see more details in "Vegetation communities").

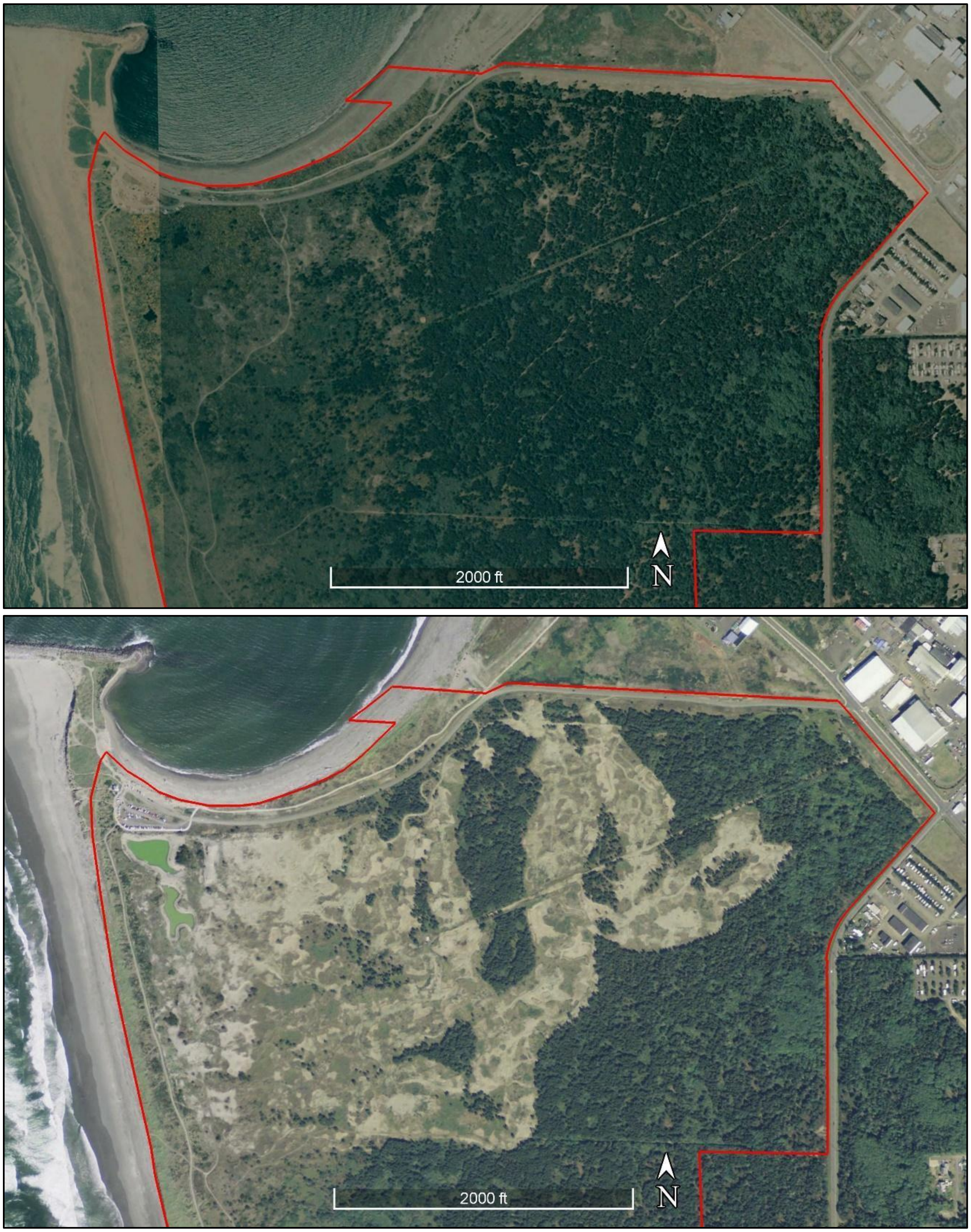

Figure 8. Aerial imagery from before (2006; top) and after (2009; lower) previous golf course development. Vegetation removal, earth moving, surface scouring, and pond installation were among the impacts. Red outline is today's state park boundary. Map data: Google, USGS, USDA Farm Service Agency.

Figure 9. Photo from 2008 investigation report by the U.S. Army Corps of Engineers documenting impacts to the site by the golf course development, including wheel tracks, wetland fill, extensive scouring and sand moving, and tree cutting (USACE 2008).

4.4 Wetlands and hydrology

Freshwater wetlands are ubiquitous across the deflation plain at Westport. They have received much attention over the years because of local and federal regulations that affect potential development. Multiple wetland delineations have occurred in the past, and another was accomplished this year by AECOM (2021a). Delineation is particularly challenging because the sandy soil poorly exhibits hydric indicators, such as colored reduction-oxidation reactions, that are typically used to detect the boundaries of wetlands.

Aboveground hydrologic patterns are characterized by extensive interdunal wetlands that are inundated seasonally. Each winter, many areas of the deflation plain become covered with water up to 3 feet or more deep (Figure 10). The extensive inundation evident in this 1963 image includes areas that are upland dunes today. This likely resulted from the aforementioned erosion that occurred between 1974 and 2016, with corresponding eastward movement of the foredune and associated infilling of sand into portions of the deflation plain. This image, together with the terrain profile in Figure 5, show the surprisingly complex interspersion of wetlands and uplands across this relatively flat landscape. Elevational differences of just a few inches can result in the ground surface intersecting the water table much of the year, allowing wetland vegetation to dominate. Collectively, these figures underscore the dynamic and rapidly-changing nature of the shoreline, terrain, and vegetation that has long characterized the coastal environment at Westport.

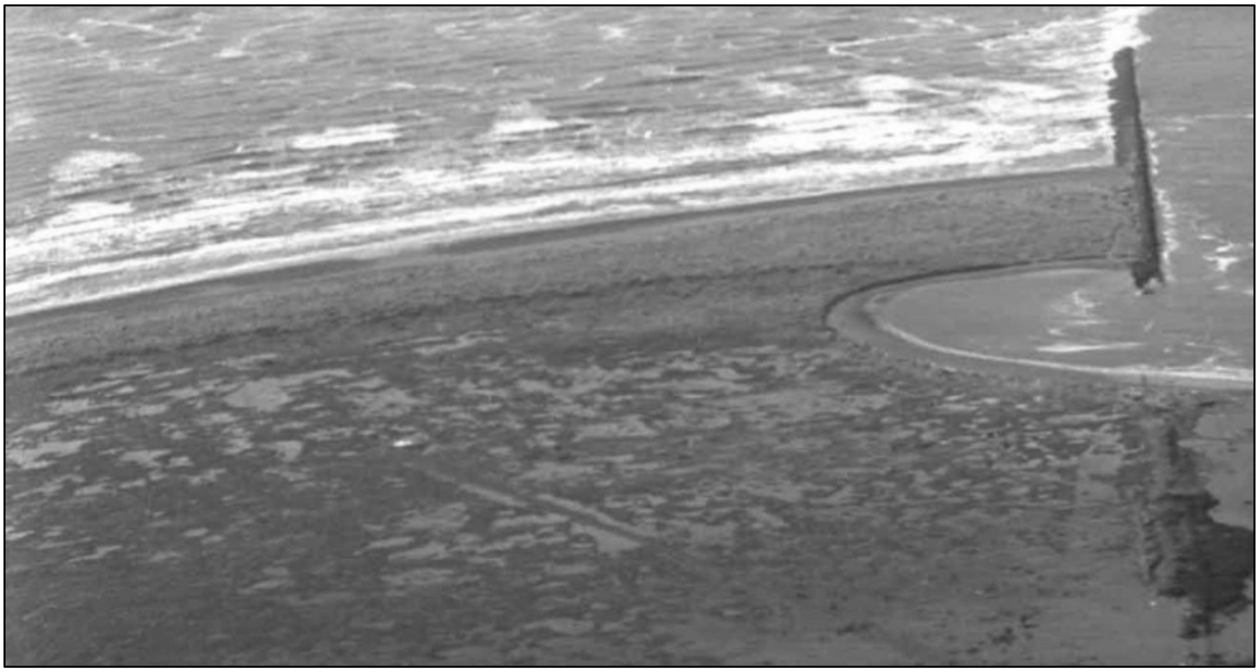

Figure 10. Aerial photo from November 1963, looking west toward the Pacific Ocean and the Westport Jetty, showing winter inundation of the deflation plain in the northern half of Westport Light State Park. The white structure in the center is a radio range station constructed in the 1950s and deconstructed in approximately 2007. Photo from the Jones Photo Historical Collection, Anderson & Middleton Company.

This dynamic nature, as well as the challenges of delineating interdunal wetlands, can be highlighted by the differences in wetland mappings by different institutions. The National Wetlands Inventory (NWI) depicts wetlands on only 30% of the property, primarily in the southern half of the park, while the City of Westport maps roughly twice this in their local wetland inventory (Appendix A-4 of AECOM 2021a). Most recently, AECOM delineated nearly three-quarters of the park as wetland.

AECOM mapped 337 acres of the park as a mosaic of wetlands and uplands (with 68% wetlands), contiguous with 28 acres of coastal willow swamp and 21 acres of red alder/slough sedge wetland (Figure 11; AECOM 2021a). AECOM mapped another 28 individual small wetlands, each up to 0.43 acre, in the northwest section of the park. The two constructed ponds in the northwest corner, created during the previous golf course attempt, are non-jurisdictional wetlands (i.e., not subject to federal regulations). Together, the mosaic and individual wetlands cover 70% of the park. This suite of wetlands is the second largest expanse of interdunal wetlands in Washington (AECOM 2021a).

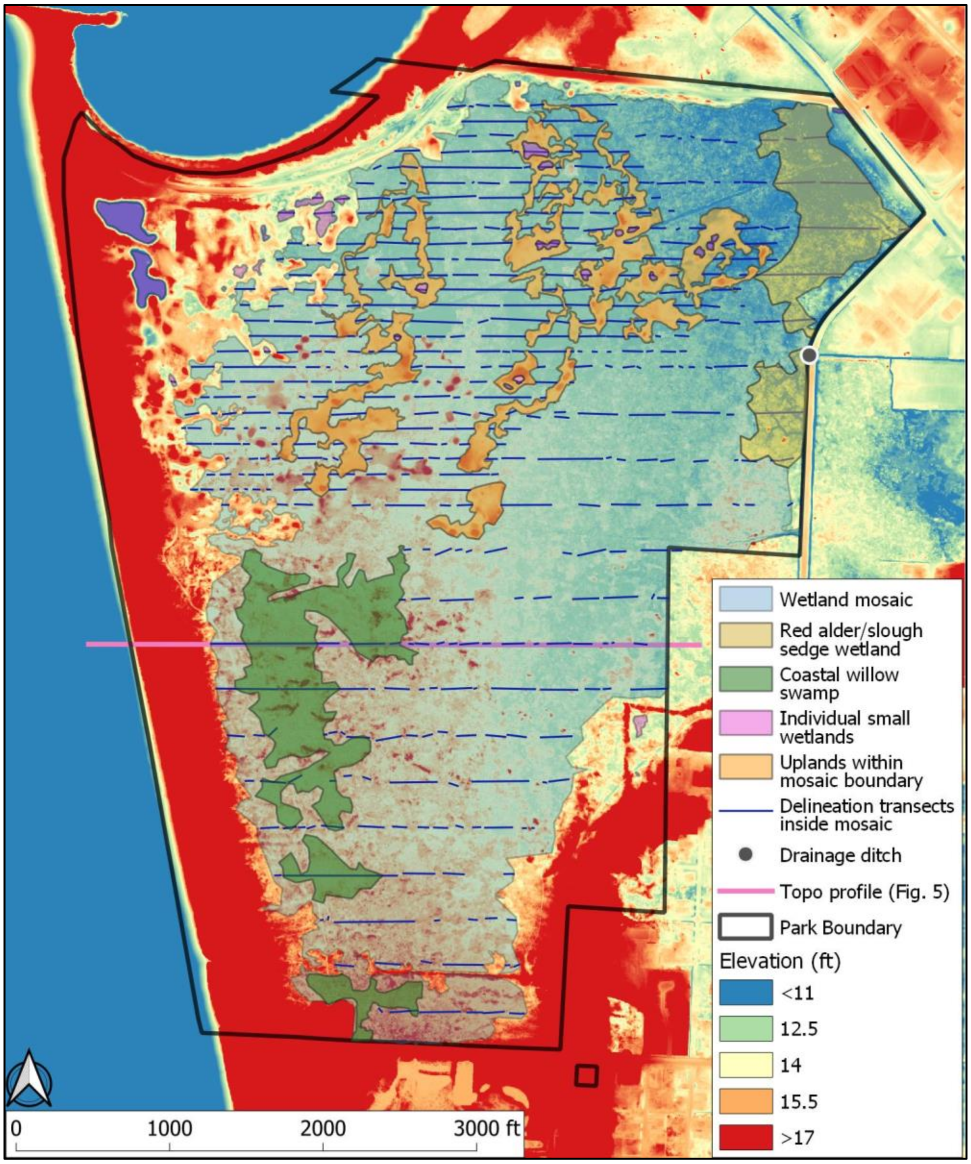

Figure 11. Wetlands delineated by AECOM in 2021 and the drainage ditch on the east side of the property. The wetland mosaic includes 68% wetlands and 32% uplands; the solid portions of the delineation transects show where wetland characteristics were detected. Wetlands largely correspond with topography evident on underlying Lidar image. Pink line shows location of topographic profile depicted in Figure 5. Wetland data from Washington State Park and Recreation Commission and Lidar data from Southwest WA OPSW 2019 Lidar project (vertical datum NAVD 88) obtained from Washington DNR.

All wetlands appear to be exclusively fresh water and fed primarily by precipitation that accumulates atop the lens of salt water that extends inland underground from the ocean. AECOM (2021a) reported that the primary water inputs to the wetlands are a seasonally high water table, precipitation, and surface runoff. Inundation tends to occur from November through April or longer each year; aerial imagery shows that the wetlands tend to dry up entirely in most years by mid-summer. The highly-permeable sandy soils result in a quick descent of the water table after precipitation reduces in the late spring.

In their wetland report, AECOM (2021a) provided a summary of the conditions and functions of the wetlands and their buffers. They listed a number of functions provided by the large wetland mosaic, including nutrient removal, high habitat suitability, and native plant richness, and rated its overall habitat function as high due to the diversity of plant structures and species, multiple water regimes, and abundance of dead wood. The survey, which considered wetland condition within the context of the surrounding communities and buffers, concluded that the wetlands in the southern half of the park are in good condition, while those in the northern half that were disturbed by the previous golf course development are in poor condition. The northern vegetation community survey (AECOM 2017), on the other hand, considered just the floristic composition of the wetland communities and concluded that many of the previously-disturbed wetlands are in good condition.

No streams flow through the park. A drainage ditch connected to Grays Harbor runs under N. Wilson Ave and intersects the park on the eastern boundary (Figure 11). It appears to direct several natural channels that flow out of the red alder/slough sedge wetland under the road and into Grays Harbor. The surrounding wetland vegetation was mapped within the wetland mosaic.

4.5 Effects of invasive plants

4.5.1 Beachgrass

Prior to the introduction of beachgrass, the Westport site would likely have consisted largely of hummocky open sand extending inland from the beach. American dunegrass (*Leymus mollis*) would have contributed to stabilizing low foredunes, but extensive areas would have been sparsely vegetated. As a result, this interdunal landscape would have been even more dynamic than it is today, with blowing sand periodically burying vegetation and scouring new swales.

Sand-stabilizing beachgrass was introduced to the Pacific Northwest coast in the 19th and 20th centuries, including at Westport. European beachgrass (*Ammophila arenaria*) was planted widely along the coast in the early 1900s. American beachgrass (*A. breviligulata*), native to the East Coast and Great Lakes of the U.S., was also planted along the coast, though much less extensively: near the mouth of the Columbia River in Oregon and on the south end of Long Beach Peninsula in Washington (Seabloom and Wiedemann 1994). It has now spread all along the southern shoreline of Washington, from the Columbia River to Westport. Both species tend to outcompete the native dunegrass.

At Westport, European beachgrass is the most abundant over much of the site, but we also observed American beachgrass in isolated locations in the deflation swales. This is somewhat in contrast to research that shows where the two beachgrasses co-occur, American beachgrass tends to outcompete European beachgrass (Rebecca Mostow via Andrea Thorpe *pers. comm.* 2-23-21, Seabloom and Wiedemann 1994). They may also hybridize; hybrid individuals have been found from just north of Grays Harbor to south of Pacific City, Oregon, including possibly at Westport (Sally Hacker via Andrea Thorpe *pers. comm.* 2-23-21).

European beachgrass has dramatic effects on dunal geomorphology (Carlson et al. 1991, Seabloom and Wiedemann 1994, Christy et al. 1998). Once introduced to a site, it will spread to the tide line, where it intercepts the surface wind and traps sand, forming a densely vegetated, grassy foredune much taller and persistent than the hummocky dunes native vegetation would support (Figure 12). The foredune persists through the winter storm cycle, when high-velocity winds move large amounts of sand, because beachgrass is tolerant of burial and grows from its rhizomes up through the deposited sand each spring and summer. The tall foredune intercepts most sand blowing along the beach, resulting in very little sand deposition in the deflation plain behind it. Thus, as wind scours the deflation plain without concurrent sand deposition, depressions become deeper, more widespread, and more long-lasting. Beachgrass can also be found consistently on upland areas within the deflation plain, but because it thrives mainly where there is a regular input of windblown sand, it tends to die out as areas become more densely vegetated with shrubs and trees (Figure 13).

Today, perspectives among landowners and land managers regarding both species of beachgrass are mixed. Many people still value its ability to stabilize dunes and sandy shorelines, helping to slow erosion and keep open sand sheets from drifting across roads, property, and houses. However, these competitive abilities have allowed these species to transform coastal landscapes and completely exclude many upland and wetland communities in many areas, resulting in considerable degradation of native plant communities and loss of native species.

Figure 12. Foredune stabilized by beachgrass at Westport, as seen from the ocean beach on Dec 21, 2020. The foredune is an average of 10 feet high and runs parallel to the ocean. It erodes with winter storms.

Figure 13. Vegetated upland portions of the deflation plain inland from the stabilized foredune at Westport. European beachgrass and Scotch broom in the foreground transition to shore pine forest in the distance.

4.5.2 Shore pine

Roughly 48% of Westport vegetation has a component of shore pine (*Pinus contorta* var. *contorta*). It was planted in 1979 and 1980 at several coastal parks in Washington, but it is not clear if it was planted at Westport or spread there from other sites (Miles Wenzel *pers. comm.* 2-23-21). Aerial imagery from 1974 to 2021 shows that shore pine has rapidly expanded shoreward across the deflation plain (Figure 14). Roughly 70 acres were cut and leveled with golf course development in 2006; today, these areas are predominantly Hooker's willow wetlands and Scotch broom shrublands (more information in "Vegetation communities" below).

Although the distribution of shore pine neared its maximum extent by 2006, there are still young, rapidly growing stems infilling the western areas of the park today. Trees 3 to 15 years old with internode growth lengths of 1 to 1.5 feet surround many of the herbaceous wetlands in the northwest (Figure 15). Many trees appear to be of the same cohort that is roughly 12 years old; historical imagery suggests trees of this cohort germinated several years after the golf course development, both in locations where existing trees had been cut and in previously unoccupied areas.

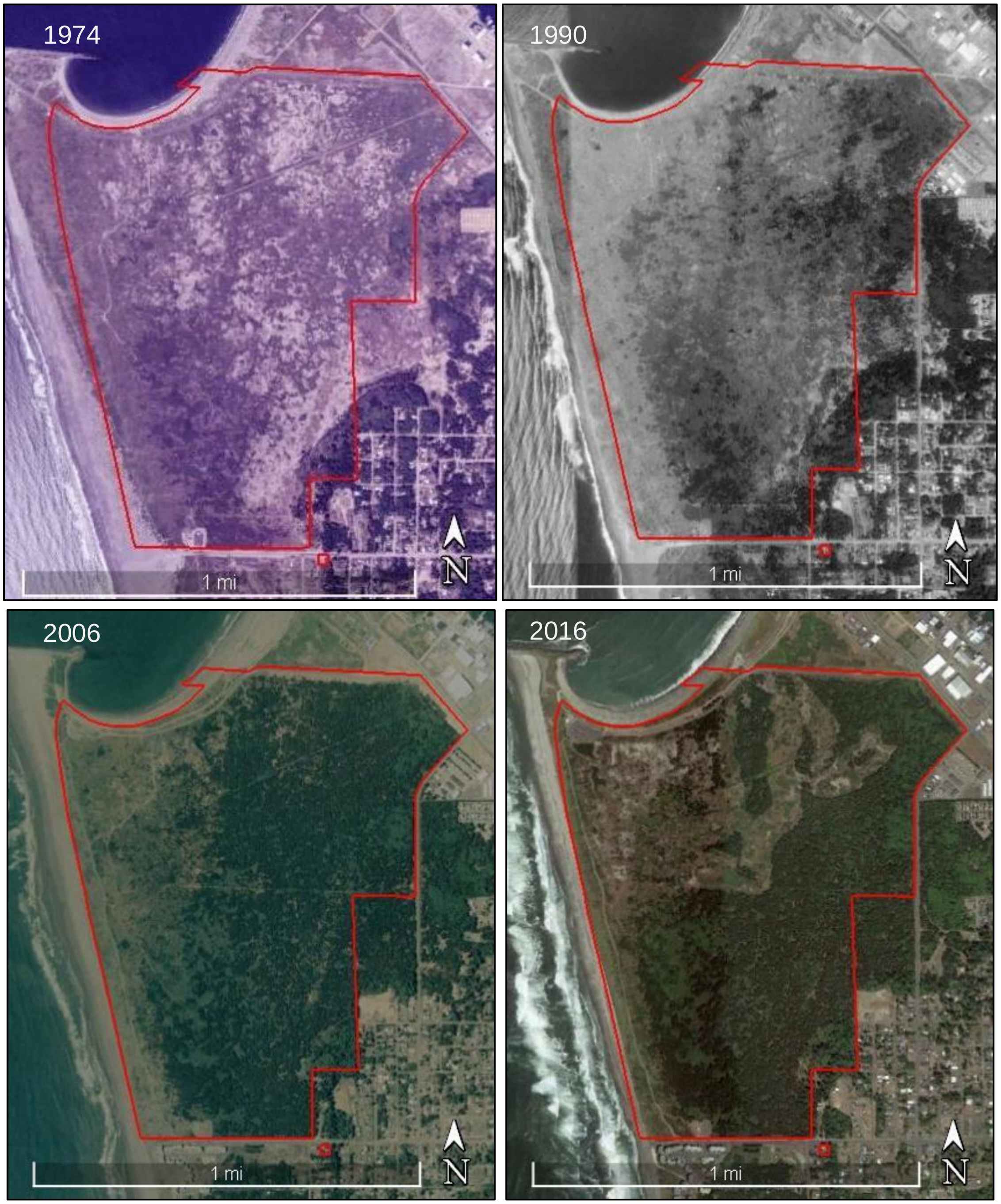

Figure 14. Shore pine expansion across Westport Light State Park (red outline), from 1974 (top left) to 2016 (bottom right). Expansion was rapid after 1990, appearing to have reached its maximum extent by 2006. Cutting for development of a golf course in the northern half of the park occurred in approximately 2007; re-invasion of these areas by shore pine has not occurred. Map data: Google, USGS, USDA Farm Service Agency.

Figure 15. Young, rapidly-growing shore pine grow to the edge of an herbaceous wetland that is inundated seasonally. A *Juncus* community is just emerging at the water's edge. Photo taken March 29, 2021.

It is possible such abundance and rapid growth of the shore pine is affecting the freshwater table and resulting vegetation distribution. No literature exists specifically regarding the hydrologic effects of shore pine in interdunal ecosystems, but research about lodgepole pine (*Pinus contorta* var. *latifolia*; the same species but different variety as shore pine) physiology, encroachment, and establishment patterns in other ecosystems reveals the following:

- Helms (1987) found that periods of invasion by lodgepole pine into meadows in Yosemite National Park was associated with lower groundwater, either due to channel erosion or lower precipitation. Waves of establishment appeared to be related to establishment success rather than seed availability.
- Cohen et al. (1990) reported that lodgepole pine trees can transport and transpire substantial amounts of water.
- DeMeo et al. (1992) describe shore pine trees as "sponges" that retain water and become sources of groundwater during dry periods.
- Lubetkin et al. (2017) found that among other factors, lodgepole encroachment into montane meadows in the Sierra Nevada was found to be related to strong soil drying and favorable climatic conditions, which included a high snowpack, warm summer maximum temperatures, and high summer precipitation.
- Surfleet et al. (2020) found that four years after thinning lodgepole in and around a montane meadow, groundwater was an average of 0.15 m closer to the surface, and soil moisture varied more strongly with seasons (drier in the dry season, wetter in the wet season).

This research suggests that the young cohort of shore pine at Westport most likely established during a warm and wet climatic period with strong summer soil drying, and that they very well may be transpiring a substantial amount of groundwater. Groundwater transpiration combined with anticipated climate changes of increased temperatures and drier summers may make future conditions even more favorable for additional shore pine establishment and expansion (Climate Impacts Group 2021).

4.5.3 Scotch broom

Scotch broom (*Cytisus scoparius*), a noxious weed in Washington, is ubiquitous throughout the uplands of the park. It is co-dominant with European beachgrass and/or shore pine in virtually all areas between wetlands. Together they dominate the upland matrix, weaving among the complex of herbaceous and shrubby wetland swales. As mapped in vegetation communities, Scotch broom is prominent in 94% of the uplands and 31% of the entire park (Figure 16, below; AECOM 2017, 2021b). It is more frequent in the northern half of the park, where uplands are more common.

Scotch broom's ability to grow in low-nutrient conditions, rapid growth, resistance to wind, and ability to fix nitrogen made it a desirable plant for dune stabilization in the early 1900s (Carlson et al. 1991). It was often planted along with European beachgrass to stabilize foredunes and sand sheets. An extensive planting was accomplished in the 1930s just below the mouth of the Columbia River to stabilize the foredune, which had entirely blown out and threatened nearby farmland, recreation, and navigational channels (Carlson et al. 1991). Jetty construction in the area had contributed to rapid sand accumulation with little stabilizing vegetation.

At Westport, Scotch broom has likely been around nearly as long as European beachgrass (since the early 1900s). It may have been planted as well to stabilize sand in the area. However, blooming plants are apparent in 1974 imagery only on the far eastern boundary of the park, as well as across the road bordering today's northern boundary (Figure 14). Presumably, the water table was higher then and kept Scotch broom at bay. Disturbance from golf course construction in 2006 appears to have abetted its spread across the entire northern half of the park. Only wet soil and dense forest cover now seem to preclude its presence.

Since Scotch broom was planted many decades ago, ecologists have recognized its ability to rapidly invade many habitats, and it is now listed as a Class B noxious weed in Grays Harbor County. Its seeds stay viable for up to 50 years, making control a long-term endeavor. Recommended control methods include cutting stems when they are drought-stressed, burning, and systemic herbicide (Harshovksy 2001).

4.6 Vegetation communities

Current patterns of vegetation at Westport are the result of the geomorphic, hydrologic, and disturbance histories, as well as biological processes such as plant succession and the expansion of beachgrass and shore pine. All plant communities are relatively young, and some are characteristically early-seral, such as the shallow wetlands dominated by herbaceous plants and low shrubs.

Vegetation communities at Westport Light State Park were surveyed and mapped most recently in 2017 (northern half; AECOM 2017) and 2021 (southern half; AECOM 2021b) (Figure 16, Table 1). The communities described in these reports were keyed using Rocchio et al. (2020), which drew descriptions of interdunal communities from earlier work by Alfred Wiedemann, Linda Kunze, and John Christy (Kunze and Cornelius 1982, Kunze 1994, Christy et al. 1998).

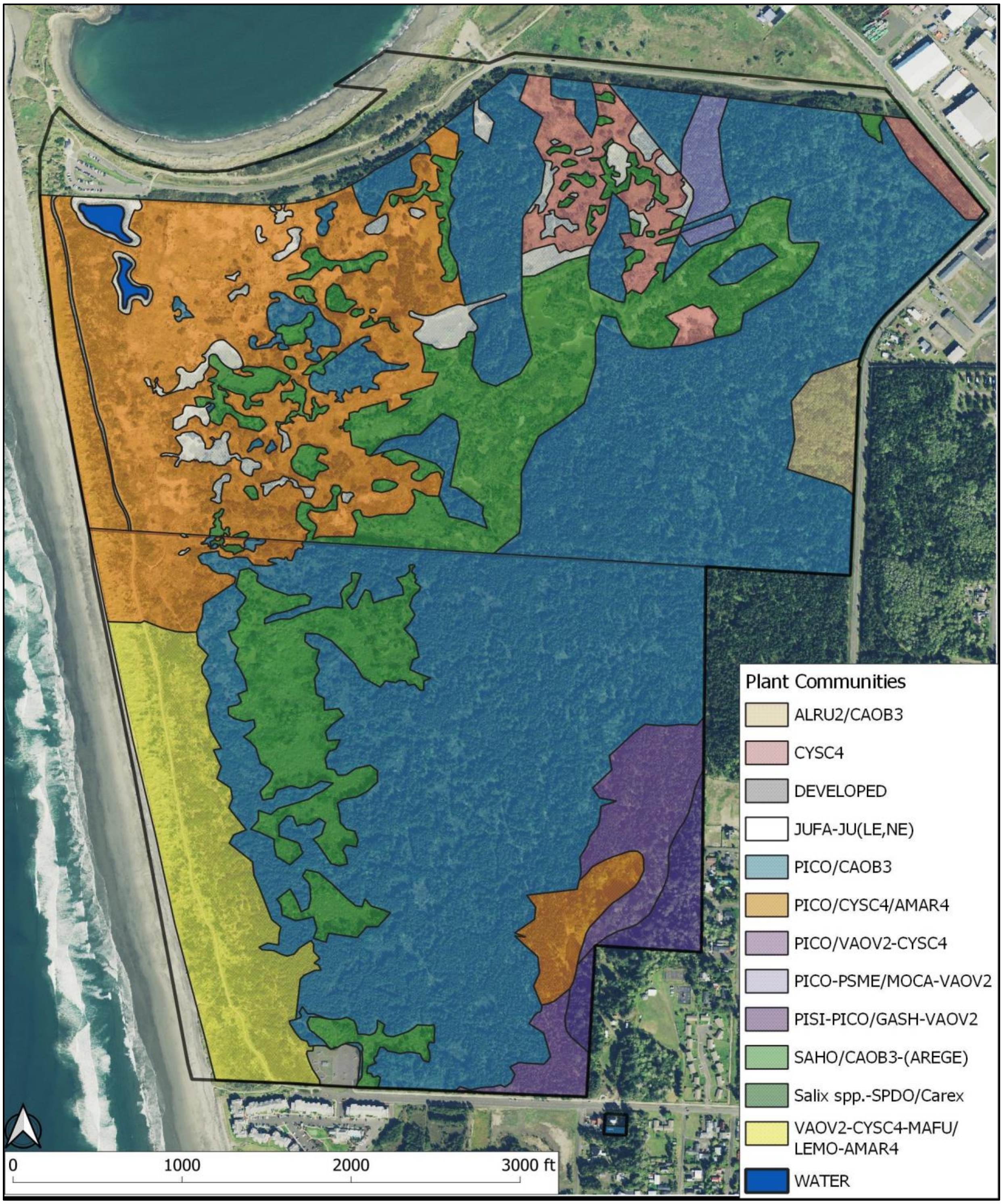

Figure 16. Mapped plant communities at Westport Light State Park. See text and Table 1 for descriptions of plant community codes. Communities were mapped by AECOM in the northern half in 2017 and in the southern half in 2021. Map data from Washington State Parks and Recreation Commission.

Table 1. Summary of plant communities reported in AECOM (2017, 2021b) or observed at Westport, including vegetation structure, rank[1], acreage, and most similar Oregon counterpart from Christy et al. (1998).

	Abbreviation	Name	Structure	Rank	Reported acres	Oregon counterpart
Early-seral wetland communities						
	JUFA-JU(LE,NE)	Juncus falcatus - Juncus (lesueurii, nevadensis) Wet Meadow	Herb	G3/S1?	12.1	Juncus falcatus-Juncus lesueurii Herbaceous Vegetation
	CAOB3-AREGE	Carex obnupta - Argentina egedii ssp. egedii Wet Meadow	Herb	G4/S2?	Unmapped	Carex obnupta-Argentina egedii Herbaceous Vegetation
	SAHO/CAOB3-(AREGE)	Salix hookeriana / Carex obnupta – (Argentina egedii ssp. egedii) Shrub Swamp	Shrub	G4/S1?	78.5	Salix hookeriana/Carex obnupta-Argentina egedii Shrubland
	SA sp.-SPDO/CA sp.	Salix spp. - Spiraea douglasii / Carex spp. Wet Shrubland	Shrub	G3G4/S2Q	0.2	Douglas spiraea Saturated Shrubland or Salix hookeriana/Carex obnupta-Argentina egedii Shrubland
Mid-seral wetland						
	PICO/CAOB3	Pinus contorta var. contorta / Carex obnupta Swamp Forest	Forest	G2S1	250.4	Pinus contorta var. contorta/Carex obnupta Seasonally Flooded Forest
Non-native upland						
	PICO/CYSC4/AMAR4	Pinus contorta var. contorta / Cytisus scoparius / Ammophila arenaria Semi-natural Forest or Shrubland	Forest or Shrub	GNR/SNR	96.2	Pinus contorta var. contorta/Cystisus scoparius/Ammophila arenaria Forest
	CYSC4	Cytisus scoparius Shrubland	Shrub	GNR/SNR	16.5	Pinus contorta var. contorta/Cystisus scoparius/Ammophila arenaria Forest
	VAOV2-CYSC4-MAFU/LEMO-AMAR4	Vaccinium ovatum – Cytisus scoparius – Malus fusca / Leymus mollis – Ammophila arenaria Shrubland	Shrub	GNR/SNR	35	Pinus contorta var. contorta/Cystisus scoparius/Ammophila arenaria Forest
	PICO/VAOV2-CYSC4	Pinus contorta var. contorta / Vaccinium ovatum – Cytisus scoparius Forest	Forest	GNR/SNR	16	Pinus contorta var. contorta/Cystisus scoparius/Ammophila arenaria Forest
Minor forest types						
	ALRU2/CAOB3	Alnus rubra / Carex obnupta Ruderal Flooded Forest	Forest (wetland)	GNR/SNR	5.9	Alnus rubra/Rubus spectabilitis/Carex obnupta-Lysichiton americanum Saturated Forest
	PICO-PSME/MOCA-VAOV2	Pinus contorta var. contorta – Pseudotsuga menziesii / Morella californica – Vaccinium ovatum Forest	Forest (upland)	GNR/SNR	4.2	Pinus contorta var. contorta – Pseudotsuga menziesii / Myrica californica – Vaccinium ovatum Forest
	PISI-PICO/GASH-VAOV2	Picea sitchensis – Pinus contorta var. contorta / Gaultheria shallon – Vaccinium ovatum Forest	Forest (upland)	G3/S2	7	Pinus contorta var. contorta - Picea sitchensis/Vaccinum ovatum Forest

[1] Rankings report the rarity of a plant community or taxa within the state (S-rankings) and across the globe (G-rankings). Rankings range from 1 to 5, where 1 is the rarest and 5 is the most common. The Natural Heritage Program of the Washington State Department of Natural Resources assesses and provides these rankings (https://www.dnr.wa.gov/natural-heritage-program).

We augmented the vegetation reports with our observations from field visits to the park, particularly the variation in depth, area, location, disturbance history, and dominant vegetation of the wetland swale. We developed comprehensive species lists for each vegetation type to assist in guiding possible restoration and relate their occurrence to these other variables. All species observed in each swale were recorded and ranked on a 5-point abundance scale. A total of 22 swales were surveyed, and each wetland was classified, based on the most dominant species, as belonging to a particular wetland community (data in Appendix A).

4.6.1 Early-seral wetland communities

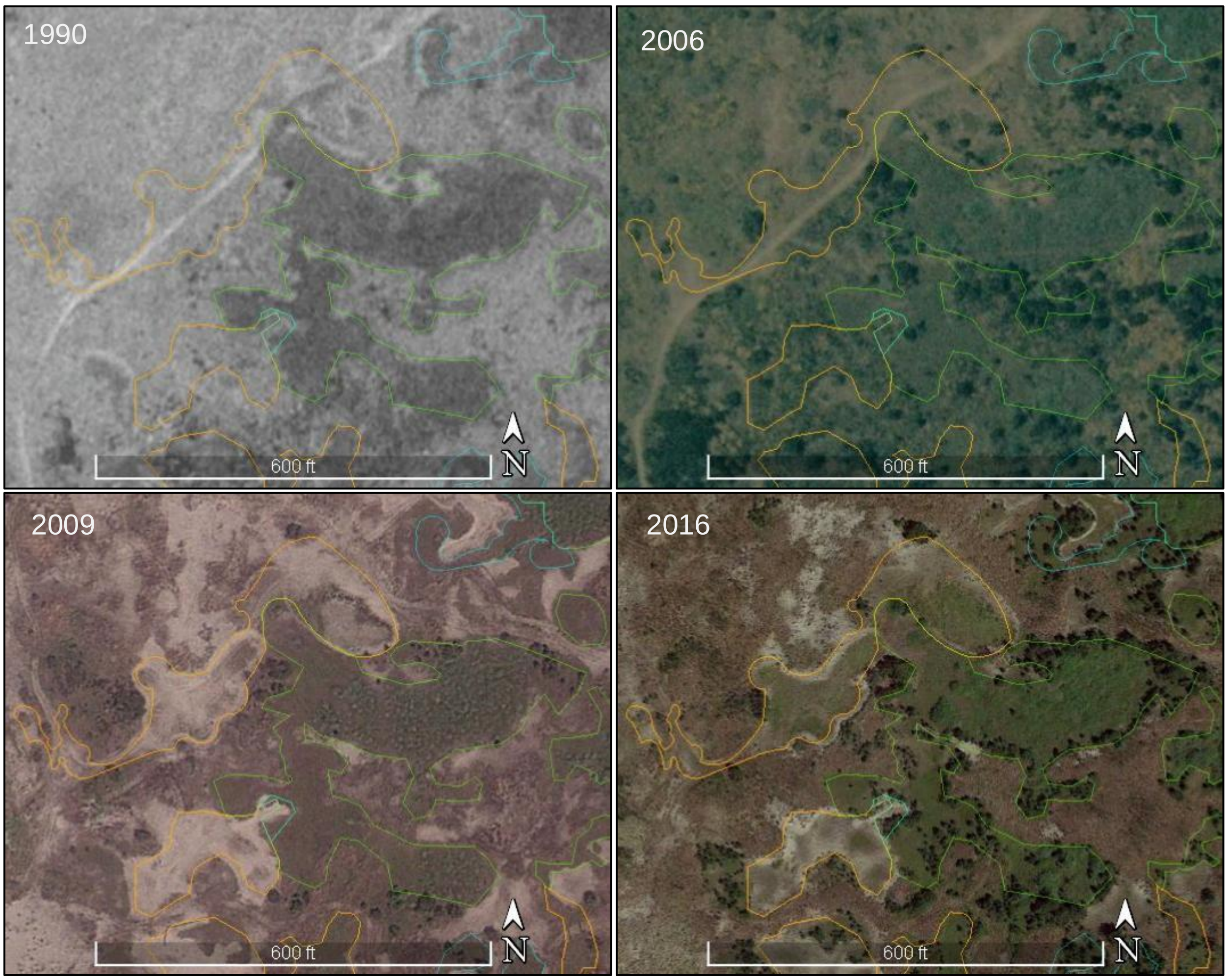

Figure 17. Historical aerial imagery focusing on several *Juncus* (orange outline), Hooker's willow (green), and shore pine-slough sedge (blue) wetlands in the northwest region of Westport Light State Park. Outlines denote plant communities mapped in 2017. Cutting and excavation for a golf course occurred in 2006. Young shore pine visible in 2016 grows both where it grew prior to cutting and in new areas. The locations of plant communities, primarily Hooker’s willow, were apparent prior to golf course development, while others, such as the *Juncus* wetlands, appear to have resulted from excavation. Map data: Google, USGS, USDA Farm Service Agency.

4.6.1.1 Herbaceous wetland communities

The herbaceous-dominated wetland communities at Westport are located in swales throughout the deflation plain. Historically, wind scours the surface until it intersects with the water table and these wetland communities are among the first to develop. At Westport, other disturbances such as bulldozing and off-road vehicle activity have reduced the ground elevation in much the same way, effectively resetting the successional clock so that the wetland communities can establish anew in created swales (Figure 17).

The herbaceous wetland communities are dominated by native graminoids and tend to vary in composition with depth (approx. 0.5-6 feet). Community dominants grade from *Carex obnupta* (slough sedge) in the deepest swales to *Juncus breweri*[2] in the shallowest, with a mix of graminoids in between.

While only one community type was mapped in reports (*Juncus falcatus* – *Juncus (lesueurii, nevadensis)* Wet Meadow), we observed a mix of multiple, intergrading community types. In particular, we identified a *Carex obnupta*-dominated community (*Carex obnupta - Argentina egedii* ssp*. egedii* Wet Meadow) that we consider in our restoration discussion ("Restoration opportunities"). It may have been overlooked during the June 2017 survey because it would have been under water; surveys of the edges of the swales likely recorded and over-emphasized the presence of *Juncus* species (Figure 15; further discussion in "Discussion of early-seral wetland communities").

There are few extant examples of these community types that illustrate their historical range of composition and condition in the region. However, several deflation plain, herbaceous wetland types have been described from dune environments in coastal Oregon that have many similarities to these counterparts in Washington. We examined multiple examples of these, as they provide useful guidance in identifying potential compositional and functional conditions. Table 1 lists the Westport communities and their Oregon counterparts.

The mapped herbaceous wetland community is the *Juncus falcatus* – *Juncus (lesueurii, nevadensis)* Wet Meadow (JUFA-JU(LE,NE)). It is a very early seral wetland community that is dominated by native herbaceous species, particularly rushes (see more details in box below). Vegetation mapping conducted by AECOM at Westport identified multiple examples of this vegetation type and noted its rarity in Washington (rank G3/S1?).

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[2]*Juncus breweri* (Brewer's rush) is the currently accepted name for what has previously been referred to as *Juncus lesueurii* or *Juncus lescurii* (Salt rush), both of which were misapplied. Since all of the references cited in this report refer to the species and the community type in which it grows using the older name, we continue to follow this nomenclature (e.g. *J. lesueurii,* JULE). Similarly, *Argentina egedii* spp*. egedii* (Pacific silverweed) is now properly referred to as *Potentilla anserina* ssp. *pacifica*, but we have retained use of the older name and acronym (AREGE) for consistency and clarity with the older references.

Juncus falcatus – Juncus (lesueurii, nevadensis) Wet Meadow
JUFA-JU(LE,NE)
Sickle-leaved rush – Salt rush Wet Meadow

- Characteristics
  - Very early seral wetland community
  - Dominated by native graminoids; shrubs and short trees sparse
  - 6-13 species at Westport
  - Rarity ranking: G3/S1?
  - Thin layer of organic material atop sand
- Distribution and size
  - Wetter parts of deflation plain in northern half of park only
  - Shallower swales
  - Some patches appear to have been created by earth-moving during the previous golf course attempt (Figure 12)
  - Small patches <0.5 ac
- Condition
  - Very few non-natives present
  - Less rich than those at Oregon Dunes: 6-13 vs. 48 species
  - Smaller in size than those at Oregon Dunes
  - Can succeed to Hooker's willow or shore pine communities

The *Carex obnupta - Argentina egedii* ssp*. egedii* Wet Meadow (CAOB3-AREGE) was not described at Westport by AECOM in 2017 or 2021. However, based on our observations of the dominance of *Carex obnupta* in many of the deeper swales (Figure 18 and Appendix A), we believe that many mapped occurrences of the JUFA-JU(LE,NE) and willow-dominated communities (described in the following section) more closely resemble this type. It is consistent with the same-name community described by Christy et al. (1998) in Oregon, except for the constancy of *Argentina* and total herb diversity. Similar types are described in Washington by Kunze (1994). This association is ranked G4S2? in Washington.

Carex obnupta - Argentina egedii ssp*. egedii* Wet Meadow
CAOB3-AREGE
Slough sedge – Pacific silverweed Herbaceous Vegetation

- Characteristics
  - Very early seral wetland community
  - Dominated by *Carex obnupta*; other graminoids abundant
  - 10-18 species at Westport
  - Rank G4S2?
  - 2-20" organic material atop sand
- Distribution and size
  - Not mapped, but better fits composition of some swales
  - Deeper swales of deflation plain in northern half of park only
  - Many patches dug or scoured during the previous golf course attempt
  - Small patches <0.5 ac
- Condition
  - Dominated by natives, but non-native *Hypochaeris radicata* abundant
  - Can succeed to Hooker's willow with age and dewatering
  - Compared to Oregon examples: considerably smaller, less *Argentina egedii*, and many fewer herbaceous species (10-18 vs. 54 species)

Figure 18. Close-up image showing the CAOB3-AREGE herbaceous wetland community. This community is present in deeper swales and is dominated by *Carex obnupta*, with components of *Argentina egedii* ssp*. egedii* and other herbs such as *Sisyrinchium californicum*, as seen here.

4.6.1.2 Shrub-dominated wetland communities

Two other early seral vegetation types are present at Westport that likely represent the typical successional process as shrubs invade the open herbaceous communities. Both are dominated by shrubs, either Hooker's willow (*Salix hookeriana*) or Douglas spiraea (*Spiraea douglasii*), which typically occur in small amounts in the herbaceous communities.

The *Salix hookeriana / Carex obnupta – (Argentina egedii* spp*. egedii*) Shrub Swamp (SAHO/CAOB3-(AREGE)) is a shrub-dominated association with an herbaceous understory comprised primarily of slough sedge. It is regarded as an early-successional type that replaces the CAOB3-AREGE association with either age or dewatering of the swale (via natural or artificial means). As the shrubs establish and mature, they increase in stature; at Westport, Hooker's willow ranges from 1-15 feet or more in height, with the herbaceous layer decreasing in abundance as the shrub layer increases in density and height (Figure 19). Christy et al. (1998) described this community in the coastal deflation plains of Oregon, and Kunze (1994) described a similar type in Washington but did not include Pacific silverweed. This association is ranked G4S1? in Washington. This was the major wetland association noted by AECOM in the northern portion of the Westport site, where they mapped over 50 acres.

Salix hookeriana / Carex obnupta – (Argentina egedii spp*. egedii*) Shrub Swamp
SAHO/CAOB3-(AREGE)
Hooker Willow / Slough Sedge – (Pacific Silverweed) Shrub Swamp

- Characteristics
    - Early-seral; replaces herbaceous communities, precedes shore pine
    - Hooker's willow dominates, underlain by sparse slough sedge
    - 3-20 species at Westport
    - Sand overlain by 2-20 inches of organic muck
    - Rarity ranking: G4/S1?
- Distribution and size
    - Mapped as small patches (<1 ac) plus contiguous matrix throughout disturbed area in northern half of park
    - Mapped as large patches in southern half
    - Reported as a common inclusion in PICO/CAOB3 Forest
- Condition
    - Very few non-natives present
    - Herbs much less rich than at Oregon Dunes (42 herb species)
    - May succeed to PICO/CAOB3 Forest

Figure 19. Ten-foot-high, dense Hooker's willow in the SAHO/CAOB3-AREGE community. Herbs become sparse as the shrubs become taller and denser in this community.

A second, closely-related shrub-dominated wetland type also exists at Westport. It is very similar to the willow-dominated association described above except that Douglas spiraea is the dominant shrub instead, with Hooker's willow sometimes absent (Figure 20). Although AECOM did not distinguish it as present in the northern portion of the Westport site, they did map a single, small occurrence of a *Salix spp. – Spiraea douglasii / Carex (aquatilis* var*. dives, obnupta, utriculata*) Wet Shrubland in the immediately-adjacent southern portion of the site. We consider this patch, along with other examples we observed in the northern half, to be a very slight variation on the SAHO/CAOB3-(AREGE) community. As such, we combine it with this much more common community in our restoration discussion. It falls somewhere between the Douglas spiraea Saturated Shrubland and Hooker's willow/slough sedge-Pacific silverweed associations described by Christy et al. (1998) in Oregon.

Figure 20. Depauperate herb layer under Douglas spiraea in the SPDO-SAHO community. Relatively tall-statured moss is ubiquitous, and few herb species are present.

4.6.1.3 Discussion of early-seral wetland communities: Occurrence, ecology, and floristics

All of these early-seral communities occur in the deflation plain swales at Westport, where they typically occupy sandy substrates with relatively thin accumulations of organic matter. They occur in swales that are seasonally inundated, beginning to hold standing water in the fall as the freshwater table rises in response to autumn rains, and continuing to stay flooded until water tables drop during the following summer drought. Shallow swales and those at higher elevations tend to be filled for shorter periods than the deeper basins.

The two herbaceous-dominated types we identified appear to differ due to the duration of inundation. The *Juncus*-dominated type (JUFA-JU(LE,NE)) occurs at the shallowest water depths, which we estimated to not exceed 1.5 feet, based on their position relative to apparent shorelines. Thus, this type was found in the shallowest (and often smallest) swales, as well as at similarly shallow depths (which often occur in fairly narrow bands) around the margins of deeper swales. As a result, species such as Sandmat (*Cardionema ramosissima*), which are more typical of dune uplands but can tolerate some inundantion, were frequent associates. The

JUFA-JU(LE,NE) type is not particularly species-rich at Westport, with only 6-13 species recorded in the swales we documented. While the dominant taxa, especially the graminoids, are natives, non-natives are also present, as several weedy species are able to tolerate some inundation (e.g., *Hypochaeris radicata/Leontodon saxatilis, Plantago lanceolata,* and *Rumex acetosella*).

In contrast, the CAOB3-AREGE association primarily occurs in the lower portions of deeper swales, which generally range from 1.5-6 feet deep. The dominance of slough sedge makes this association readily apparent, and it often replaced the *Juncus*-dominated vegetation toward the center of swales. The species data we collected from these swales, however, were drawn from the entire swales, including both shallower and deeper areas. As a consequence, the data included vegetation that has been separated by others into two different herbaceous wetland types (CAOB3-AREGE in the deeper areas, JUFA-JU(LE,NE) in the shallows). This, in turn, results in higher species diversity values for the CAOB3-AREGE swales (10-18 species), as shown in Appendix A. As would be expected, herbaceous species that tolerate or require longer periods of inundation that were absent from the JUFA-JU(LE,NE) associations were found in this type, including Spring-bank clover (*Trifolium wormskioldii*), Marsh speedwell (*Veronica scutellata*), and Pacific silverweed (*Argentina egedii* ssp. *egedii*). Interestingly, Dune rush (*Juncus nevadensis*), one of the typical dominants in the JUFA-JU(LE,NE) community as it has been described elsewhere, was only found in the deeper, slough-sedge dominated swales. This illustrates the close affinities and considerable overlap in composition that occur among these plant associations.

The overlap in composition and co-occurrence within a swale can make it difficult to distinguish one herbaceous type from another, which no doubt has led to some of the differences noted above in nomenclature and mapping. We believe that some of the differences may derive from when the communities were surveyed (June 7-9; AECOM 2017). In spring and early summer, the lower portions of the deeper swales are inundated, inhibiting the growth and visibility of the CAOB3-AREGE associations (Figure 15 above). Thus, many of these swales were mapped as *Juncus*-dominated rather than *Carex*-dominated communities, since only the vegetation towards the swale margins would have been visible.

Despite differences in the nomenclature used to describe these herbaceous plant associations, there is little difference in terms of the significance of these associations from an ecological, floristic, or rarity perspective. They both occur in the same areas at Westport, and are the main communities that become established in deflation swales that intersect the water table, regardless of whether they are artificially dug or developed naturally. In addition, both are highly ranked associations in Washington (S1 or S2), and there is considerable overlap in their species composition.

Christy et al. (1998) found these two herbaceous associations to be the most floristically diverse of any described in the Oregon dunes, with 48 species recorded in the *Juncus*-dominated type and 54 in the *Carex obnupta*-dominated association. They were not nearly as diverse at Westport, although most of the dominant species were the same in both Oregon and

Washington. This difference in diversity may reflect the much greater area occupied by these associations in the Oregon Dunes, since in general, larger areas tend to support higher numbers of species. It may also reflect the younger age of these vegetation types at Westport, where much of the landscape appears to have originated less than 150 years ago and many of the swales were disturbed 15 years ago. Importantly, it suggests that there may be considerable potential for significantly increasing the diversity of these communities with concerted restoration efforts.

Further, the communities appear to rapidly recover from disturbance. We compared swales that had been disturbed by activities associated with the 2006 golf course construction with those that were undisturbed by that activity. The topography and plant communities of the latter may be considerably older, having developed exclusively through wind-driven deflation and avoided surface disturbance. However, comparisons between them revealed no differences in species composition or diversity (Appendix A), suggesting rapid re-growth (if vegetative propagules remained intact) and/or colonization of disturbed sites. The main distinguishing feature was that the dug swales had more abrupt edges with steeper margins. This resulted in the occurrences of the JUFA-JU(LE,NE) associations being narrower, less extensive, poorly developed, or missing altogether if gradually sloping shorelines were absent.

The willow- or spiraea-dominated associations (SAHO/CAOB3-(AREGE), SA sp.-SPDO/CA sp.) are widespread at Westport, where they occur in both recently younger swales as well as in older, undisturbed areas. As already noted, they are successional to the herbaceous-dominated associations, particularly the deeper swales that hold water later into the summer. As the shrubs gradually increase in height and density, organic matter accumulates to form a mucky substrate, and many of the herbaceous taxa disappear. Few new species become established beneath the willows and spiraea, although Leathery grapefern (*Sceptridium multifidum*) was one species that we only found in this association.

Due to the variability in size, age, and density of the shrub layer, the shrub-dominated swales vary greatly in species diversity (3-20). As might be expected, the two swales with the tallest willows had the fewest species (3 and 6), whereas those with the shortest and sparsest willows had some of the highest diversity (13 and 20). These also were the two occurrences of this association that we suspect had been deepened during the 2006 golf course construction, so the shrubs had only a few years to become established.

Like the herbaceous communities, the shrub communities are depauperate in species (particularly herbs) compared to examples in Oregon. This may be a product of their direct development from the depauperate herbaceous communities; similarly, there may be opportunities to enhance their diversity. However, the growing shrubs would likely outcompete many herbaceous plants in time.

4.6.2 Mid-seral wetland community

The *Pinus contorta / Carex obnupta* Swamp Forest (PICO/CAOB3) is by far the most abundant vegetation community at Westport. This mid-seral community replaces earlier-seral herbaceous or shrub-dominated wetland communities; aerial imagery shows shore pine spreading rapidly across the park since 1990 (Figure 14, above). It tends to invade as swales become drier, and likely facilitates further drying by transpiring large volumes of water.

Pinus contorta / Carex obnupta Swamp Forest
PICO/CAOB3
Shore pine / slough sedge Swamp Forest

- Characteristics
  - Overstory of shore pine with understory dominated by slough sedge or moss; shrubs sparse
  - Mid-seral: replaces herbaceous or shrub communities, precedes upland forest like PISI-PICO/GASH-VAOV2
  - Canopy cover 60-85%
  - < 30 years old in northern half of park; 25-40 years old in southern half
  - Inclusions of SAHO/CAOB3 communities in depressions
  - Forest shrubs and sword fern grow on small mounds
  - Low species diversity
  - Ranking: G2/S1
- Distribution and size
  - Most abundant community type: covers roughly half the park, primarily in eastern half
  - Large swath in northern half cut during previous golf course attempt
- Condition
  - Very few non-native plants
  - Intact, widespread at Westport
  - Relatively young
  - Good condition, but not a diverse community
  - May succeed to upland forest types

4.6.3 Non-native upland communities

Four upland communities dominated by non-native plants were distinguished in the vegetation surveys (Table 1). The most common is the *Pinus contorta* var*. contorta / Cytisus scoparius / Ammophila arenaria* Semi-natural Forest or Shrubland (PICO/CYSC4/AMAR4), which always includes dominant components of Scotch broom and European beachgrass, typically with shore pine. The other three are variations on this theme, with more or less Scotch broom and native shrubs. They occur primarily in the western area of the park, where beachgrass and Scotch broom have invaded the foredune or uplands interspersed among the swales, but without heavy shore pine cover that limits the non-natives.

Pinus contorta var*. contorta / Cytisus scoparius / Ammophila arenaria* Semi-natural Forest or Shrubland
PICO/CYSC4/AMAR4
Shore pine/Scotch broom/European beachgrass Semi-natural Forest or Shrubland

- Characteristics
    - Scotch broom and often European beachgrass beneath an overstory of shore pine with canopy cover <25%-80%
    - Appearance ranges from open shrubland with 90% cover of Scotch broom to closed-canopy forest with intermittent Scotch broom openings
    - Unranked
- Distribution and size
    - Large matrix with herbaceous and shrubby wetland communities in northwest portion of park, plus smaller patch in southeast
- Condition
    - Non-native species abundant or dominant
    - Inherently poor condition

4.6.4 Minor forest communities

Three other forested communities were mapped, each covering 7 or fewer acres (Table 1). One is a wetland community dominated by red alder, *Alnus rubra / Carex obnupta* Ruderal Flooded Forest (ALRU2/CAOB3) on the northeast edge of the park, the most similar Oregon counterpart of which was associated with stream floodplains east of the dunes (Christy et al. 1998). Indeed, at Westport, the community is the farthest east and in the vicinity of a drainage ditch next to the road. It is a mid-seral association that succeeds CAOB3-AREGE and precedes Sitka spruce communities.

Two of these minor communities are upland forests with a substantial evergreen huckleberry components in the shrub layer: *Pinus contorta* var*. contorta – Pseudotsuga mensiezii / Morella california – Vaccinium ovatum* Forest (PICO-PSME/MOCA-VAOV2) and *Picia sitchensis – Pinus contorta* var*. contorta / Gaultheria shallon – Vaccinium ovatum* Forest (PISI-PICO/GASH-VAOV2). They are mid-seral communities that replace PICO/CYSC4/AMAR4 or PICO/CAOB3, with Sitka spruce being the eventual canopy dominant. They are generally located eastward in the park, where shore pine established earliest and has had the most time to transition to these other forest types.

4.7 Rare plants and fungi

Biological surveys conducted so far have reported no federal or state-listed plant species in the park. However, several rare species have been reported from similar habitats along the Washington coast, including *Abronia umbellata var. acutalata* and *Sanicula arctopoides*. There is insufficient suitable open sand habitat at the site to support the *Abronia*, but there is some possibility that the *Sanicula* could be introduced to the site, as noted further in Section 5.3.2.

The Natural Heritage Program has recorded one observation of a rare lichen, *Kaernefeltia californica*, ranked as G3/S2. The species was observed on the bark of shore pine in the dune area between older Sitka spruce forest and the beach in 1994. Three previous collections as early as 1908 from the same area also documented it growing on both living and dead shore pine (AECOM 2021b). However, there is no information regarding its abundance or distribution on the site when these previous observations were made, nor is it known whether it still persists on the site. It is recommended for listing and under review in Washington and has been under evaluation as a Survey and Manage species under the U.S. Forest Service Northwest Forest Plan, which lists species that are closely associated with late-successional or old-growth forests. It is reported to be threatened by the loss of habitat or impacts to occupied habitat such as changes in microclimate or removal of substrate (Lesher et al. 2003). In Washington it has been collected in the San Juan Islands, Kitsap Peninsula, and near Westport. It also is known from the Oregon Dunes National Recreation Area.

4.8 Wildlife habitat

An assessment of wildlife habitat at Westport was conducted by AECOM in 2021 (AECOM 2021c). They categorized and scored habitat types based on observed and potential wildlife use, considering characteristics such as size, uniqueness, food, water, and cover. Table 2 summarizes the habitat types, together with the scores they assigned to each type. The table also includes the plant associations described in this report for comparison with the wildlife habitat types.

AECOM concluded the habitat types with greater structure and diversity – areas dominated by trees and native shrubs – offered the greatest benefits to wildlife in general. They documented a diversity of birds that frequented various of the habitats at Westport (Table 3 in AECOM 2021c), but observed evidence of relatively few other fauna – just black-tailed deer, black bear, coyote, and northwestern garter snake, all but the last of which use most of the habitat types present on the site. We also observed evidence of porcupine in a small patch of older shore pine.

No threatened, endangered, or otherwise-listed species were observed at Westport, but two have suitable habitat near the park (Oregon silverspot butterfly, western snowy plover). Four Birds of Conservation Concern (migratory bird species not listed but that may become candidates without conservation action, as determined by the U.S. Fish and Wildlife Service) were documented during surveys: olive-sided flycatchers, rufous hummingbirds, whimbrels, and bald eagles. The first two were observed on the site; the last two were flyovers.

Table 2. Wildlife habitat types and ratings assigned by AECOM (2021c). Plant associations described in this report that are present in the habitat types are listed in the last column.

Wildlife Habitat Type	Average Habitat Scoring	Habitat Rating	Plant Associations
Mixed Conifer Forest	64	Medium-High	PICO/CAOB3; PICO-PSME/MOCA-VAOV
Mixed Open Wet Areas	73	High	SAHO/CAOB3-(AREGE); PICO/CYSC4/AMAR4; JUFA-JU(LE,NE); CAOB3-AREGE
Coastal Shrublands	36	Low	PICO/CYSC4/AMAR4; AMAR4
Riparian Shrub Areas	60	Medium	SAHO/CAOB3-(AREGE)
Mixed Deciduous Forest	78	High	ALRU/CAOB3
Disturbed Open Grasslands	36	Low	AMAR; CYSC4; JUFA-JU(LE,NE); CAOB3-AREGE

No observations were made of use on the site by small mammals or invertebrates, and there was limited documentation of reptiles and amphibians. As a result, little is known about the abundance or diversity of these animals at Westport. The Oregon silverspot butterfly, a federally threatened and state endangered species, was reported as being mapped to potentially occur in the park by the U.S. Fish and Wildlife Service.

Comments from the Friends of Grays Harbor to the EPA in 2003, in response to the U.S. Army Corps of Engineers' Environmental Impact Assessment for the initial golf course development, claimed that coho salmon may access the drainage ditch that enters the property on the eastern side (Figure 11) and over-winter and rear in the inundated deflation swales. While it is possible a salmon could reach the ditch from Grays Harbor and perhaps the channels feeding it from the eastern *Alnus rubra* forest, we consider it extremely unlikely that a salmon could reach the deflation swales and use them for over-wintering or rearing. Further, no other reports of salmon activity have been documented, and the wetland and wildlife reports stated that the site does not provide fish habitat (AECOM 2021a, c). Thus, we did not further consider salmon habitat in this report.

5. Lessons learned from Chambers Bay and Bandon Dunes

To provide a broader context for evaluating the feasibility of restoration with the proposed golf course at Westport and deepen our understanding of the design and management of Scottish links-style golf courses, we visited two such courses in coastal Washington and Oregon – Chambers Bay (Tacoma, Washington) and Bandon Dunes Golf Resort (Bandon, Oregon). We were particularly interested in understanding how natural ecological features can be incorporated into these courses and exploring what restoration opportunities were used that may be compatible with development at Westport. The two courses were chosen because both are designed as links courses and were constructed close to the Pacific shore, thereby presenting some similarities in vegetation, climate, sandy substrate, and course design. A major difference that distinguishes these sites from Westport is their geomorphic and topographic setting. While the Westport course would be constructed on a coastal sand sheet that is 10-30 feet above sea level, the two other courses both lie atop coastal bluffs that are considerably higher. (Bandon Dunes ca. 80-150 feet ASL; Chambers Bay 25-240 feet ASL).

The Chambers Bay course was constructed in an abandoned gravel pit and as such had few existing natural features of ecological value to incorporate into its design. No natural sand dunes were present around which to sculpt the terrain as with a traditional links course, nor was there extensive coastal vegetation dominated by grasses and low shrubs that characteristically comprise the vegetation in the roughs and non-playable surfaces. Instead, extensive contouring and shaping of the terrain was required to construct the network of greens, fairways, and roughs. The latter were then vegetated with fescue and other grasses to resemble links-style courses. Based on our observations, few native plants were incorporated into its design, and the roughs are regularly mowed and managed. A small forested area dominated by Douglas-fir at the northern end of the site, connected by a walking path to the playable course, provided an example of native vegetation. Our overall impression of the course was that it provided little ecological value.

In contrast, the six courses comprising the Bandon Dunes Resort were designed from the outset as traditional links courses, incorporating the coastal sand dunes and existing vegetation into courses that closely resemble their counterparts in the British Isles. To a considerable extent, the design of many of the courses leaves an environmentally-friendly impression and intends to preserve natural ecological values. Of the six golf courses, Bandon Dunes Preserve was the best example of how existing ecological features can be integrated conspicuously and deliberately into a playable course. The course supports the largest population of a rare plant – Silvery phacelia (*Phacelia argentea*) – in existence, and its preservation is prominently featured by the resort (it is the course logo). Other native dune grasses, forbs, and low shrubs occur in some of the roughs between the fairways. Environmental stewardship is a conspicuous element, which includes a relatively light use of fertilizers, recycling of grass clippings, aggressive control of invasive gorse shrubs, and a dedication of net proceeds to a local non-profit that focuses on local ecological initiatives.

But even the most environmentally-inclined golf courses come with ecological costs as well. The footprint of the course layout inevitably eliminates many acres of native habitat and impedes the dynamic movement of dune landscapes, while fertilizers and irrigation may pose threats to water quality in the area. The Old McDonald course at Bandon Dunes illustrates some of these tradeoffs. The first course of the resort, it was established in a vast shrubland of gorse (*Ulex europaeus*), an introduced, highly-flammable plant that had led to multiple wildfires in the town of Bandon (ironically, gorse is one of the classic features of traditional link courses in Scotland). The course was successful in reducing the extent and connectivity of the gorse, thereby presumably greatly reducing the fire risk as well. However, as with Chambers Bay, there were few ecological features to preserve through construction, and today, gorse is present in the roughs and unmanaged portions of the course despite the agronomists' desire to eradicate the species from the site (Ken Nice, *pers. comm.* 10-6-21).

In all, the courses somewhat improved poor ecological conditions – an open gravel pit, high wildfire risk posed by expansive stands of a non-native shrub in a wildland-urban interface – but also both stimulated development in, and simultaneously preserved aspects of, an existing high-value environment. The Westport site presents similar scenarios that are likely to have both positive and negative impacts. Opportunities exist for reducing the extent of invasive stands of Scotch broom and European beachgrass, but they would be exchanged for the negative impacts to existing communities from the construction and operation of a golf course as well the ecological benefits realized from restored native plant communities.

6. Constraints on restoration and golf course design

Several constraints on the design of the golf course and potential restoration guided our development of restoration opportunities at Westport. Both Parks and the developers have constraints on design for a variety of reasons.

1. Minimal filling of wetlands.
    a. Reasoning: The State Parks Critical Areas Policy states a preference to limit construction in, or impacts to, wetlands, but does allow for fill if impacts are unavoidable, can be mitigated, and are consistent with a Commission-adopted park plan. If wetland impacts are unavoidable, Parks will ensure its actions do not contribute to a net loss in the acreage or function of the State's wetlands.
    b. Outcomes: Mapped wetlands cover 70% of the park. Including potential buffers around wetlands, the remaining area available for course development is highly restricted. This results in the need to transform a large portion of upland areas into fairways and greens. This would leave few upland areas available for restoration opportunities but preserve much of the existing wetlands.
2. Need 18 holes of golf.
    a. Reasoning: Standard course size is necessary for profitable financial return on investment.
    b. Outcomes: Little flexibility on area needed for playable course. Nearly all uplands needed for development (see #1).
3. Year-round play.
    a. Reasoning: Year-round play is necessary for profitable financial return on investment.
    b. Outcomes: Wildlife (e.g., bird nesting) would be impacted by human presence and movement during every season. Seasonal closures for nesting or migration would not be possible.
4. No removal of beachside foredune stabilized by European beachgrass.
    a. Reasoning: The foredune blocks the ocean from flooding and/or eroding the cement walking path, as well as preventing ocean flooding and sand deposition in the deflation plain. Removing or bulldozing the foredune (as was accomplished at Leadbetter State Park to provide rare plant habitat) would dramatically increase the potential for ocean flooding and sand movement on and off the foredune and deflation plain. This is undesirable because Parks wishes to maintain recreation access to the cement path and the golf course needs to be built on stable substrate not subject to active sand movement.
    b. Outcomes: Conversion of the stabilized dunes into a dynamic system with shifting sands is not possible. Stable, vegetated dunes would remain as the geomorphic structure upon which a golf course will be developed. The introduction of plant species adapted to shifting sands would be extremely difficult.

7. Restoration opportunities

There are numerous restoration actions that potentially could enhance the ecological attributes of the Westport site. In considering the various opportunities, four categories stand out that are feasible to consider at Westport and typically desirable to ecological restoration practitioners. These include pursuing actions that:

1. Enhance the diversity and viability of plant communities, with a particular emphasis on rare or uncommon community types,
2. Enhance the diversity of native species, with a particular emphasis on incorporating viable populations of rare species,
3. Reduce the abundance of highly invasive, non-native species that tend to outcompete native taxa, and
4. Enhance habitats for particular wildlife.

These restoration actions are not mutually exclusive and restoration efforts often combine several of them in ways that often can be mutually reinforcing and synergistic. Enhancing wetland and upland plant communities can either involve communities or species that already occur on the site, or that potentially could be restored[3] to the site. Enhancing species diversity often serves as a key strategy in enhancing communities, and is frequently partnered with removal of invasive non-native species. Enhancing wildlife habitat may be combined with any of the other three restoration actions that are compatible with, or enhance habitat suitability for, target wildlife.

7.1 Action 1: Enhancing wetland plant communities

7.1.1 Restoration potential

In exploring Action 1 at Westport, we identified four existing native wetland communities that are rare or uncommon, considered their condition and size, and compared them to counterparts in Oregon that provide guidance in identifying potential restoration objectives. Detailed summaries of the communities are provided previously in “Vegetation communities.” Here, we use that information to assess the potential for restoration and enhancement.

Three S1- and one S2-ranked wetland communities have been identified at Westport. The S1 communities include the *Juncus falcatus-Juncus* (*lesueurii, nevadensis*) Wet Meadow (JUFA-(JU(LE,NE)), *Salix hookeriana / Carex obnupta* – (*Argentina egedii* spp. *egedii*) Shrub Swamp (SAHO/CAOB3-(AREGE)), and *Pinus contorta* var. *contorta / Carex obnupta* Swamp Forest (PICO/CAOB3), and the S2 community is *Carex obnupta - Argentina egedii ssp. egedii* Wet Meadow (CAOB3-AREGE) The wet meadow and shrub swamp types are early-successional,

[3] We use the terms “restore” and “restoration” in both the traditional sense to refer to establishing or enhancing species or communities that are or once were known to be extant on a site, as well as to refer to establishing species or communities that may not ever have existed on the site but are known from other sites with similar conditions.

herbaceous or shrub-dominated communities that occur in the sandy, low-nutrient deflation plain swales behind the primary foredune at Westport. The *Pinus contorta* swamp forest tends to replace the early-successional communities but transitions in dominance to *Picea sitchensis* (Christy et al. 1998; *pers. obs*.), and thus is considered a mid-successional type.

All three of the early-successional communities are very rare in Washington and thus are of considerable ecological significance. The examples at Westport are in good condition, generally with few non-native plants even though many were created or heavily disturbed by bulldozing within the last 15 years. However, these early-successional communities are neither numerous nor very large, at least in the northern half of the park, as is evident from maps where the individual swales have been delineated (Figure 11). The largest examples of both the *Juncus* and *Carex*-dominated wet meadow types are <0.5 ac and many are considerably smaller. The swales with *Salix* and *Spiraea*-dominated shrub swamp vegetation also occur as relatively small patches in the deflation plain, but are more numerous than the herbaceous types. The largest example we could find was just under 1 ac. However, there is also an extensive example of the *Salix* swamp in the southern half. Based on our assessment of individual examples within the “wetland mosaic” mapped by AECOM (2021), we conclude that collectively, these community types do not amount to more than a few tens of acres.

The communities’ small size makes them extremely vulnerable from multiple threats. These include partial or complete eradication by the infilling of drifting sand, physical disturbances that damage or destroy much of the vegetation, encroachment of competitive non-native species that can overwhelm native assemblages, ecological succession that results in the loss of early successional species and communities (see below), and degradation of community composition brought about by changes in water quality (such as chemical input from adjacent upland land uses).

These communities also are not particularly species-rich, especially compared with their occurrences in Oregon where they occupy many acres (about a dozen species at Westport compared to 50 in the Oregon Dunes). This is likely a result of their small size, recent origin, and lack of nearby occurrences that could have served as sources for establishing a greater diversity of species. The examples in Oregon also include small mounds that harbor a different community of species than the surrounding low swale; these mounds add considerably to the total species diversity of the community.

The mid-successional, S1-ranked PICO/CAOB3 community is much more extensive at Westport than the three early-successional communities. It has spread considerably across the park in recent years (Figure 14) and seems to be in no danger of eradication or conversion. Several large examples of this community are present in the northern areas of Westport that may be protected by a deed restriction (Andrea Thorpe *pers. comm.* 11-3-21). Older examples of this community (ca. 40 years) are present in the southern portion of the park. These older stands are less common, take longer to develop, and may harbor uncommon species (such as the lichen *Kaernefeltia californica*; see “Rare plants and fungi”); we consider them to be of greater ecological value than the relatively young stands in the northern portion. Based on these patterns, we conclude that there is little value in actively restoring or establishing more of the PICO/CABO3 community. Rather, we propose protecting a substantial portion of the extant older forest.

One other wetland community described at Westport - the *Alnus rubra / Carex obnupta* Ruderal Flooded Forest – could potentially be hydrologically enhanced. This type is not currently ranked in Washington and occurs in a discrete, relatively small area at the far eastern edge of the property. It is, however, highly rated for wildlife habitat value (AECOM 2021c).

Several natural channels flow out of the stand into a drainage ditch that provides a direct surface connection to saltwater in Grays Harbor (Figure 11). The ditch is noted in the AECOM (2021a) wetland assessment, but they made no comments regarding its possible influence on wetland hydrology. Historically, such ditches were often dug to accelerate or re-direct water to facilitate use of adjacent areas impeded by excessive water. If this were the case at Westport, blocking or otherwise retiring this ditch could potentially slow the rate of water leaving the site, resulting in larger areas of wetlands or longer periods of inundation in the park. However, this is largely speculation on our part and a thorough hydrological study would be required to better understand the role this ditch plays in affecting the depth and duration of water levels in the Westport wetlands.

7.1.2 Restoration actions

Improving the various early-successional, herbaceous and shrub-dominated wetland types (JUFA-JULE, CAOB3-AREGE, and SAHO/CAOB3-AREGE) at Westport is the most significant ecological enhancement to consider. The recent, human-influenced history of some of them provides solid evidence that it is feasible to establish some form of this community fairly readily if the terrain, substrate, and hydrology are suitably constructed. From a restoration perspective, it is also encouraging that they apparently became vegetated on their own after being regraded, largely with native species (i.e., we have no evidence that they were deliberately planted). It is likely that the addition of seed or plugs of other species would successfully increase the species diversity in these habitats at Westport.

Removing the intervening uplands between the swales would also remove shore pine, potentially many stems due to their high density in many places. Cutting substantial amounts of shore pine could reduce transpiration and raise the water table, as observed after lodgepole thinning in a montane meadow (Surfleet et al. 2020). This could recharge underground aquifers and increase – or restore – levels and timing of annual surface inundation. Detailed hydrological studies would be needed to ascertain the magnitude of potential changes that could result in the water table.

We also recommend protecting (or maintaining protection, in the case of the deed restriction) existing high-quality examples of the PICO-CAOB3 swamp forest. These communities are rare statewide but locally common, so balancing their extent with that of the rare herbaceous communities can both maintain their commonness and allow for enhancement of the herbaceous communities.

The following are actions that would enhance the ecological value of the wetland communities:

1) Increase the area of all these community types by enlarging existing swales and creating additional small swales. Priority could be given to connecting nearby swales by removing intervening uplands, particularly those that are dominated by non-natives.
    a. Advantages: Increasing the cumulative area occupied by these swales would potentially increase community and species viability in several ways. Larger areas would support larger populations of many species and increase opportunities for metapopulation dynamics that would facilitate species movement and genetic interchange among subpopulations in nearby swales. They would also provide more locations in which more native species could be introduced, thereby increasing beta diversity. The removal of shore pine between wetlands may alter hydrologic patterns.
2) Increase the heterogeneity of habitats within and among communities. By creating bigger swales (Action 1), more opportunities would exist to create microtopographic variation, such as mounds, and increase compositional variation and alpha diversity within swales. Alternatively or in addition, creating additional swales at slightly different depths and cross-sectional profiles would similarly diversify habitats in water depth and duration of inundation.
    a. Advantages: Increased within- and among-community heterogeneity would facilitate increased species diversity and community resilience.
3) Regardless of the swale area and/or number, these communities could be further enhanced by adding new species to each swale, further increasing alpha diversity. Species that might be added could be drawn from the overall species list from swales at Westport, as well as from Oregon sites (Table 5 in Action 3). Although no species that are listed as rare in Washington have been identified in the Westport wetlands, several occur in their counterparts in Oregon that potentially could be introduced into this site; this opportunity is discussed in Action 3 below.
    a. Advantages: More and larger populations of uncommon species would make them more viable and less likely to become extirpated or extinct.
4) Protect the best and oldest examples of the PICO-CABO3 forest.
    a. Advantages: Protecting existing communities already in good condition is less expensive and more assured of success. In addition, it facilitates the harboring of old forest-related species.

7.1.3 Restoration implementation strategy

Implementation can aim toward creating opportunities for the natural sorting of species among swales. The two herbaceous wetland communities overlap considerably in species composition and often are contiguous or closely interspersed with each other, differing only due to small differences in depth and duration of inundation. Therefore, it would be very difficult to set precise compositional goals for individual wetlands. Instead, restoration would best proceed by focusing on creating a diversity of shallow wetlands that vary in their physical characteristics - size, connectedness, shoreline steepness, heterogeneity of microtopography, etc. These would then be sown with propagules from both community types to the extent they are available, and largely let nature sort out which species are best adapted to the environmental conditions across each swale. Species could be drawn from the lists presented in Appendix A and in Table 5 (see Action 3). Based on our observations of how the wetlands appear to have been naturally revegetated following previous disturbances, this approach would very likely result in an assortment of swales that vary in composition and structure, but all of which would be of considerable ecological value.

Shrub-dominated wetlands would naturally arise from the herbaceous wetlands as succession occurs. This development appears to happen fairly rapidly, perhaps within a decade or so, as evidenced by small willows present in many of the swales. Restoration of these communities would thus arise naturally from the restored swales described in the previous paragraph. This approach, which some have termed "successional management," is being increasingly embraced by restoration practitioners in appropriate settings (Krueger-Mangold et al. 2006).

As listed in Table 1, the herbaceous communities are ranked either G3S1 or G4/S2, while the shrub communities are either G4S1 or G3G4/S2Q. Thus, regardless of which community type establishes, rare community types would be promoted. However, because the shrub-dominated communities likely persist on the landscape considerably longer than the herbaceous types, it is likely that the herbaceous types will disappear more quickly and hence be rarer, absent some mechanism for creating new occurrences on a regular basis.

7.2 Action 2: Enhancing upland plant communities

7.2.1 Restoration potential

In the northern portion of Westport, upland community types consist primarily of vegetation heavily dominated by non-native species. The two main types are the *Pinus contorta* var. *contorta / Cytisus scoparius / Ammophila arenaria* Semi-Natural Shrubland and the *Cytisus scoparius* Shrubland. Originally planted to stabilize the sand, the non-natives further increased in extent and density after widespread surface disturbance during the previous golf course construction. Today, the two community types form an extensive mosaic intermixed with the deflation plain swale wetlands described above. Native species are relatively scarce. Thus, neither provide examples of native community types that would be desirable to restore. Rather, they exemplify the species-poor, exotic-dominated communities that would be prime targets for removal and conversion to some more desirable type.

In the southern half of the park, another fairly extensive upland community was described: V*accinium ovatum – Cytisus scoparius – Malus fusca / Leymus mollis – Ammophila arenaria* Shrubland. Located along the foredune on either side of the cement walking path, this community plays an important role in maintaining stabilization of the sand (see "Constraints on restoration and golf course design"). It consists of a mix of natives and non-native species and could be targeted for restoration to shift dominance more toward native species.

Two upland forest types, both small in area, were also described in the park: *Pinus contorta* var. *contorta* – *Pseudotsuga menziesii / Morella californica* – *Vaccinium ovatum* Forest and *Picea sitchensis* – *Pinus contorta var. contorta / Gaultheria shallon* – *Vaccinium ovatum* Forest. The first consists of relatively young shore pine, with an understory dominated by native evergreen shrubs and a few herbs (with little or no Douglas-fir, despite its name). It is not a ranked community in Washington, nor is it known to include any rare or uncommon species. While it provides value as a native community type that can exclude some of the communities dominated by non-natives described above, it adds little to the overall diversity of species on the site. Based on these considerations, we consider it as only marginally contributing to the native community value and do not regard it as a type that should be prioritized for ecological restoration.

The second forested community, the *Picea* upland forest, is ranked S2 - rare in Washington State. Similar to the *Pinus* upland forest, it consists of an overstory of Sitka spruce and shore pine with an understory of native evergreen shrubs and a few herbs. It does not contain uncommon or rare species and is fairly young, but its rare ranking makes it important to consider for restoration and/or protection. It is a mid-seral community that may expand if stabilized dunes dry out; it does not need active management to be maintained. Thus, we did not consider it to be a candidate for active restoration in the form of planting or structure modification, but did consider it for protection.

7.2.1.1 Upland communities currently absent from Westport

Other upland communities that are currently absent from the Westport site could, if successfully established, add significantly to the community and species diversity of the site and increase the presence and diversity of rare communities. Rocchio and Crawford (2015) report a number of highly ranked communities that occur in dune systems along the Pacific Northwest coast (Table 3). While these types are now extremely rare or absent from Washington, we encountered a number of them in Oregon, where they have been extensively described by Christy et al. (1998).

Table 3. Upland vegetation associations that occur in dune systems along the Washington coast. (Source: Rocchio and Crawford 2015).

Vegetation Association	**Global/State Rank**
Agrostis pallens Herbaceous Vegetation	G1Q/S1
Artemisia campestris - Festuca rubra / Racomitrium canescens Herbaceous Vegetation	G1/S1
Carex macrocephala Herbaceous Vegetation	G1G2/S1
Festuca rubra - Ambrosia chamissonis Herbaceous Vegetation	G1/S1
Festuca rubra Stabilized Dune Herbaceous Vegetation	G1/S1
Leymus mollis ssp. *mollis - Abronia latifolia* Herbaceous Vegetation	G2?/S2
Lupinus littoralis Dune Herbaceous Vegetation	G3/S1
Poa macrantha Herbaceous Vegetation	G1/S1

The *Festuca rubra* dune grasslands described by Christy (2012) in Oregon were historically a common community dominating semi-stabilized dunes before European beachgrass became ubiquitous. This community may have occurred in similar habitats in Washington as well, although we are not aware of any current examples in the state. Christy noted that “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.” He describes them as typically species-poor, with up to 90 percent bare sand. In addition to *Festuca rubra*, whose taxonomy remains problematic (being variously called var. *littoralis,* var. *pruinosa,* or *F. ammobia*), other conspicuous associates reported by Christy include *Glehnia leiocarpa, Polygonum paronychia,* and *Lupinus littoralis*. *Festuca rubra* (including var. *pruinosa* and var. *littoralis*) continues to occur at Westport, at least in small numbers. Furthermore, it is noteworthy that the main associates also still persist in or near Westport. *Polygonum paronychia* and *Lupinus littoralis* are both encountered not infrequently in open sand in the park, and *G. leiocarpa* was rediscovered this year near Tokeland (iNaturalist - 7/1/2021), after having been regularly collected from Westport (until 1964) and nearby (Twin Harbors State Park, 1951).

The *Festuca rubra* dune grasslands generally appear to succeed *Poa macrantha* (see below) or *Lupinus littoralis* community types, both of which have more sand movement (Christy 2012). They can, in turn, be replaced by *Pinus contorta / Arctostaphylos uva-ursi, Ammophila arenaria,* or other later successional types. In addition to succession, trampling and vehicular damage pose the greatest threats to this community.

Christy (2012) described the *Poa macrantha* community in Oregon as “formerly common on foredunes, dry deflation plains, and partially-stabilized dunes further inland.” Many of the main associates of the *Festuca rubra* dune grasslands are the same in this community, including *Glehnia leiocarpa, Polygonum paronychia,* and *Lupinus littoralis*, and like the *Festuca rubra* community, these habitats have largely been converted to *Ammophila arenaria*-dominated vegetation.

It is clear that one of the biggest challenges with restoring these or similar dune communities at Westport is posed by the abundance of *Ammophila arenaria, Cytisus scoparius*, and *Pinus contorta* across most of the uplands on the site. Christy (2012) considered beachgrass to be the greatest threat to these community types in Oregon, where it continues to invade and outcompete the native species in many areas and stabilizes the sandy substrate to such an extent that it can no longer support native species that require the open, largely unvegetated conditions. At Westport, the abundance of Scotch broom and young shore pine compound the problem.

We are strongly encouraged, however, by evidence that elements of these communities still persist in many of the degraded uplands at Westport. During our field visits, we briefly compiled a list of native dune species and were surprised by the diversity present (Table 4). Compiling a more comprehensive inventory of native dune species could be fruitful in guiding the restoration of representative examples of these rare communities. The continued presence of these species at Westport provides considerable source material for initiating and enhancing restoration some expression of these native dune communities.

Table 4. Potential species to restore and diversify upland dunes at Westport. Present at Westport column is based on our observations, herbarium records, and iNaturalist reports (www.inaturalist.org). R = uncommon or rare at Westport. Species present at Oregon dunes are potentially suited to Westport habitats. H = present historically.

Species	Present at Westport	Present near Westport	Present in Oregon dunes
Abronia latifolia	R	x	x
Achillea millefolium	x	x	x
Agrostis pallens	x	x	x
Anaphalis margaritacea	x	x	x
Arctostaphylos uva-ursi	x	x	x
Armeria maritima ssp. californica	R	x	x
Baccharis pilularis subsp. consanguinea			x
Calystegia soldanella	R	x	x
Camissoniopsis cheiranthifolia			x
Cardionema ramossisimum	x	x	x
Carex macrocephala	R	x	x
Corethrogyne filaginifolia			x
Erigeron glaucus			x
Festuca rubra	R	x	x
Fragaria chiloensis ssp. pacifica	x	x	x
Gamochaeta ustulata	x	x	x
Leymus mollis	R	x	x
Lupinus littoralis	R	x	x
Phacelia argentea			x
Poa confinis	R	x	x
Poa macrantha	R	x	x
Polygonum paronychia	x	x	x
Polypodium glycyrrhiza	x	x	x
Pseudognaphalium stramineum	R	x	x
Pteridium aquilinum	x	x	x
Sanicula arctopoides		H	H
Spiranthes romanzoffiana		x	
Tanacetum bipinnatum	x	x	x
Trifolium wormskioldii	R	x	x

7.2.2 Restoration actions

In light of the conditions and challenges described above, the following are the limited options available for restoration or enhancement of upland plant communities:

1. Establish representative examples of rare dune communities by controlling the invasives and adding native species in sufficiently large dune areas where some native species persist.
    a. Advantages: Potential to significantly increased community diversity, as well as establish communities that may be resilient to future climate change.
2. Shift the composition of the *Vaccinium* Shrubland toward native species by removing Himalayan blackberry patches, removing patches of Scotch broom, and planting native shrubs.
    a. Advantages: Low cost.
3. Protect the *Picea* upland forest from development. Allow it to continue to develop into a forest comprised more of *Picea* than *Pinus*.
    a. Advantages: Maintains a community that is currently uncommon at Westport. Low cost. Fosters the development of old-growth forest.

7.2.3 Restoration implementation strategy

The historical species composition of the native upland dune communities remains somewhat uncertain due to a lack of high-quality reference communities and the extensive alterations that have transpired on the site. Therefore, as with the wetland swales described above, restoration might best be approached using the native plants themselves to guide the outcome rather than attempting to be overly prescriptive. Restoration could focus both on larger blocks of upland within the deflation plain matrix, as well as on small uplands between swales. In both cases, a goal would be to minimize the proximity to extant patches of beachgrass, Scotch broom, and shore pine to provide a greater assurance that they would not be immediately reinvaded from surrounding areas.

Restoration would begin by removing the dominant invasive species as completely as possible. In areas where some native species still persist in the understory, pines and broom might best be removed by hand, which could leave native species relatively undisturbed. But in many areas, especially where beachgrass is dominant, it may be more efficient and effective to create a fresh dune substrate by scraping; herbicide application may be necessary if the beachgrass cannot be entirely removed by mechanical means. Installation of native species would then be initiated via seeding and plugging. Depending on the exposure of the individual sites, additional measures (jute netting, snow fencing, etc.) may be helpful to prevent substrates from being lost to wind scour. Ongoing vigilance will be necessary to ensure that the invasive species continue to be controlled.

7.3 Action 3: Promoting species diversity and rare species

7.3.1 Restoration potential

Promoting the diversity of native species that occur at Westport would have multiple ecological benefits. Communities with a greater number of species often are more ecologically resilient as different species respond to environmental changes in different ways. This can result in a community whose composition varies over time, but which remains a vigorous, viable assemblage of native species that resists invasion by non-native species, provides habitat for diverse organisms, and perpetuates the long-term survival of numerous taxa.

Enhancing diversity also provides an opportunity to especially benefit vulnerable species. Selecting to specifically promote species that are currently uncommon, rare, or entirely absent from Westport can increase the likelihood of their survival over the long term. Creating and increasing the amount of suitable habitat for such species, as well as deliberately planting them, are important restoration actions. Both the creation of multiple populations and increasing population sizes are well-established conservation strategies for vulnerable species.

Potential species that could aid in diversifying upland and swale communities are listed in Table 4 (above) and Table 5 (below).

As was suggested in Action 1, ecological benefits may be attained by considering alternatives that incorporate elements currently absent from Westport, and which may never have been present there. Species from south of Westport may become increasingly suited to conditions further north with future changes in climate. Experimentally introducing such species in restoration efforts at Westport could enhance their long-term viability via assisted migration. We noted several species in the Oregon dunes that might be considered for such introduction in the two tables.

Table 5. Potential species to diversify wetland communities at Westport. Present at Westport column is based on our observations, herbarium records, and iNaturalist reports (www.inaturalist.org). R = uncommon or rare at Westport. Species present at Oregon dunes are potentially suited to Westport habitats.

Species	**Present at Westport**	**Present near Westport**	**Present in Oregon dunes**
Carex pansa	x	x	x
Carex viridis			x
Lilaeopsis occidentalis	R		x
Lycopodiella inundata		x	x
Argentina egedii ssp. egedii	x	x	x
Ranunculus flammula	R	x	x
Rhododendron columbianum		x	x
Sceptridium multifidum	R	x	x
Sisyrinchium californicum	R	x	x
Symphyotrichum subspicatum/chilense	x	x	x
Veronica scutellata	R		

7.3.2 Restoration actions

These strategies of enhancing native species diversity and viability on a site can be accomplished in multiple ways. Native habitats that are currently species-poor can be improved by adding species that are currently absent, or by increasing the size of their populations where they are infrequent. In Action 1 described above, special efforts can be taken to maximize species diversity in newly-created communities.

A third, less common approach is to focus on incorporating native species into a vegetation matrix designed to serve functions beyond ecological restoration – such as a golf course. We came across a prime example of this approach at the Bandon Preserve, one of the golf courses at the Bandon Dunes Golf Resort in Oregon, where conservation of a rare sand dunes endemic – Silvery Phacelia (*Phacelia argentea*) – was an explicit focus of the course management. Numerous occurrences of this threatened species (in Oregon; under review for federal listing) were planted and enhanced in patches throughout the course layout, resulting in perhaps the largest extant population of this species (Figure 21).

Figure 21. Two examples where subpopulations of Silvery phacelia (the grey-green plant in the center of both photos) have been incorporated into roughs between the fairways at the Bandon Preserve Golf Course.

Actions targeted specifically at the restoration of rare species, such as Silvery phacelia at Bandon Preserve or choices from Tables 4 and 5 at Westport, can play an important role in preserving viable populations of at-risk plants. Creating and maintaining small occurrences, while not necessarily facilitating the entire ecosystem a rare species needs, can serve to maintain genetic variation, resist extinction, and even provide restoration material for elsewhere. One advantage of such integration into a golf course is the ongoing management attention, which can adjust practices as needed to maintain the population. While there is risk of failure with such experimental introduction, it would not result in negative consequences for golf course managers.

While vascular plants are common restoration targets, without considerably more information regarding the current abundance and distribution of the rare lichen *Kaernefeltia californica*, it is difficult to propose specific restoration actions that might enhance the viability of this species at Westport. Most likely, it would benefit primarily by protecting stands of older shore pines, which provide the primary substrate on which this lichen grows. As such, *K. californica* might appropriately serve as an "umbrella species" (Lindenmayer and Westgate 2020) under which other, currently undocumented species associated with stands of older shore pine might also be protected. Therefore, it may be desirable to avoid disturbing or destroying such stands to the extent possible (as also recommended in Action 1).

In sum, options include:

1. Augment existing herbaceous swales with additional species from Table 5.
    a. Advantages: Low cost, low risk.
2. Plant new swales created via Action 1 with both extant species and species not currently present at Westport.
    a. Advantages: Same as 1.
3. Explore creating and maintaining small occurrences of a specific rare species (such as those in Table 4) into the native vegetation matrix between fairways.
    a. Advantages: Could help preserve highly-ranked rare species, but high risk of failure. Failure would not result in negative consequences for golf course managers.
4. Protect the known site of *Kaernefeltia californica* and additional stands of older shore pine.

7.4 Action 4: Reducing invasive species

7.4.1 Restoration potential

The reduction or elimination of species that are highly invasive is often a key strategy in projects that aim to restore diverse native communities. Such species exhibit characteristics such as rapid growth, high reproductive capacity by vegetative spread or seed, and high competitive abilities that allow them to exclude associates and, at times, form near monocultures. While such species frequently are introduced, non-native taxa, some indigenous species can exhibit similar traits, inhibiting the restoration of highly-diverse communities.

Reducing invasive species is rarely a restoration goal by itself, since their eradication on a site seldom is sufficient to stimulate the establishment and growth of diverse native species, which typically are primary objectives. In most cases, additional efforts need to be made to sow native seeds or otherwise enhance site conditions and introduce native propagules. This not only facilitates the establishment of diverse assemblages of native species, but also helps to preclude the re-establishment of aggressive invasives.

As noted previously, three main invasive species dominate much of the upland habitat at Westport: European beachgrass, Scotch broom, and shore pine (Figure 22). In the northern half of the park, AECOM (2017) mapped 16.5 acres of *Cytisus scoparius* Shrubland and nearly 80 acres of *Pinus contorta* var*. contorta / Cytisus scoparius / Ammophila arenaria* Semi-Natural

Shrubland, which they regarded to be in poor condition (see map in Figure 16). Most of these expanses occur in a matrix with the rare early-seral wetland communities, where the inundated swales preclude invasion but the adjacent uplands are occupied by the invasives. Many of these uplands were built up, or at least disturbed, during the previous golf course attempt.

Figure 22. Example of invasive-dominated upland, with abundant European beachgrass, Scotch broom, and shore pine, adjacent to a native-dominated swale (foreground), in which annual inundation precludes invasion.

The extent and abundance of these three species and the vegetation types associated with them creates both opportunities and obstacles for restoration. Eradicating or significantly reducing the acreage of this vegetation would greatly reduce the availability of propagules on the landscape that pose a continual threat to native habitats. In addition, restoring this significant acreage to other, more desirable native plant communities offers a considerable opportunity for a large net gain in the overall ecological value of the Westport site. However, one should not underestimate the challenges of carrying out invasive reduction on this large a scale. These include the difficulty in thoroughly eradicating such aggressive invasive species, the sheer magnitude of clearing, potentially reshaping, and replanting such a large acreage, and the complexity of undertaking such a task in an area where these communities are highly intermixed in a mosaic pattern with various native plant associations.

In the southern half of the park, AECOM (2021) mapped 17 additional acres of *Pinus contorta* var*. contorta / Cytisus scoparius / Ammophila arenaria* Semi-Natural Shrubland, 16 acres of *Pinus contorta* var*. contorta / Vaccinium ovatum – Cytisus scoparius* Forest, and 35 acres of *Vaccinium ovatum – Cytisus scoparius – Malus fusca / Leymus mollis – Ammophila arenaria* Shrubland. The first community they described as in poor condition, but the latter two (which are not present in the north) were described in fair to good condition because of the relative preponderance of native species. The same challenges mentioned above exist for rehabilitating the first, highly-invaded community, but there may be more potential for aiding the rehabilitation of the latter two communities. If Scotch broom and beachgrass were manually removed, the forest canopy cover and natural propagation of nearby native shrubs may help resist re-invasion.

7.4.2 Restoration actions

We identified several restoration opportunities to consider with the objective of reducing the abundance of invasive species:

1) Remove some of the small, invaded uplands that currently separate existing swales to create fewer, larger swales. Consolidate removed material into a small number of larger uplands. This would result in an increase in the overall acreage of ecologically significant wetland community types while simultaneously eliminating equal acreages of poor quality upland.
    a. Advantages: Might require minimal replanting, since they are likely to self-seed from contiguous swales.
2) Restore reshaped and enlarged upland "islands" with native dunegrass (*Leymus mollis*) and other rare open dune communities (such as those discussed in "Enhancing upland plant communities").
    a. Advantages: Restoring rare dune communities would enhance community diversity, although some types, such as the dunegrass community, would add little to species diversity. Other dune communities could include greater species diversity if it were possible to establish and maintain them.
3) Restore reshaped and enlarged upland "islands" to one of the upland *Pinus contorta* var. *contorta* forest types (such as *Pinus contorta* var. *contorta – Pseudotsuga menziesii / Morella californica – Vaccinium ovatum* Forest).
    a. Advantages: Shore pine forest would be relatively simple to establish but would not add to acreage of rare community types or enhance community or species diversity.
4) Convert areas of degraded upland community types to golf course, with interspersed wetland and upland native community types.
    a. Advantages: Low cost, though acreage available to be restored to native communities would be significantly reduced.
5) In the *Pinus contorta* var. *contorta / Vaccinium ovatum – Cytisus scoparius* Forest and *Vaccinium ovatum – Cytisus scoparius – Malus fusca / Leymus mollis – Ammophila arenaria* Shrubland in the southern half of the park, manually remove Scotch broom and European beachgrass where canopy cover and adjacent native shrubs will resist re-invasion.
    a. Advantages: Low cost.

7.5 Action 5: Enhancing wildlife habitat

7.5.1 Restoration potential

To identify restoration actions that might confer the greatest benefits to wildlife at Westport, we drew upon AECOM's (2021c) evaluation of wildlife habitat quality on the site and their assessment of extant and potential wildlife using the site (summarized in "Wildlife habitat"). We also considered their recommendations for particular actions that would further enhance habitats for wildlife.

There is relatively limited wildlife use of the different habitat types at Westport, and there seems to be little likelihood that the site provides significant habitat for any sensitive species. In addition, the most important wildlife values, in terms of numbers, diversity, and occurrence of rare species, are largely represented by the vast numbers of shorebirds and waterfowl that migrate along the coast, but which use the beaches and coastal waters almost exclusively rather than the onshore habitats at Westport.

We consider the "Mixed Open Wet Areas" as the most important wildlife habitat to consider for restoration, based on the diversity of closely interspersed plant associations, the large area it occupies at Westport, and the potential for enhancement of the plant communities it encompasses. As evident in Table 2, it embraces multiple vegetation types, including not only the three early-seral herbaceous and shrubby wetland communities, but also areas of upland dominated by European beachgrass, Scotch broom, and small-statured shore pine. Such a diversity of interspersed types is widely recognized to support a greater mix of wildlife.

The Oregon silverspot butterfly, a federally threatened and state endangered species, was mentioned in the report as being mapped to potentially occur in the park. It is closely associated with *Viola adunca* (hookedspur violet), a species not observed at Westport. The coastal meadows and grasslands that support the butterfly's habitat, sustained by regular fire, are not habitat types that are feasible to establish at Westport because of the extensive interdunal wetlands that dominate the park. Unless park hydrology was considerably altered, we do not consider establishment of viable sizes of Oregon silverspot habitat to be possible.

7.5.2 Restoration actions

To improve wildlife habitat at Westport, we emphasize the importance of several strategies similar to those recommended by AECOM in their assessment.

1. Increase the size, connectivity, and heterogeneity (in area, depth, and shape) of the wetland patches within the "Mixed Open Wet Area" matrix. Enhancement of all these factors will help increase both the diversity and viability of wildlife using these important habitat areas.
    a. Advantages: Simultaneously accomplishes vegetation and wildlife habitat enhancement objectives.
2. Preserve wetland patches with older/taller shrubs and trees that take many years to establish. This will help to ensure a diversity of structural and compositional types persist on the landscape that will further enhance habitat heterogeneity.
    a. Advantages: Low cost. Simultaneously accomplishes vegetation and wildlife habitat enhancement objectives.
3. Convert upland areas dominated by a few non-native species (e.g., European beachgrass, Scotch broom) to more diverse assemblages dominated by native species.

These can be restored with native dune associations, or the substrates can be reconfigured to augment and enlarge adjacent wetlands. Although wildlife often makes no distinction between native and non-native species, enhancing the diversity of plant associations often results in increased faunal diversity as well.

a. Advantages: Simultaneously accomplishes vegetation and wildlife habitat enhancement objectives.

8. Compatibility of restoration opportunities with golf course development

In the previous section we described five categories of restoration actions that could provide various levels of ecological enhancement to Westport. Here, we examine the degree to which each option would be compatible with a golf course developed on the site. We also specifically address compatibility in the context of climate change.

The extent to which each action is compatible varies depending on the precise layout of the course and which areas are directly impacted, the manner in which it is constructed, the amount of effort that is expended to ensure the success of restored communities, and how the course is operated. For this analysis, we have assumed that best efforts will be made throughout the design, construction, and operation of the course to minimize impacts to sensitive resources and ensure the long-term survival of diverse, viable natural communities in the areas surrounding playable surfaces.

8.1 Enhancing wetland communities

The current proposed golf course footprint would be primarily located on existing upland areas, with limited disturbance occurring in existing wetlands or the wetland mosaic. A majority of impacts would be targeted in previously disturbed areas in the north half of the site, preserving a majority of the intact wetland areas to the south. Therefore, it is reasonable to expect that taking measures to ecologically enhance the existing wetlands would be generally compatible. Such measures could include re-contouring, planting native species and controlling invasives, or other manipulations that would increase wetland area, add topographic and biological diversity, and enhance their overall viability.

While it is possible that enlarging existing wetlands may remove upland areas available for the golf course, beneficial enlargement could primarily occur by manipulating intervening uplands within the mapped wetland mosaic. It should, however, be understood that the seasonal wetlands adjacent to the golf course, which may be dry during the summer, should not be considered playable portions of the course.

There are numerous actions that could be taken to enhance the most ecologically significant (S1-ranked) early-seral communities that are also compatible with a golf course. As already noted, enlarging some of the smaller swales and increasing the connectivity among them by removing the narrow uplands between swales may contribute significantly toward enhancing their viability and would not interfere with many possible golf course layouts. Adding subtle topographic heterogeneity by creating small-scale mounds and shallow depressions within the swales could increase habitat diversity (and corresponding biological diversity), a feature we noted in similar communities in Oregon. Similarly, regrading steep banks that remain from the previous golf course's wetland manipulations to create more gradually sloping wetland perimeters would create larger zones with slightly differing periods of inundation and species composition. Sand left over from wetland enlargement and recontouring could be used as needed for course construction or contribute to upland restoration.

Protecting the best and, particularly, the oldest examples of the PICO-CAOB3 community (wetland swamp forest; also S1-ranked) is also compatible with development. These areas are largely located towards the southern end of the park, and care would need to be taken to ensure that the oldest stands remain undisturbed. Slightly younger examples may be protected with compliance with the deed restrictions in the northern half of the park.

In contrast, run-off of pesticides, herbicides, and fertilizers (through individual applications or the use of treated waste water) used in the establishment and/or maintenance of the fairways and greens may not be compatible with enhancement of native wetlands. The interdunal wetlands are naturally low-nutrient environments and would likely form thick (and often unpleasantly aromatic) algal mats that smother plants if supplied with additional nutrients (Figure 23). Such nutrient addition would also likely stimulate the growth of weedy species that could readily outcompete the native flora.

Filtration devices, standard for golf courses in sensitive habitats, could potentially help limit aboveground runoff, but additional measures would need be taken to prevent the underground movement of chemicals through the porous sand. Abating impacts from such runoff into the wetlands is a serious and potentially difficult problem. High-quality upland buffers around wetlands are effective at intercepting nutrients and can protect wetlands from adjacent land use; maintaining these buffers as roughs or unplayable areas would help mitigate chemical runoff. Considerable planning and care would need to be taken to be certain that golf course construction, vegetation establishment, and normal operation would not result in unacceptable degradation of the adjacent wetlands.

Figure 23. Dried algal mat on slough sedge in a swale at Westport. Nutrient run-off from golf course maintenance may lead to much more extensive algal mats that could smother native plants and stimulate growth of many weedy species.

Water used to irrigate the playable surfaces of the golf course poses another potential problem that requires further study on how it may impact the wetlands. Problems may come about in several ways. Maintaining playable surfaces generally requires large amounts of water, particularly in the dry summers typical of the Mediterranean climate at Westport. This can result in local and regional drawdown of the water table during periods of peak demand, with the extent of the impacts dependent on numerous factors (e.g., the size, depth, recharge rate, and configuration of the aquifer being tapped, the number, depth, and pumping rate of the wells being used, as well as other activities occurring elsewhere in the watershed). While some of the water applied to the greens and fairways will make its way back into the water table through surficial or underground flow (potentially carrying deleterious chemicals with it, as noted above), the remainder may be lost from the site through evaporation and transpiration. A detailed hydrological study that accurately considers anticipated water use by the golf course would be needed to assure that wetlands would not be negatively impacted.

8.2 Enhancing upland communities

Existing upland communities at Westport vary greatly in condition and ecological value, and correspondingly their restoration potential and compatibility. In many areas in the northern part of the site, uplands have been highly disturbed by previous golf course construction and are heavily overrun by invasive non-native species. To the extent that these areas could be reconfigured to create wetlands (see above) or restored by removing non-natives and establishing small native upland communities, some compatible ecological gains could be realized. However, as we discussed in Section 7, establishing the large, open expanses of shifting sands that typify upland dune sheets, which may naturally have occurred on the site and harbor rare communities and species elsewhere in the region, is not feasible in the relatively small area available at Westport. Nor would such a dynamic, movable substrate be compatible with a golf course. However, it may be possible to restore smaller dune assemblages within the wetland matrix that include some of the species that once may have been found in some of the rare sand dune communities. These would represent valuable ecological gains were they to be restored and would be compatible with golf course development.

Potentially valuable upland vegetation types currently present at Westport include the *Vaccinium* shrubland (VAOV2-CYSC4-MAFU/LEMO-AMAR4) (GNR/SNR) along the foredune in the southern half of the park, and the Sitka spruce forest (PISI-PICO/GASH-VAOV2) (G3/S2) and shore pine / evergreen huckleberry forest (PICO/VAOV2-CYSC4) (GNR/SNR) near the southeast corner of the park. Whether restoration or protection of any of these communities is compatible with a golf course depends on whether the course design would need to occupy these uplands to comply with wetland development restrictions. The G3/S2-ranked Sitka spruce forest is the most significant and would represent the greatest loss of an extant upland type were it to be impacted. Some of it could remain intact as out-of-bounds areas between fairways, but it could not easily be played over or from given the stature of the shrubs. Potentially, these shrub and forest communities could be planted in remaining upland in the northern part of the park among the existing wetland matrix. These would likely be compatible with a golf course, which could work around these smaller areas. However, establishing these communities would take time, given the slower rate at which trees and shrubs grow compared with upland herbaceous vegetation. Furthermore, they would not represent a large ecological gain on the site due to the small areas available for planting. Only the Sitka spruce forest would add incrementally to the ecological benefit, given its G3/S2 rank.

8.3 Promoting species diversity and rare species

Adding ecological value to the Westport site by increasing the species diversity in any native community persisting through golf course construction is highly compatible. Augmenting existing swales with new species and planting new swales with a diversity of new species are both important options to consider. As noted in Table 4 and Table 5, there are many species that do not currently occur at Westport but are found in similar community types nearby or in the dunefields further south in Oregon. Introducing some of these to restoration projects at Westport could represent an interesting and innovative approach to adding ecological resilience to sites in anticipation of climate changes.

Finally, establishing small occurrences of specific rare species in the golf course vegetation matrix is compatible, as demonstrated with Silvery phacelia (*Phacelia argentea*) at the Bandon Dunes Preserve. This requires a significant, long-term commitment by the golf course owners as well as the agronomists who oversee their protection. It also requires careful selection of species that would potentially find suitable habitat in the sorts of areas that could exist within the golf course layout. In addition to the Silvery phacelia, other possible candidates might include American glehnia (*Glehnia leiocarpa*) and bear's-foot sanicle/Footsteps of spring (*Sanicula arctopoides*). None of these species currently occur at Westport, but the *Glehnia* is present close by and the *Sanicula* is reported historically from the area.

8.4 Reducing invasive species

Reducing or removing invasive species independently or in conjunction with other restoration activities can add to the ecological benefits incurred with the other restoration opportunities presented. The greatest benefits occur where the invasives are removed from native, highly-ranked communities such as the herbaceous swales. It is also valuable to remove them from unranked communities with an abundant native plant component (e.g., PICO/VAOV2-CYSC4 Forest and VAOV2-CYSC4-MAFU/LEMO-AMAR4 Shrubland), where they pose significant sources of seed that can invade nearby areas, and where removing them opens up opportunities for restoring native communities. Invasive removal is compatible with the golf course anywhere the native communities are able to persist.

Simply converting heavily degraded upland areas dominated by invasives to golf course can reduce source populations of undesirable invasives. This is, of course, compatible with constructing a golf course, but offers considerably less ecological value than other options, as it does not directly contribute to the diversity of native communities and species.

8.5 Enhancing wildlife habitat

As discussed in Section 7, a primary recommendation for enhancing wildlife habitat is to increase the area, connectivity, diversity, and heterogeneity of the wetlands, particularly in the northwest portion of the park. This recommendation directly coincides with those made for enhancing the floristic value and resilience of the site, even though the benefits to wildlife conveyed by these enhancements are not likely to be large. As described in Action 1, this is largely compatible with development of a golf course.

We also recommended preserving older, forested communities, and converting non-native uplands to more diverse native upland communities as additional means for enhancing wildlife. Compatibility of the former is largely dependent on whether the golf course footprint can work around these forests.

Activities associated with the use and maintenance of the golf course could potentially disturb birds nesting in natural vegetation in habitats adjacent to the course, but such disturbance would likely be confined largely to within a short distance from the edge and not extend into the interior of potential nesting habitat.

8.6 Resilience to climate change

Ecologists generally concur that diverse species assemblages and ecosystems comprised of multiple communities are likely to be among the most resilient in being able to adapt to, if not withstand, future changes associated with global warming. While droughts and fires are already impacting many areas in the western U.S., coastal areas in the mesic Pacific Northwest are expected to suffer from coastal erosion associated with accelerating sea level rise and an increase in the frequency and severity of major storms. In the geomorphically-dynamic coastal environment at Westport, both effects will almost certainly dramatically alter the physical landscape and topography before species assemblages and communities adapt to the warming climate. Thus, regardless of what restoration actions are taken at Westport to enhance the viability of plant communities, it is the physical features of the site that are most tenuous and vulnerable to change.

The history of shoreline retreat over the last ca. 50 years (Figure 7), coupled with sea-level rise due to climate change, suggests that golf course development immediately along–the foredune is incompatible with further shoreline retreat likely to occur in the near future as sea level rises. Since 1974, the shoreline of the park retreated 300–560 feet (7–13.3 ft/yr). In 2016, the paved path on the foredune was 150-200 feet from the shoreline. If the shoreline continues to erode at this recent rate, the path would be expected to begin to fall onto the beach within the next decade. We can also expect to see the foredune migrate eastward into the deflation plain behind it, gradually infilling the wetlands and converting them to upland dune communities. Thus, any golf course constructed within several hundred feet of the shoreline is likely to have a relatively short life expectancy, and even activities considerably further inland would be heavily impacted as the entire dune system moves eastward.

The interdunal ecosystem at Westport can be characterized by change, at scales from seasons to centuries. The preponderance of early-seral communities, and their ability to rapidly re-establish after disturbance, reflects the dynamic physical landscape upon which the ecosystem exists. Adding the changes expected with climate change only amplifies the need for resilience and flexibility of ecological conditions. Restoration efforts will be most successful if they focus on increasing ecological flexibility rather than aiming for a specific outcome, which could be erased in a single storm. Therefore, we conclude that permanently-positioned features of any sort, from roads and parking lots to campgrounds and golf courses, especially located in close proximity to the Westport shoreline, are problematic over the long-term as the physical and biological landscape at Westport continues to change in the coming decades.

8.7 Restoration in the absence of a golf course

The focus of this report is to examine potential ecological benefits that might be realized in association with the construction of a golf course on the site. However, in light of the long-term difficulties posed by the presence of any permanently-positioned features at Westport, we briefly present what ecological benefits might be attained if no golf course were to be constructed on the site.

Undertaking restoration at Westport under this scenario primarily adds more flexibility to the restoration agenda and options, although it does not fundamentally change the ecological alternatives we outline above. In other words, the same alternatives and priorities pertain, but can be considered and implemented with much greater latitude regarding location and extent. This added flexibility includes:

- Wetland swales in the deflation plain can be larger, more diverse in composition, depth, shape, and connectivity.
- Upland dune restoration can incorporate larger areas and allow movement of dunes across areas that can be more flexibly managed than if permanent features existed.
- Ecological priorities can be kept paramount rather than having to be tailored to accommodate other on-site features that serve non-ecological functions.

9. Assessment of ecological value

Decisions about whether and how to ecologically enhance Westport Light State Park are complicated by its human-influenced history. We tend to think of the wild landscapes along the Washington coast as a natural result of eons of Pacific winds and surf interacting with coastal sediments, shoreline landforms, and native vegetation. In reality, the park is a landscape that has been heavily modified by a number of human factors: shoreline accretion and erosion produced by the jetty constructed at the mouth of Grays Harbor, the introduction of non-native beachgrasses and Scotch broom, planting of shore pine, and disturbance from previous human activities on the site. In short, the Park exists on land that would not be present in its current form without prior human activities. This has created a condition in which restoration of the site back to an original, unaltered, or “natural” state is impossible. Rather, these modifications have created a somewhat artificial landscape upon which restoration decisions must be made based on objectives other than returning to an unaltered ecosystem.

The Westport site is also unique in the variety of plant communities that may be considered for enhancement. It is unlike many sites where alternatives are limited by what historically occurred on the site or what communities can reasonably be expected to thrive given existing physical and environmental conditions. In contrast, at Westport, multiple wetland and upland communities of conservation concern exist in close proximity to one another and would be valuable targets of restoration.

As a result, it is difficult to develop a system for objectively valuing the ecological benefits of restoration opportunities that unambiguously prioritizes among them. The different opportunities do not often represent alternatives where one presents far greater ecological benefits than another. Instead, they may simply represent “apples versus oranges,” where the practitioner must choose based on personal preference. For example, there is little basis for choosing one rare community type over another that is equally rare if both are likely to succeed, or where one suite of species is enhanced while another of similar diversity is not.

We consulted principles and standards for ecological restoration developed by the Society for Ecological Restoration (Gann et al. 2019) for possible means to assess the ecological value of different potential restoration alternatives. Their approach uses a “Recovery Wheel” that can assist managers in evaluating the degree to which an ecosystem undergoing restoration is recovering (https://www.seraustralasia.com/wheel/index.html; Figure 24). As they describe, the evaluation compares the various attributes of the degraded system to its reference ecosystem. This tool incorporates six main attributes, each with three sub-attributes, and assesses each’s similarity to the reference ecosystem on a five-point scale.

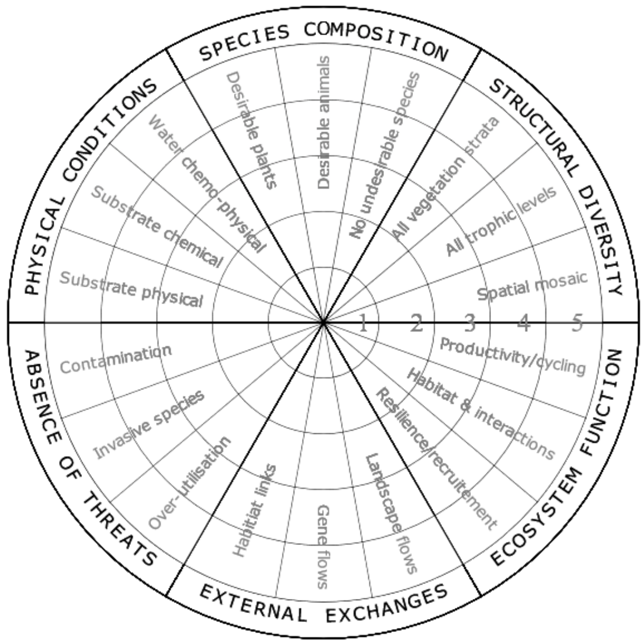

Figure 24. SER Recovery Wheel to assist in ecological evaluation of restoration.

We encountered some challenges in applying the Recovery Wheel approach to the Westport site. First, it is based on the goal of emulating a reference ecosystem. It does not allow for alternatives that might be novel and potentially more resilient to future conditions, and for which no reference condition may currently exist. Also, it can be a somewhat complex tool to apply, given the number of attributes and sub-attributes to be assessed. Nevertheless, it illustrates the complexity of different factors that contribute to the overall ecological value of a particular system.

We also explored using the Ecological Integrity Assessment approach described by the Washington Natural Heritage Program. This is an effective tool to assess the condition of an existing community, and to consider how to assess the condition of a restored community using field measurements to evaluate landscape context, condition, and size. We consulted it to understand how improvements to existing communities could be made, though it did not provide guidance on how to choose among restoration targets.

After considering various approaches, we developed one that is fairly simple and draws upon basic principles that are widely used to assess ecological integrity and resilience. Most of the criteria are included in traditional community ranking metrics and in ecological integrity assessments. While it may not distinguish among similar actions, it can be used to identify general criteria for assigning ecological values to various restoration actions, which may in turn provide useful guidance in making restoration decisions.

These criteria include assigning <u>greater</u> ecological value to alternatives that:

1) Contain larger total areas of native plant communities.
2) Support higher numbers of native plant species.

3) Have fewer invasive plants that may displace native species.
4) Support higher numbers or abundance of rare or uncommon plant, fungi, and animal species (high G or S ranks).
5) Provide habitat to a greater number of desirable fungi and animal species.
6) Contain a greater area and/or number of viable examples of plant communities with higher Global and State Ranks.
7) Contain a larger area of structures and/or seral states that are scarcer on the landscape.
8) Take longer to form (i.e.. later successional).
9) Appear to be most resilient to climate change, or that are likely to be of greater ecological benefit (by meeting the above criteria) under future climate conditions.

In Table 6, we indicate how the restoration actions presented in “Restoration opportunities” apply to the ecological value criteria proposed here.

Table 6. Ecological values of restoration options. X’s indicate which values restoration opportunities generally enhance.

	Option 1: Enhancing wetland plant communities	Option 2: Enhancing upland plant communities	Option 3: Promoting species diversity	Option 4: Reducing invasive species	Option 5: Enhancing habitat for wildlife
More total area of native plant communities	x	x			x
More native plant species	x	x	x		x
Fewer invasive plants				x	
More rare species			x		
More habitat for animals and fungi					x
More rare plant communities	x	x			
More scarce seral states	x	x			
Later successional seral states	x				
More resilient to climate change	x		x		

As noted above, choosing among an array of alternatives can be difficult when none clearly stand out from the others. Furthermore, even the best tools for evaluating and comparing ecological benefits exist within a universe of additional factors that constrain the selection process or prioritize some alternatives over others. In addition to the ecologically-based criteria presented here, site managers often must incorporate other, non-ecological considerations in making decisions. Cost, ease of implementation, feasibility, likelihood of restoration success in the short- and long-term, and compatibility with other land uses – such as a golf course – are other factors that may influence the prioritization of restoration opportunities.

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Appendix A: Species observed in Westport swales

	JUFA-JU(LE,NE)					CAOB3-AREGE									SAHO/CAOB3-(AREGE)							
Estimated disturbance	Scraped	Scraped	Dug	Natural	Dug	Dug	Natural	Natural	Natural	Dug	Dug	Natural	Dug	Dug	Natural	Natural	Natural	Natural	Natural	Dug	Dug	Natural
Estimated depth (ft)	0.5	0.5	3	1.5	Unk.	5	1.5	Unk.	2.5	4	5	1	6	2	Unk.	2	3	6	4	Unk.	3	Unk.
GRASSES, SEDGES, RUSHES																						
Agrostis pallens/exarata/stolonifera	4	1	2	4	2	2	3	2	2	1	2		1	2					1	3	1	1
Ammophila breviligulata											1											
Anthoxanthum odoratum							1															
Carex macrocephala		1																				
Carex obnupta			2	2		5	3	5	5	5	4	5	4	5	5	5	3	5	5	5	5	5
Carex pansa			1	2	1	2	3	2	1	1	2	5			1					1		2
Danthonia decumbens		3					2					3						3				
Dichanthelium acuminatum			5	1	2	5	1	4	4	4	5		1	1						2	1	
Eleocharis cf. macrostachya													3									
Equisetum arvense																				1		
Holcus lanatus	1			2																		
Juncus breweri		4	3	3		1	2	3	2	3	2	1		4				1	1	1	2	2
Juncus bufonius var. *bufonius*																						
Juncus falcatus ssp. *sitchensis*					1	1		2	1	2	1	1	1	1						2		
Juncus nevadensis var. *inventus*						1	2	2	2	2	2		2	2					1	1	4	
Poa pratensis												1						1				
HERBS																						
Cardionema ramossisimum	4	4	2	2	4		2	2	1	2	2			1						1		
Centaurium erythraea							1															
Epilobium ciliatum											1											
Fragaria chilense							1															
Galium aparine															1							
Galium trifidum																		1				1
Gamochaeta ustulata							1															
Hypochaeris radicata/Leontodon saxatilis	3	3	3	4	3	3	3	3	2	4	4		1	4			1	2	3	3	3	
Lupinus littoralis		1																				
Plantago lanceolata	1	2	1	1																		
Platanthera sp.																		1				
Polygonum paronychia	1		1	1																		
Potentilla anserina ssp. *pacifica*						1					1		4					1		4	3	1
Pseudognaphalium stramineum										2	1		1							1	1	
Rumex acetosella	1	1		1																		
Rumex crispus						1				1		1									1	
Sceptridium multifidum															2		1	1	2			1
Sisyrinchium californicum													1									
Symphyotrichum subspicatum			1	1		1	1	2	2	2	2	1			2			2	1			2
Tanacetum bipinnatum		1	1																	1		
Teesalia nudicaulis	1																					
Trifolium wormskioldii						2				2	1									2	4	
Veronica peregrina var. *xalapensis*									1													
Veronica scutellata						1				2	1	1	2					1	1	1	1	1
TREES AND SHRUBS																						
Alnus rubra																				1		
Arctostaphylos uva-ursi								1														
Lonicera involucrata																						1
Malus fusca				1								1		1			1	1	2			1
Morella californica															2					1		
Pinus contorta						1					1			1	4				1	1		
Rubus bifrons																						1
Rubus ursinus														1				1				
Salix hookeriana						1					1		2		4	5	5	4	5	4	4	
Spiraea douglasii						1			1				1	1	4	2	2	5	4	2	1	5
Total number of species	**8**	**10**	**11**	**13**	**6**	**16**	**14**	**11**	**12**	**14**	**18**	**10**	**13**	**12**	**9**	**3**	**6**	**15**	**12**	**20**	**13**	**13**

Each taxa is rated on a 5-point abundance scale (rare, occasional, frequent, common, or abundant).

	JUFA-JU(LE,NE)		CAOB3-AREGE		SAHO/CAOB3-(AREGE)	
	Constancy (n=5)	Average abundance (n=5)	Constancy (n=9)	Average abundance (n=9)	Constancy (n=9)	Average abundance (n=9)
GRASSES, SEDGES, RUSHES						
Agrostis pallens/exarata/stolonifera	1.00	2.60	0.89	1.67	0.50	0.75
Ammophila breviligulata	0.00	0.00	0.11	0.11	0.00	0.00
Anthoxanthum odoratum	0.00	0.00	0.11	0.11	0.00	0.00
Carex macrocephala	0.20	0.20	0.00	0.00	0.00	0.00
Carex obnupta	0.40	0.80	1.00	4.56	1.00	4.75
Carex pansa	0.60	0.80	0.78	1.78	0.38	0.50
Danthonia decumbens	0.20	0.60	0.22	0.56	0.13	0.38
Dichanthelium acuminatum	0.60	1.60	0.89	2.78	0.25	0.38
Eleocharis cf. macrostachya	0.00	0.00	0.11	0.33	0.00	0.00
Equisetum arvense	0.00	0.00	0.00	0.00	0.13	0.13
Holcus lanatus	0.40	0.60	0.00	0.00	0.00	0.00
Juncus breweri	0.60	2.00	0.89	2.00	0.63	0.88
Juncus bufonius var. *bufonius*	0.00	0.00	0.00	0.00	0.00	0.00
Juncus falcatus ssp. *sitchensis*	0.20	0.20	0.89	1.11	0.13	0.25
Juncus nevadensis var. *inventus*	0.00	0.00	0.89	1.67	0.38	0.75
Poa pratensis	0.00	0.00	0.11	0.11	0.13	0.13
HERBS						
Cardionema ramossisimum	1.00	3.20	0.67	1.11	0.13	0.13
Centaurium erythraea	0.00	0.00	0.11	0.11	0.00	0.00
Epilobium ciliatum	0.00	0.00	0.11	0.11	0.00	0.00
Fragaria chilense	0.00	0.00	0.11	0.11	0.00	0.00
Galium aparine	0.00	0.00	0.00	0.00	0.13	0.13
Galium trifidum	0.00	0.00	0.00	0.00	0.25	0.25
Gamochaeta ustulata	0.00	0.00	0.11	0.11	0.00	0.00
Hypochaeris radicata/Leontodon saxatilis	1.00	3.20	0.89	2.67	0.63	1.50
Lupinus littoralis	0.20	0.20	0.00	0.00	0.00	0.00
Plantago lanceolata	0.80	1.00	0.00	0.00	0.00	0.00
Platanthera sp.	0.00	0.00	0.00	0.00	0.13	0.13
Polygonum paronychia	0.60	0.60	0.00	0.00	0.00	0.00
Potentilla anserina ssp. *pacifica*	0.00	0.00	0.33	0.67	0.50	1.13
Pseudognaphalium stramineum	0.00	0.00	0.33	0.44	0.25	0.25
Rumex acetosella	0.60	0.60	0.00	0.00	0.00	0.00
Rumex crispus	0.00	0.00	0.33	0.33	0.13	0.13
Sceptridium multifidum	0.00	0.00	0.00	0.00	0.63	0.88
Sisyrinchium californicum	0.00	0.00	0.11	0.11	0.00	0.00
Symphyotrichum subspicatum	0.40	0.40	0.78	1.22	0.50	0.88
Tanacetum pipinnatum	0.40	0.40	0.00	0.00	0.13	0.13
Teesalia nudicaulis	0.20	0.20	0.00	0.00	0.00	0.00
Trifolium wormskioldii	0.00	0.00	0.33	0.56	0.25	0.75
Veronica peregrina var. *xalapensis*	0.00	0.00	0.11	0.11	0.00	0.00
Veronica scutellata	0.00	0.00	0.56	0.78	0.63	0.63
TREES AND SHRUBS						
Alnus rubra	0.00	0.00	0.00	0.00	0.13	0.13
Arctostaphylos uva-ursi	0.00	0.00	0.11	0.11	0.00	0.00
Lonicera involucrata	0.00	0.00	0.00	0.00	0.13	0.13
Malus fusca	0.20	0.20	0.22	0.22	0.50	0.63
Morella californica	0.00	0.00	0.00	0.00	0.25	0.38
Pinus contorta	0.00	0.00	0.33	0.33	0.38	0.75
Rubus bifrons	0.00	0.00	0.00	0.00	0.13	0.13
Rubus ursinus	0.00	0.00	0.11	0.11	0.13	0.13
Salix hookeriana	0.00	0.00	0.33	0.44	0.88	3.88
Spiraea douglasii	0.00	0.00	0.44	0.44	1.00	3.13