



Lewis and Clark National Historic Park Vegetation Classification and Mapping Project Report

Natural Resource Report NPS/NCCN/NRR—2012/597



ON THE COVER

Benson Beach, Cape Disappointment State Park

Photograph by: Lindsey Koepke Wise

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Executive Summary

The National Park Service (NPS) Vegetation Inventory Program (VIP) is an effort to classify, describe, and map existing vegetation of national park units as part of generating baseline data products for the NPS Natural Resources Inventory and Monitoring Program. A vegetation map of the Lewis and Clark National Historic Park (LEWI) was developed as part of a cooperative project between the National Park Service (NPS) and the Institute for Natural Resources' Oregon Biodiversity Information Center (ORBIC). The project complemented ongoing species-level inventory at the park which took place during 2009 and 2010.

The vegetation classes developed for the LEWI map build on the U.S. National Vegetation Classification Standard (USNVC, <http://usnvc.org>). An initial classification was developed drawing on ORBIC and NPS staff expertise of vegetation types in the area. Training data points (n=254) were collected in 2009 and 2010.

Several imagery sources were used to derive the vegetation map, primarily Light Imaging and Detection Radar (LiDAR) and aerial imagery from the National Agriculture Imagery Program. The eCognition software package and Berkley Imaging Segmentation was used to create the initial image segments and polygon map. The mean values of variable inputs were summarized for each of the training data polygons and were used to generate a predictive non-parametric model using RandomForest in the statistical program *R*. The model was then applied to all polygons. The resulting draft map was reviewed by experts familiar with the vegetation types of the area.

The final map includes 24 classes, representing 3 land cover types and 21 alliance-based map classes. A field-based, blind random sample accuracy assessment of the map was carried out in mid-August 2011 and December 2011. A total of 175 accuracy assessment points were collected. Based on the assessment, the total map accuracy was 88.9%, exceeding the program standard of 80%.

In general, the combination of having access to LiDAR and multiple imagery sources, a relatively small area to map, and a large number of roads and trails for accessing training and accuracy assessment plots resulted in very accurate and meaningful results. Following the accuracy assessment, all of the polygons which had been identified as being mapped incorrectly were updated, so the final product has no known errors and should be very useful for management decisions at LEWI.

The LEWI vegetation inventory project delivers a suite of final products in both hardcopy and digital format. These products include a comprehensive report detailing the methods, results, vegetation descriptions and key, map class descriptions, and a contingency table showing the results of the mapping accuracy assessment. In addition, the product suite includes imagery, and a geodatabase of vegetation community polygons combined with field plot and accuracy assessment point locations. This combined suite of products provides a baseline inventory of vegetation at the park and enhances the usability of these data for natural resource management.

Acknowledgments

The authors would like to thank the following individuals for their assistance with this project. C. Cole and N. Eid at Lewis and Clark National Historical Park (LEWI) assisted with design and the implementation of field surveys, provided known locations of communities, and participated in frequent discussions on survey and accuracy assessment results. K. Sayce of ShoreBank Pacific worked with LEWI staff to map the vegetation of Cape Disappointment State Park and provided important background for the mapping and sampling.

The vegetation classification was built on the work of the NatureServe Ecology Staff, particularly M. Reid; along with the state classifications carefully compiled at the Washington Natural Heritage Program by R. Crawford, J. Rocchio and C. Chappell, who are responsible for most of the Washington work. The wetlands classification was entirely done by J. Christy of the Oregon Biodiversity Information Center (ORBIC), who also assisted with field work and project review.

N. Bacheller of the Oregon Parks and Recreation Department provided information on Fort Stevens and Sunset Beach resource management. C. Schull and M. Reich with the ORBIC assisted in field work and specimen preparation during the botanical inventories, which provided the base of the fieldwork for the mapping project.

The authors would like to thank N. Antonova, C. Cole, T. Cook, and K. Brown for their assistance reviewing this report.

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Acronyms

ArcGIS™ - A group of geographic information system (GIS) software products produced by ESRI

BIS - Berkley Imaging Segmentation

CART - Classification and Regression Tree

CESU - Cooperative Ecosystem Study Unit

DEM - Digital Elevation Model

ESRI - Environmental Systems Research Group

FGDC - Federal Geographic Data Committee

GIS - geographic information system

GLOVIS - United States Geological Survey Global Visualization Viewer

GPS - Global Positioning System

Landsat - A global land-imaging project consisting of a series of satellites that routinely gather land imagery from space

LEWI - Lewis and Clark National Historical Park

LiDAR - Light Imaging Detection and Ranging

MORA - Mount Rainier National Park

NAD - North American Datum

NAIP - National Agricultural Imagery Program

NCCN - North Coast and Cascades Network

NDMI - Normalized Difference Moisture Index

NDVI - Normalized Difference Vegetation Index

NOCA - North Cascades National Park Complex

NPS - National Park Service

NVCS - National Vegetation Classification Standard

PSU - Portland State University

OLYM - Olympic National Park

ORBIC - Oregon Biodiversity Information Center

SPOT -Système Pour l'Observation de la Terre - high resolution, optical imaging Earth observation satellite system

TCW - Tasseled Capped Wetness

TNC - The Nature Conservancy

VIP - Vegetation Inventory Program (National Park Service)

Introduction

The National Park Service Vegetation Inventory Program

The hundreds of parks, monuments, and landmarks managed by the National Park Service (NPS) encompass a diverse set of habitats and communities. The Vegetation Inventory Program is an effort begun by NPS in 1992 to classify, describe, and map vegetation communities present on these NPS units across the United States. The resulting maps, classifications, and reports contribute to the inventory of NPS resources and inform management and planning decisions. As of December 2011, 129 parks had completed vegetation mapping inventories and projects were ongoing at 136 parks, with 46% of the project completed (NPS 2011a).

Working with partner organizations that had experience in vegetation mapping, the NPS developed procedures and standards for vegetation classification, mapping, and accuracy assessment for the mapping program (TNC and ESRI 1994a and 1994b; TNC et al. 1994). These initial efforts focused on the development of a National Vegetation Classification Standard (NVCS) that could be adopted by many agencies and organizations across the United States. National Park Service vegetation classification guidelines were updated in 2011 (Lea 2011) and assessment procedures were updated in 2010 (Lea and Curtis 2010) to tailor the original universal guidelines from the 1990s to a more NPS-oriented, site-specific scope. Nonetheless, the NPS continues to support the NVCS through participation in committees and panels and through funding support.

The primary objective of the Vegetation Inventory is to identify and classify vegetation types that are characteristic of parks in the Network; to produce high-quality, standardized maps and associated data sets of vegetation and other land-cover occurring within parks; and to provide this information in written, tabular, and digital formats for vegetation mapping, park resource managers, and others.

Lewis and Clark National Historical Park Vegetation Inventory Mapping Project

Oregon Biodiversity Information Center (ORBIC) developed vegetation inventory and maps for Lewis and Clark National Historical Park (LEWI). ORBIC has been collaborating with the NPS through the Pacific Northwest Cooperative Ecosystem Study Unit (CESU) to develop similar products for a number of other parks in the North Coast and Cascades Network (NCCN) of the NPS, including Mount Rainier (MORA), North Cascades (NOCA) and Olympic (OLYM). Mapping work done by ORBIC was preceded by the vegetation classification work at for MORA, NOCA and OLYM in 2005-2007 (Crawford et. al, 2009). The NPS-ORBIC collaboration started with the mapping at MORA, and then moved on to LEWI, and OLYM and NOCA (Table 1). Project coordination for all NCCN inventory and mapping was provided by Catharine Copass, an NPS North Coast and Cascades Network (NCCN) ecologist.

Table 1. Timeline of the vegetation inventory initiative for the North Coast and Cascade Network. (AA = Accuracy Assessment; Clsf = Classification; Veg = Vegetation)

National Park	2008	2009	2010	2011	2012	2013
Mount Rainier	Field Clsf	Field Clsf	Mapping	Mapping	Products	
Lewis and Clark		Veg Clsf, Mapping	Veg Clsf, Mapping	Field AA	Products	
Olympic			Veg Clsf	Veg Clsf, Mapping	Veg Clsf, Mapping	Mapping, Field AA
North Cascades					Field Clsf	Field Clsf

In 2008, ORBIC began a two-year Plant Species List Inventory of LEWI. This project was coordinated by Regina M. Rochefort, the Science Advisor to the NCCN, with assistance from Angela Evenden, NPS CESU Coordinator. In 2009, ORBIC initiated a vegetation map for LEWI following similar protocols to those used for the MORA mapping project. ORBIC was able to take advantage of the field biologists working on the plant species inventory at LEWI in 2009 and 2010 to collected training data for the vegetation map.

Field surveys occurred in the spring and summer of 2009 and 2010. A vegetation map was developed in summer 2011 and was assessed via field visits in late summer and fall 2011 to determine map accuracy. The final products were delivered in winter 2012.

This study generated three main products for LEWI: 1) Vegetation classification; 2) Vegetation map; and 3) Map accuracy assessment.

The National Vegetation Classification Standard

All vegetation maps developed for the NPS Vegetation Inventory Program (VIP) use the National Vegetation Classification Standard. Adopted by the Federal Geographic Data Committee (FGDC) in 1997, the NVCS is a collaborative effort to classify the vegetation communities of the United States in a standardized, scientifically based, hierarchical manner. Several federal agencies and non-profit organizations including the National Park Service, Fish and Wildlife Service, The Nature Conservancy, US Geological Survey, and the Ecological Society of America contribute to the classification and its revisions. In 2008 a major revision to the 1997 standard was adopted. The 2008 revision incorporates newly documented floristic units and a reworking of the hierarchy to give greater emphasis on biological rather than abiotic criteria (such as hydrologic regime) to determine the classification. The 2008 revised hierarchy more broadly defines upper level types to reflect ecological relationships, and provides clear distinction between natural and cultural vegetation, among other changes (FGDC 2008).

The NVCS employs a hierarchical classification where the highest levels define broad ecological types such as Pacific Northwest forests and Great Plains grasslands, the middle levels refine these types based on biogeography, and the lower levels refine further based on species combinations. The upper levels (class, subclass, and formation) are based on physiognomic features (i.e., based on structure and ecological role of growth form rather than specific species); the lower levels (alliance and association) are distinguished by differences in floristic composition (i.e., structure and composition of specific species within the type); and the mid-

levels (division, macrogroup, and group) are determined by a combination of regional climate, physiognomic and floristic features. An example of the full NVC hierarchy for a common Pacific Northwest Forested Plant Association appears in Table 2. Each type is given a scientific name and a colloquial name; only the scientific name is given in Table 2. Cultural vegetation types such as apple orchards or corn fields follow a similar hierarchy. The cultural types at LEWI are composed of: mowed lawns in and around the park buildings; planted, usually non-native deciduous trees in and around these buildings; and pastures that are mowed or hayed each year. The cultural types at LEWI have all been mapped as “Lawn and Pasture” and are further discussed in the map class descriptions.

Table 2. An example of the National Vegetation Classification System hierarchy Version 2 (2008) for a common Pacific Northwest coast Forested Plant Association.

Hierarchy for Natural Vegetation	Vegetation Example	Code
Upper		
Level 1 – Formation Class	Forest & Woodland (Mesomorphic Tree Vegetation)	1
Level 2 – Formation Subclass	Temperate Forest	C
Level 3 – Formation	Cool Temperate Forest	2
Mid		
Level 4 – Division	Western North American Cool Temperate Forest	b
Level 5 – Macrogroup	Vancouverian Lowland & Montane Rainforest	M024
Level 6 – Group	North Pacific Hypermaritime Sitka Spruce Forest	G239
Lower		
Level 7 – Alliance	<i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Forest Alliance	A.NCCN-027
Level 8 – Association	<i>Picea sitchensis</i> / <i>Gaultheria shallon</i> Forest	CEGL000401

Study Area

Location and Brief History

Lewis and Clark National Historical Park is located near the mouth of the Columbia River on the Pacific coast in Clatsop County, Oregon and Pacific County, Washington (Figure 1). The park is composed of nine disconnected units in Oregon and Washington. The central unit of the park is the Fort Clatsop site in Oregon, which was first established as a National Memorial in 1958.

Since then, the park has continued to expand. In 1979 the 0.2 acre Salt Works parcel in Seaside was purchased and added to the park. The Fort Clatsop unit was expanded to about 1200 acres in 2002 under the Fort Clatsop Boundary Expansion Act. A major expansion came in 2004 with the passage of the Lewis and Clark National Historical Park Designation Act, which added units in Washington and additional sites in Oregon. The park now covers a total of 3,358 acres.

There are six National Park Service units: Cape Disappointment, Middle Village/Station Camp, Dismal Nitch, Sunset Beach/Yeon, Fort Clatsop and the Salt Works, a treed city lot. There are also three State Park units: Fort Columbia, Fort Stevens, and Ecola State Parks. Salt Works is the only park unit that is not included in the mapping project extent.

Three units are located in Washington State. The largest is Cape Disappointment State Park, located at the extreme south-western tip of Washington. While this unit continues to be managed by Washington State Parks, it is within the legislative boundaries of LEWI as defined in the 2004 LEWI designation act. The other two Washington units are located further west and upstream along the Columbia River. They are Middle Village/Station Camp, a site of both pre- and post-European contact significance located west of the Astoria Bridge, and Dismal Nitch, a smaller unit located just east of the Astoria Bridge.

In Oregon, the original National Memorial site, Fort Clatsop, is located on the Lewis and Clark River south-east of the city of Astoria. This 1,200 acre unit now includes the Fort to Sea trail which connects the fort to the ocean. The Fort to Sea trail terminates at Sunset Beach State Recreation Area, which is owned by Oregon State Parks but is within the legislative boundaries of LEWI, and is cooperatively managed between the two agencies. Directly south of Sunset Beach is the recently acquired Yeon property. Collectively, these two properties comprise the Sunset Beach/Yeon unit.

In addition to the six units that fall within the legislative boundaries of LEWI, there are three additional state park units that have special cooperative relationships with LEWI and have been included in this study, though they were given less intensive investigation. They are: Fort Columbia State Park located on the Columbia River immediately northwest of the Station Camp unit in Washington; Fort Stevens State Park located on the peninsula at the extreme north-western tip of Oregon, and Ecola State Park located north of Cannon Beach, Oregon. Fort Stevens is the largest unit at over 3,000 acres. Table 3 lists the names, nearest towns for reference, and areas of the nine units of LEWI.

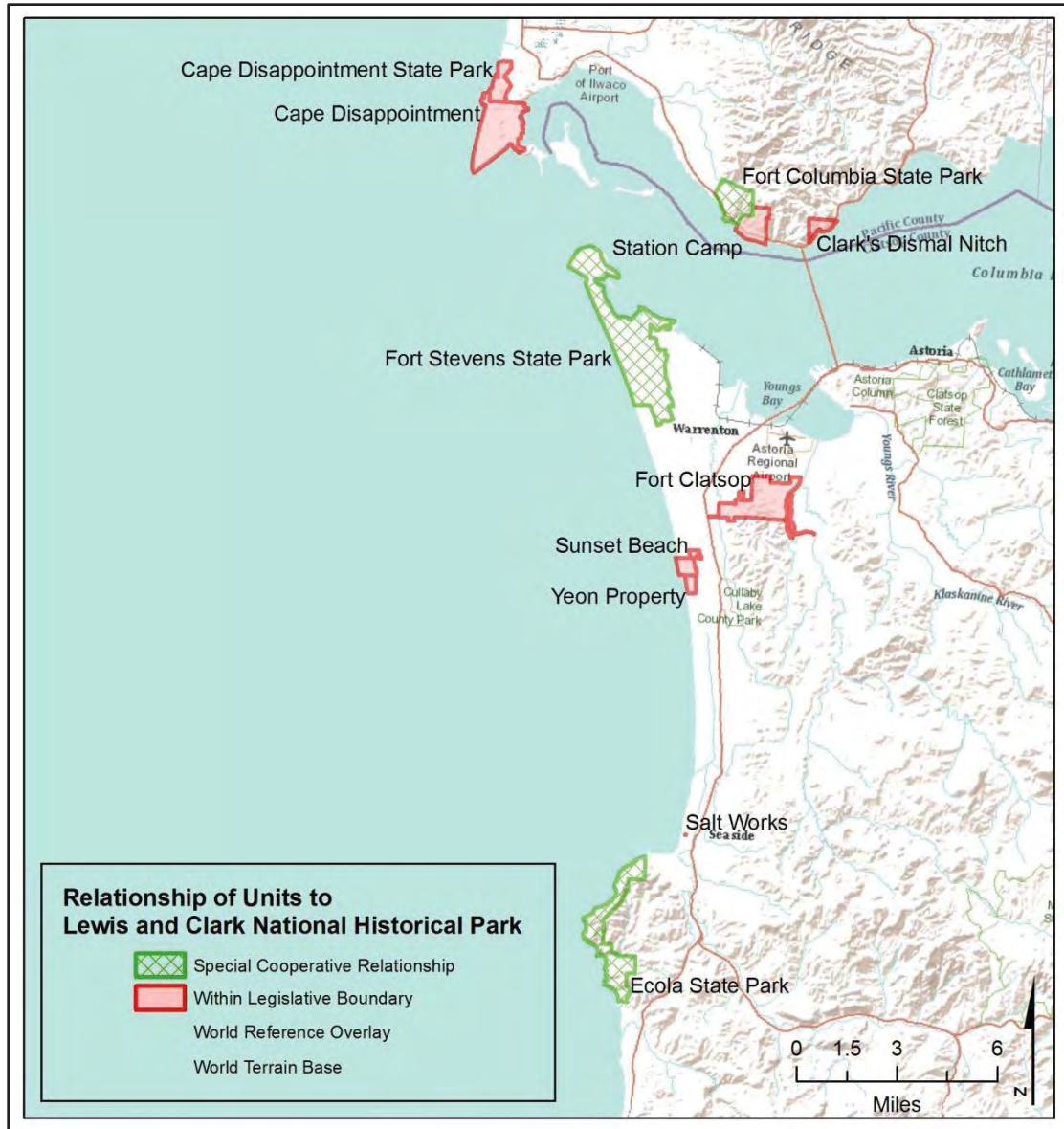


Figure 1. Locations and names of Lewis and Clark National Historical Park and State Park units.

Table 3. Names and areas of LEWI units with the nearest town given for reference.

Unit Name	Nearest Town	Acreage	Hectares
Cape Disappointment	Ilwaco, WA	1725.22	698.18
Clark's Dismal Nitch	Megler, WA	191.61	77.54
Ecola State Park	Cannon Beach, OR	1470.66	595.16
Fort Clatsop	Astoria, OR	1290.98	522.44
Fort Columbia State Park	Megler, WA	626.62	253.58
Fort Stevens State Park	Warrenton, OR	3446.49	1394.75
Middle Village/Station Camp	Megler, WA	468.61	189.64
Salt Works	Seaside, OR	0.25	0.10
Sunset Beach/Yeon	Warrenton, OR	319.00	129.09

Project Extent

Unlike the species inventory project which focused on the six legislative units of LEWI, the mapping project incorporated eight of the nine major LEWI units (Figure 1). One park holding that was not included was the Salt Works unit in Seaside, Oregon due to its extremely small size and developed setting. The mapping extent was the official LEWI boundary as provided by the Park Service. The total area covered by the project was 3860 hectares (9539 acres). A fifty-meter buffer outside of the park was mapped and included in the final products, although areas outside of the park were not sampled for the accuracy assessment. The maps in this report do not show the 50 meter buffer.

Landscape Setting

LEWI lies entirely within the Coast Range ecosystem. The mountains of the Pacific Coast Range run north-south from Alaska to California. They were formed from a volcanic island chain that collided with the North American continent about 50 million years ago. The subduction of the Juan de Fuca plate under the North American Plate in the Pacific Northwest causes uplift along the coast, creating marine terraces (Roering 2008). Marine sediments from this uplift form the lands west of the range, where the Lewis and Clark units are located. The climate along the coast is cool and wet, with average rainfall ranging around 179-254 cm (70-100 inches) per year. Winters and summers are mild with an average high of 19.5° C (67° F) and low of 1.5° C (35° F). The landscape along the coastline features rocky shores and headlands to sandy dunes, and transitions to temperate forest inland.

Storms frequently cause landscape-level changes at the coast, eroding beaches and toppling trees in forested areas. Major storms in 1999 and 2007 caused significant blow downs and beach erosion in Park units, resulting in open forest habitats (Figure 2). Figure 3 shows an undisturbed mature spruce forest for comparison. Windthrow and fire have been the major disturbance forces shaping conifer forests along the Pacific coast (Quaye 1982, Harcombe et al. 2004).



Figure 2. Spruce forest at Fort Clatsop blown down by a major wind storm event in 2007.

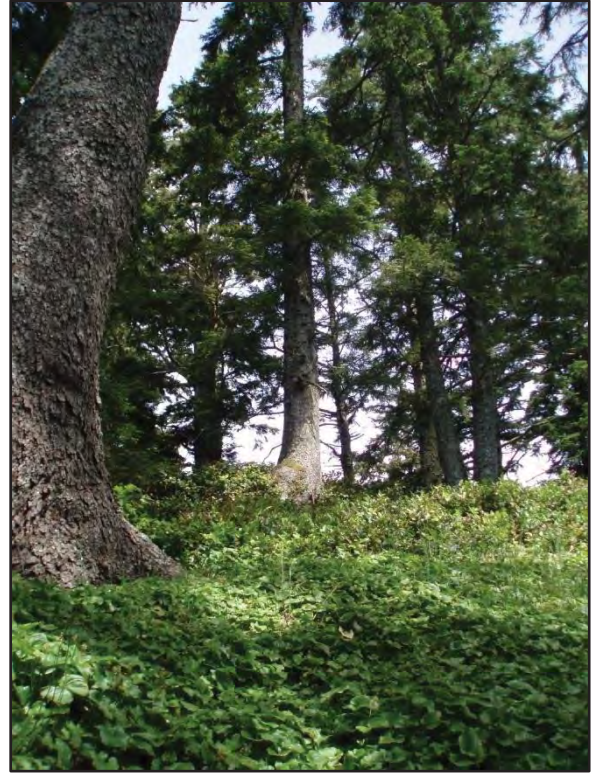


Figure 3. A mature, undisturbed spruce forest at Cape Disappointment.

Prior to European settlement and development, lands that are now Lewis and Clark National Historical Park were a mosaic of spruce forests, swamps, shrublands, dry prairies, dunes, coastal headlands, and salt marshes (Hawes et al. 2008). The Oregon Biodiversity Information Center has created historical vegetation maps for the coast from General Land Office notes and hand-drawn maps from the late 1850s, which have been collected and put on microfilm by the Bureau of Land Management (Figures 4-6). The maps developed by Hawes et al. (2008) are for the northern Oregon coast (Figure 4), Cape Disappointment (Figure 5), and Ecola (Figure 6). The Dismal Nitch, Middle Village/Station Camp, and Fort Columbia units in Washington State were not included in the scope of this historical mapping effort.

Hawes et al. (2008) used field notes on vegetation recorded by the original surveyors to create the 1850s historical maps, thus the historical vegetation classification uses simplified types. For instance, prairie includes all grasslands, coastal dune grasslands, such as coastal headland grasslands and grass balds. The historic maps were based on survey line data, so the landscape diversity within the map areas could not be fully captured. In spite of these limitations, the maps provide a unique view of the landscape in the 1800s, and provide a reference for the extent and historic setting of land cover types.

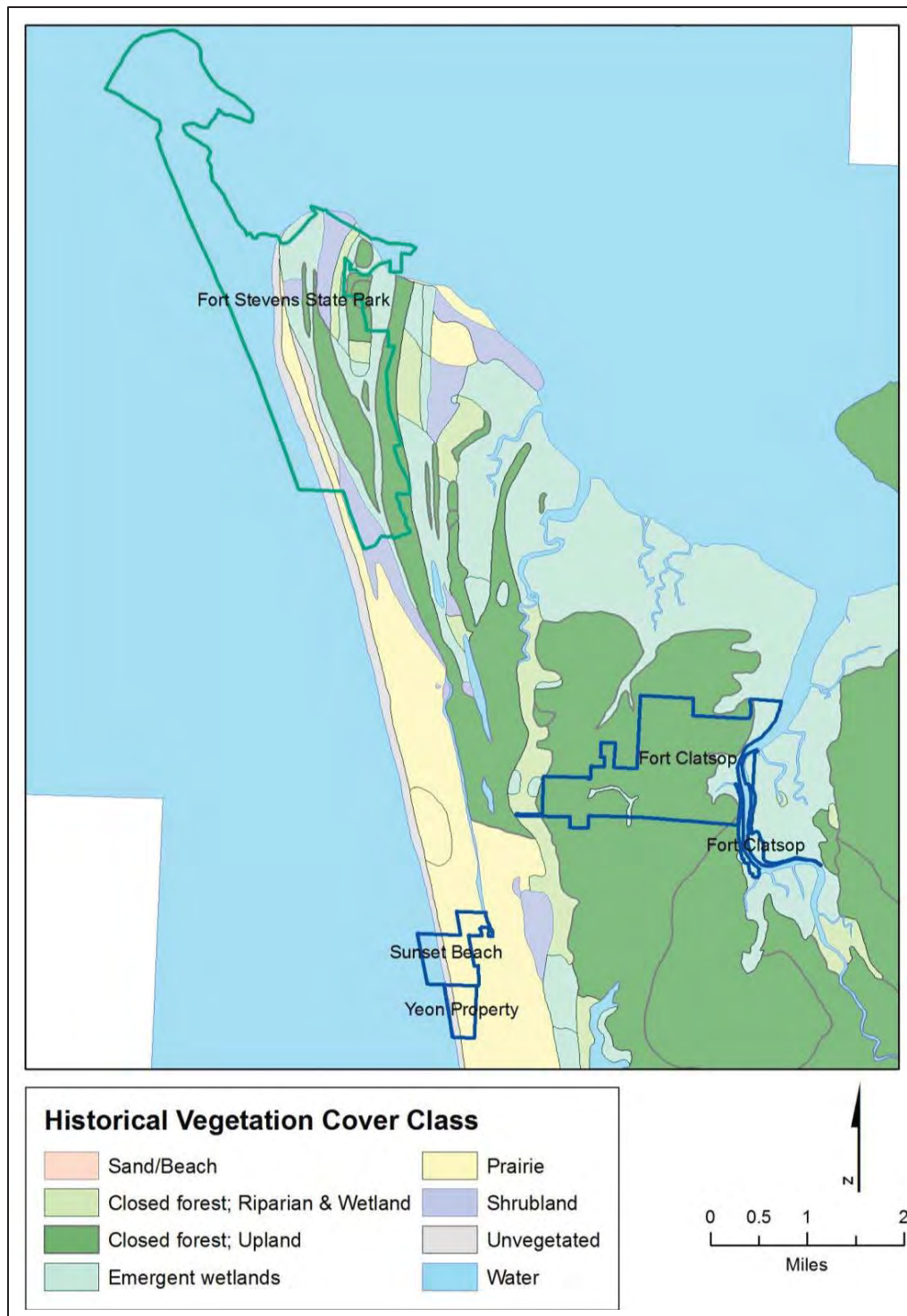


Figure 4. Historical vegetation cover of the northwest Oregon coast, as recorded in field surveyor notes during General Land Office Surveys in the 1800s and early 1900s (from Hawes et al. 2008). The blue or green lines represent the boundaries of the NPS units. The area in the historical map at Fort Stevens and part of Sunset Beach that is shown as water in the 1800s is now land that has been added by deposition of river sediments and sand influenced by the building of the jetty from 1885 to 1895. The area of “prairie” covering Sunset Beach and the Yeon property was known as Clatsop Plains, much of it composed of large patches of native beach grasses and large areas of open sand.

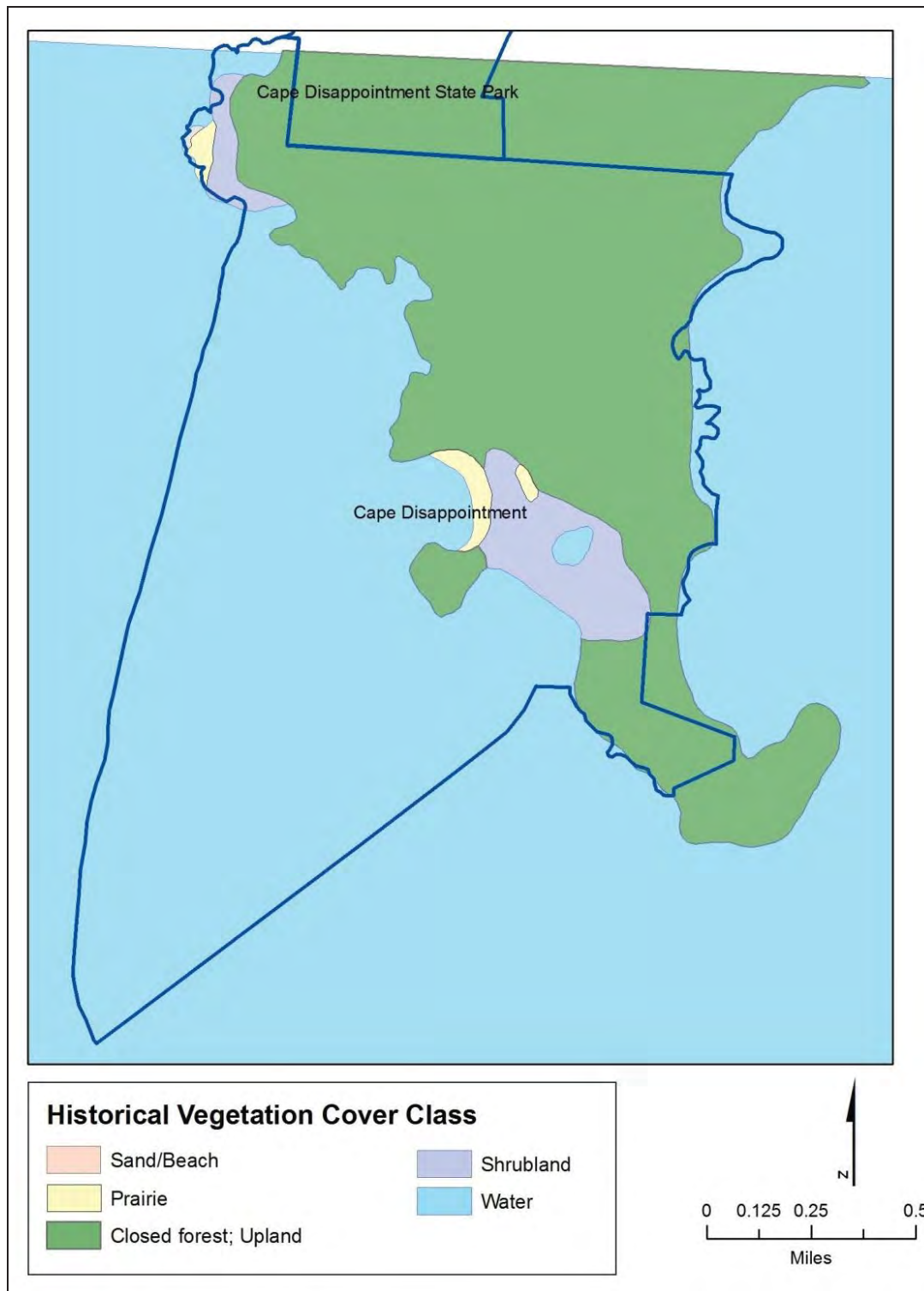


Figure 5. Historical vegetation cover of the Cape Disappointment area in southwest Washington, as recorded in field surveyor notes during General Land Office Surveys in the 1800s and early 1900s (from Hawes et al. 2008). The blue line represents the current Cape Disappointment boundary (only the southern part of the park has been mapped). The areas that were historically water are currently land that was added in the last century by deposition of river sediments and sand influenced by the building of the North Jetty from 1914 to 1917.

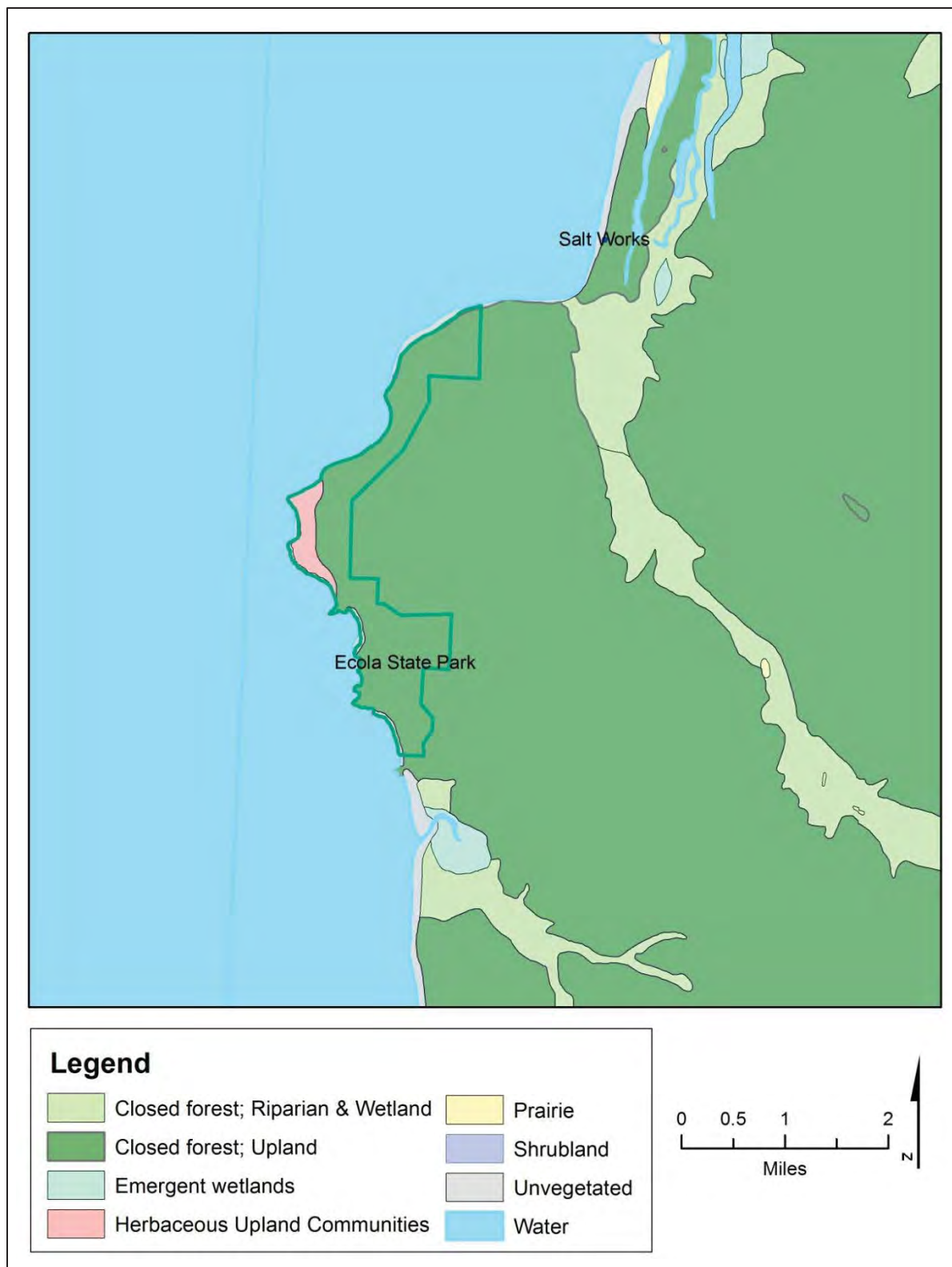


Figure 6. Historical vegetation cover at Ecola State Park (from Hawes et al. 2008). The green line shows the boundary of the park.

Although urbanization, dune stabilization, non-native species encroachment, and accretion have changed the size and ratio of the habitats presented in the 1800s historical maps, a mosaic of prairie, forest, herbaceous, shrubland, and wetland habitats is still present within the LEWI units. Native dune habitats historically were open sandy areas dominated by American dunegrass (*Leymus mollis*) often with sea pea (*Lathyrus japonicus*), salt rush (*Juncus lesueurii*) and yarrow (*Achillea millefolium*). A few remnants of native dune habitats can still be found at the Oregon Dunes National Recreation Area between Florence and Coos Bay, Oregon, and at Lanphere-Christensen Dunes Preserve near Arcadia, California (Christy et al. 1998). Unfortunately, on the northern Oregon coast, the majority of these habitats have been replaced by non-native beachgrasses (European beachgrass, *Ammophila arenaria*, native to Europe, and American beachgrass, *Ammophila breviligulata*, native to the eastern United States). The area defined as “prairie” in the historic vegetation map (Figure 4) represents these native dune grasslands, which are among the most depleted ecosystems in Oregon. A patch of comparatively native dune can be seen in Figure 7, in contrast to the European beachgrass-dominated dune shown in Figure 8.



Figure 7. Remnant dune prairie at Sunset Beach.



Figure 8. Dune at Fort Stevens dominated by non-native European beachgrass.

Dune willow (*Salix hookeriana*), Oregon crab apple (*Malus fusca*), and rose spiraea (*Spiraea douglasii*) are common shrubs in the dunes and deflation wetlands (Figure 9). Deflation wetlands or deflation plains are areas behind foredunes where wind has eroded the sand to the water table. Deflation plains are typically flooded in the winter with fresh or brackish water, and dry out during the summer (Christy et al. 1998). Many of the deflation plains in Oregon and Washington are artifacts of the establishment and spread of European beachgrass and the subsequent creation of foredunes (Pinto et al. 1972; Wilde 1982), though some were present historically (Christy et al. 1998).

Forests are dominated by Sitka spruce (*Picea sitchensis*) with Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and red alder (*Alnus rubra*) common. Shore pine (*Pinus contorta*) has been widely planted for dune stabilization. Salt marshes and tidal wetlands are found along the coast, the Columbia River, and the Lewis and Clark River (Figure 10).



Figure 9. Rose spiraea wetland at Sunset Beach.



Figure 10. Tidal wetland on the Columbia River at Dismal Nitch.

Previous Studies

Previous comprehensive vegetation mapping has not been done at LEWI. Vegetation community descriptions have been a component of previous park reports and documents, and provided background or baseline information for this project. A vascular plant species and plant community inventory took place at Cape Disappointment in 2004 (Sayce and Eid 2004). The Cape Disappointment project included an inventory of major habitat types (forests, woodlands, grasslands, etc.) and included descriptions of the plant communities found within each habitat. Most of the unit was surveyed on foot, with the rest being inventoried by binoculars or aerial photographs. Habitat types were mapped on paper.

Elk surveys have been ongoing at Fort Clatsop from 2008 to 2010. General vegetation information was collected at most of these survey points, differentiating wetland versus upland sites and deciduous versus evergreen forest types (Griffin 2010). The Lewis and Clark National Historical Park Forest Environmental Assessment (NPS 2011b) includes a map of forest stand ages and stand types for Fort Clatsop, as determined by a Weyerhaeuser inventory in 2004. Dominant tree species and stand ages are reported with about two dozen polygons covering the unit. The Fort Clatsop vascular plant species inventory was certified in 2005 with additional surveys taking place from 2006 to 2008. The LEWI Vascular Plant Inventory (Wise and Kagan 2012) covering the other units of LEWI recorded habitat information at plant collection sites; these points were used as part of the training data for the current project.

Usefulness of Previous Work to this Effort

The previous biological studies of vegetation, mammals, and other natural resources were used as legacy data whenever possible. Some of these datasets, including the elk surveys and the Cape Disappointment habitat mapping effort were not used, due to either a lack of sufficient vegetation attributes in the case of the former, or poor spatial accuracy for the latter. The forest stand type and age data from the 2004 Weyerhaeuser inventory was useful, but the Light Imaging Detection and Ranging (LiDAR) data provided more relevant information on forests size and stand density, especially given the widespread wind damage to the forests at Fort Clastop in 2007. In particular, the 2009-2010 botanical inventories by the Oregon Biodiversity

resulted in vegetation information and accurate GPS data that provided many base training points.

Vegetation Classification

Classification Methods

The North Coast and Cascades Network (NCCN) of the National Park Service developed a vegetation classification under agreement with the Washington Natural Heritage Program (Crawford et al. 2009). The Lewis and Clark National Historical Park classification drew on this previous work, as well as the updated National Vegetation Classification as described by Faber-Langendoen et al. (2011).

The Oregon Biodiversity Information Center has extensive experience with classification of vegetation in Oregon, including the habitat types found at LEWI (i.e. ORBIC and NatureServe 2009, Kagan et al. 2004, McCain and Christy 2005, Christy et al. 1998). Drawing on previous studies and the existing classifications noted above, mapping work began by creating a preliminary vegetation classification in winter 2009 by querying the Oregon Ecological Systems database (ORBIC and NatureServe 2009). The initial list of types was reviewed by ORBIC, NPS, NatureServe, and the Washington Natural Heritage Program. This preliminary classification for LEWI was used to aid in field work during the Vascular Plant Inventory and in collection of training data for the Vegetation Mapping Project.

In addition, ORBIC and NatureServe created an initial table of associations known to be or thought to be present at LEWI. This list was modified after completion of field work to result in the final classification (Appendix A) along with a key to the Groups and Alliances found at LEWI (Appendix B). Unlike some of the other NPS classification projects, many areas in the LEWI units contain vegetation which has been disturbed to varying degrees, so “natural vegetation” often is not the best way to describe the actual vegetation present. Recent mapping NPS efforts for San Juan National Historical Park have applied a “ruderal” vegetation classification (Rocchio et al. In Prep.), which describes disturbed or modified variants of natural types. These ruderal types were incorporated into or modified for the LEWI classification where appropriate.

Field Data Collection

Vegetation classification data was collected in 2009 and 2010. ORBIC field staff were provided with GPS units with base imagery and the initial eCognition polygon map created for the mapping project (see Mapping Methods section for details). Color print-outs were also provided to aid in field sampling. The field crew navigated to the interior of a polygon, used the field alliance key to determine the vegetation type, and collected a GPS point at the location using Garmin eTrex GPS units in the NAD 83 geodetic datum. Relevant habitat descriptions or plot notes were also recorded. At the next change in vegetation type, this process was repeated. The sampling was a progressive census, with field sampling focused on navigating to as many accessible plots across a variety of habitat types as was possible. Following the initial sampling, specific environments were then targeted, determined by imagery and knowledge of the park units, rather than walking transects. It was felt this approach was a better use of field time than spending many hours reaching difficult to access areas that were vegetatively homogenous. Under-sampled areas and habitats were given higher priority for field visits. Locations that did not easily fit into an existing classification were given provisional names.

Data Analyses and Results

A total of 240 training data points and polygons were collected in the 2009 and 2010 field seasons, including vascular plant species inventory plots that could be keyed to alliance based on habitat descriptions and field notes. Types that did not fit well into the initial classification were discussed, and where needed, new alliances and/or associations were generated to best reflect the current vegetation on the ground. In particular, the existence of several semi-natural or modified types resulted in extended discussion of these complicated classes. As a result of these discussions, several ruderal provisional alliances or associations were added to the final classification. Figure 11 shows the locations of training polygons. Larger-scale and more detailed maps of each training sites are presented in Appendix C.



Figure 11. Distribution of training polygon sites collected at LEWI in 2009 and 2010.

Some training points described land cover rather than vegetation type (e.g. cliff, beach); the land cover map classes were included in the final vegetation map and are described in Appendix F but are not described in the vegetation classification. A few alliances did not have enough training data available for the creation of a map class. Although these alliances were combined into other map classes, all alliances and associations known to be present at LEWI were described and included in the LEWI vegetation classification (Appendix A). For example, several aquatic types were not sampled during field work, but are known to occur at LEWI from previous work at the park or from informal observations by project staff; these were included in the classification but lumped into the non-tidal freshwater marsh map class in the vegetation map. A list of all vascular plant species found at LEWI as documented in the Vascular Plant Inventory Report (Wise and Kagan, 2012) is found in Appendix D.

The final classification for LEWI is presented in Table 4, listing the 20 groups and 29 alliances found in the park. The floristic characteristics, distribution, and mapping rules for these alliances are discussed in the classification document found in Appendix A.

Within these 29 alliances, there are 82 associations present at LEWI. These associations are presented in Table 5.

Table 4. Vegetation classification for Lewis and Clark National Historical Park.

Division	MacroGroup	Group	Alliance
1.C.1.c Western North American Warm Temperate Forest			
	MG019	Californian-Vancouverian Foothill & Valley Forest & Woodland	
		<i>G205 Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group</i>	A.NCCN-NEW1 <i>Pinus contorta</i> var. <i>contorta</i> Coastal Dune Woodland Alliance
1.C.2.b Western North American Cool Temperate Forest			
	MG024	Vancouverian Lowland & Montane Rainforest	
		<i>G237 North Pacific Red Alder -Bigleaf Maple -Douglas-fir Forest Group</i>	A.NCCN-019 <i>Acer macrophyllum</i> - (<i>Pseudotsuga menziesii</i>) Forest Alliance A.NCCN-020 <i>Alnus rubra</i> - (<i>Picea sitchensis</i> , <i>Tsuga heterophylla</i>) Forest & Woodland Alliance
		<i>G239 North Pacific Maritime Sitka Spruce Forest Group</i>	A.NCCN-027 <i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Forest Alliance A.2067 North Pacific (<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i>) Stabilized Dune Forest
		<i>G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group</i>	A.NCCN-044 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Rubus spectabilis</i> Wet Forest Alliance A.NCCN-042 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Cornus unalaschkensis</i> Mesic Forest Alliance

Table 4. Vegetation classification for Lewis and Clark National Historical Park (continued).

Division	MacroGroup	Group	Alliance
1.C.3.c Western North American Flooded & Swamp Forest			
	MG035	Vancouverian Flooded & Swamp Forest	
		<i>G254 North Pacific Lowland Riparian Forest & Woodland Group</i>	A.NCCN-001 (<i>Acer macrophyllum</i> , <i>Alnus rubra</i>) Riparian Forest Alliance
			A.NCCN-005 (<i>Picea sitchensis</i> , <i>Abies grandis</i> , <i>Tsuga heterophylla</i> , <i>Thuja plicata</i>) - (<i>Alnus</i> spp., <i>Acer</i> spp.) Riparian Forest Alliance
		<i>G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group</i>	A.NCCN-002 (<i>Alnus</i> spp., <i>Fraxinus</i> spp., <i>Populus</i> spp.) / <i>Lysichiton americanus</i> Deciduous Swamp Woodland Alliance
			A.NCCN-004 (<i>Tsuga heterophylla</i> , <i>Picea sitchensis</i> , <i>Thuja plicata</i> , <i>Abies</i> spp.) / <i>Lysichiton americanus</i> Coniferous Swamp Woodland Alliance
2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland			
	MG050	Southern Vancouverian Lowland Grassland & Shrubland	
		<i>G488 Southern Vancouverian Shrub & Herbaceous Bald & Bluff Group</i>	A.2064 <i>Festuca rubra</i> - <i>Calamagrostis nutkaensis</i> Coastal Herbaceous Alliance
			A.2065 <i>Gaultheria shallon</i> Coastal Shrubland Alliance
	MGNEW.1	Southern Vancouverian Lowland RUDERAL Grassland & Shrubland	
		<i>NEW.1 Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group</i>	A.2063 <i>Anthoxanthum odoratum</i> - <i>Holcus lanatus</i> Ruderal Coastal Grassland Alliance
2.C.3.b Pacific North American Coast Scrub & Herb Vegetation			
	MGNEW.2	North Pacific Coastal RUDERAL Grassland & Shrubland	
		<i>NEW.2 North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group</i>	A.2061 <i>Ammophila arenaria</i> - Planted <i>Leymus mollis</i> ssp. <i>mollis</i> Coastal Dunegrass Ruderal Grassland Alliance
			A.2062 <i>Cytisus scoparius</i> - <i>Ulex europaeus</i> - <i>Lupinus arboreus</i> Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance
	M058	Cool Pacific Coastal Beach, Dune & Bluff Vegetation	
		<i>G498 North Pacific Maritime Coastal Sand Dune Scrub & Herb Vegetation Group</i>	A.2066 <i>Poa macrantha</i> - <i>Leymus mollis</i> - <i>Festuca rubra</i> Sand Dune Herbaceous Alliance
			A.NCCN-NEW3 (<i>Pinus contorta</i> var. <i>contorta</i> , <i>Picea sitchensis</i> , <i>Gaultheria shallon</i>) Stabilized Dune Shrubland Alliance

Table 4. Vegetation classification for Lewis and Clark National Historical Park (continued).

Division	MacroGroup	Group	Alliance
2.C.5.b Western North American Freshwater Wet Meadow & Marsh			
	MG073	Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland	
		<i>G322 Vancouverian Lowland Riparian & Wet Slope Shrubland Group</i>	
			A.2068 <i>Salix</i> spp. - <i>Malus fusca</i> - <i>Spiraea</i> spp. Lowland Riparian & Wet Slope Shrubland Alliance
			A.NCCN-999 <i>Salix hookeriana</i> Seasonally Flooded Shrubland Alliance
			A.NCCN-997 <i>Spiraea douglasii</i> Seasonally Flooded Shrubland Alliance
		<i>G518 Western North American Temperate Interior Freshwater Marsh Group</i>	
			A.1433 <i>Schoenoplectus acutus</i> (<i>Schoenoplectus pungens</i>) Semi-Permanently Flooded Herbaceous Alliance
			A.NCCN-NEW4 <i>Typha (angustifolia, latifolia)</i> Freshwater Marsh Alliance
			A.2598 <i>Sparganium eurycarpum</i> Hydromorphic Rooted Herbaceous Vegetation
		<i>G517 Vancouverian Freshwater Coastal Marsh & Meadow Group</i>	
			A.1412 <i>Carex aquatilis</i> var. <i>dives</i> Semi-permanently Flooded Herbaceous Alliance
			A.2582 <i>Carex obnupta</i> Seasonally Flooded Herbaceous Alliance
			A.1375 <i>Juncus effusus</i> Semi-Natural Seasonally Flooded Alliance
		<i>G523 Western North American Maritime Lowland Wet Meadow, Marsh & Seep Herbaceous Group</i>	
			A.1342 <i>Eleocharis palustris</i> Seasonally Flooded Herbaceous Alliance
2.C.6.c - Temperate & Boreal Pacific Coastal Salt Marsh			
	MG081	North American Pacific Coastal Salt Marsh	
		<i>G499 Temperate Pacific Tidal Salt & Brackish Marsh Group</i>	
			A.2622 <i>Carex lyngbyei</i> Tidal Herbaceous Alliance
			A.2618 <i>Salicornia virginica</i> Tidal Herbaceous Alliance
			A.2623 <i>Deschampsia caespitosa</i> Tidal Herbaceous Alliance
5.A.1.e Temperate Seagrass Aquatic Vegetation			
	MG184	Temperate Pacific Seagrass Vegetation	
		<i>G373 Temperate Pacific Seagrass Group</i>	
			A.NCCN-NEW6 <i>Zostera</i> spp. Permanently Flooded - Tidal Herbaceous Alliance
5.B.1.a North American Freshwater Aquatic Vegetation			
	MG109	Western North American Freshwater Aquatic Vegetation	
		<i>G544 Western North American Temperate Freshwater Aquatic Bed Group</i>	
			A.NCCN-NEW5 <i>Nuphar</i> spp. - <i>Potamogeton</i> spp. - <i>Lemna</i> spp. Freshwater Aquatic Alliance

Table 4. Vegetation classification for Lewis and Clark National Historical Park (continued).

Division	MacroGroup	Group	Alliance
6.B.2.b Western North American Temperate Cliff, Scree & Rock Vegetation			
	MG114	Vancouverian Cliff, Scree & Rock Vegetation	
		G322 Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group	
			No Alliances defined
8.1.A Developed Herbaceous & Woody Vegetation			
	M491	Temperate & Tropical Lawn	
		G622 Cool-Season, Warm-Season, Dry-Season Lawn	
			A.New Temperate Mowed Lawns Alliance
	M492	Temperate & Tropical Planted Landscaping & Gardens	
		G623 Treed Landscaping	
			A.New Temperate Planted Trees/Gardens

Table 5. Associations found at Lewis and Clark National Historical Park.

Alliance		
Association Code	Association Name	
A.NCCN-NEW1	<i>Pinus contorta</i> var. <i>contorta</i>	Coastal Dune Woodland Alliance
CEGL002605	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Arctostaphylos uva-ursi</i>	Woodland
CEGL000150	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Gaultheria shallon</i>	Woodland
CEGL000151	<i>Pinus contorta</i> var. <i>contorta</i> - <i>Pseudotsuga menziesii</i> / <i>Morella californica</i> - <i>Vaccinium ovatum</i>	Forest
NEW	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i>	Semi-natural Forest
A.NCCN-019	<i>Acer macrophyllum</i> - (<i>Pseudotsuga menziesii</i>)	Forest Alliance
NEW	<i>Acer macrophyllum</i> -(<i>Pseudotsuga menziesii</i>)/ <i>Polystichum munitum</i>	Forest
A.NCCN-020	<i>Alnus rubra</i> - (<i>Picea sitchensis</i> , <i>Tsuga heterophylla</i>)	Forest & Woodland Alliance
CEGL000638	<i>Alnus rubra</i> /Polystichum munitum	Forest
A.NCCN-027	<i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>)	Forest Alliance
CEGL003266	<i>Picea sitchensis</i> /Calamagrostis nutkaensis	Woodland
CEGL000401	<i>Picea sitchensis</i> /Gaultheria shallon	Forest
CELG00XXXX	<i>Picea sitchensis</i> /Maianthemum dilatatum	Forest
CEGL000056	<i>Picea sitchensis</i> /Menziesia ferruginea-Vaccinium parvifolium	Forest
PNWCOAST_060	<i>Picea sitchensis</i> /Vaccinium ovatum	Forest
CEGL003787	<i>Picea sitchensis</i> - <i>Tsuga heterophylla</i> /Polystichum munitum	Forest
A.2067	North Pacific (<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i>)	Stabilized Dune Forest
CEGL000403	<i>Picea sitchensis</i> - <i>Pinus contorta</i> / <i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i>	Forest
NEW	(<i>Picea sitchensis</i> - <i>Alnus rubra</i>)/ <i>Carex obnupta</i>	Stabilized Dune Forest
NEW	<i>Picea sitchensis</i> /Cytisus scoparius/Ammophila arenaria	Semi-natural Shrubland

Table 5. Associations found at Lewis and Clark National Historical Park (continued).

Alliance	
Association Code	Association Name
A.NCCN-044 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Rubus spectabilis</i> Wet Forest Alliance	
PNWCOAST_158	<i>Pseudotsuga menziesii</i> -(<i>Alnus rubra</i> - <i>Tsuga heterophylla</i>)/ <i>Rubus spectabilis</i> Forest
PNWCOAST_195	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /(<i>Acer circinatum</i>)/ <i>Polystichum munitum</i> Forest
PNWCOAST_191	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /Mahonia nervosa- <i>Polystichum munitum</i> Forest
A.NCCN-042 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Cornus unalaschkensis</i> Mesic Forest Alliance	
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /Gaultheria shallon/ <i>Polystichum munitum</i> Forest
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /Gaultheria shallon- <i>Vaccinium parvifolium</i> Forest
A.NCCN-001 (<i>Acer macrophyllum</i> , <i>Alnus rubra</i>) Riparian Forest Alliance	
CEGL003298	<i>Alnus rubra</i> /Acer circinatum/ <i>Claytonia sibirica</i> Forest
CEGL003401	<i>Alnus rubra</i> /Petasites frigidus Forest
CEGL003402	<i>Alnus rubra</i> /Rubus parviflorus Forest
CEGL000639	<i>Alnus rubra</i> /Rubus spectabilis Forest
CEGL003403	<i>Alnus rubra</i> /Stachys chamissonis var. cooleyae - <i>Tolmiea menziesii</i> Forest
CEGL003398	<i>Alnus rubra</i> /Elymus glaucus Forest
A.NCCN-005 (<i>Picea sitchensis</i> , <i>Abies grandis</i> , <i>Tsuga heterophylla</i> , <i>Thuja plicata</i>) - (<i>Alnus</i> spp., <i>Acer</i> spp.) Riparian Forest Alliance	
CEGL000060	<i>Picea sitchensis</i> -(<i>Alnus rubra</i>)/ <i>Rubus spectabilis</i> / <i>Polystichum munitum</i> Forest
Unclassified	<i>Picea sitchensis</i> /Scirpus microcarpus Woodland
A.NCCN-002 (<i>Alnus</i> spp., <i>Fraxinus</i> spp., <i>Populus</i> spp.) / <i>Lysichiton americanus</i> Deciduous Swamp Woodland Alliance	
CEGL003388	<i>Alnus rubra</i> /Athyrum filix-femina- <i>Lysichiton americanus</i> Forest
NEW	<i>Alnus rubra</i> /Glyceria striata Forest
NEW	<i>Alnus rubra</i> /Rubus spectabilis/ <i>Chrysosplenium glechomifolium</i> Forest
CEGL003389	<i>Alnus rubra</i> /Rubus spectabilis/ <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Woodland
A.NCCN-004 (<i>Tsuga heterophylla</i> , <i>Picea sitchensis</i> , <i>Thuja plicata</i> , <i>Abies</i> spp.) / <i>Lysichiton americanus</i> Coniferous Swamp Woodland Alliance	
CEGL000400	<i>Picea sitchensis</i> /Rubus spectabilis/ <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Forest
CEGL002670	<i>Tsuga heterophylla</i> -(<i>Thuja plicata</i> - <i>Alnus rubra</i>)/ <i>Lysichiton americanus</i> -Athyrum filix-femina Forest
A.2064 <i>Festuca rubra</i> - <i>Calamagrostis nutkaensis</i> Coastal Herbaceous Alliance	
CEGL001567	<i>Festuca rubra</i> Coastal Headland Herbaceous Vegetation
CEGL003349	<i>Calamagrostis nutkaensis</i> - <i>Elymus glaucus</i> Herbaceous Vegetation
NEW	<i>Lomatium martindalei</i> Sparse Vegetation
A.2065 <i>Gaultheria shallon</i> Coastal Shrubland Alliance	
NEW	<i>Baccharis pilularis</i> - <i>Vaccinium ovatum</i> Coastal Headland Herbaceous Vegetation
CEGL000971	<i>Empetrum nigrum</i> - <i>Gaultheria shallon</i> Dwarf-Shrubland
Provisional	<i>Artemisia suksdorfii</i> Coastal Headland Shrubland
CEGL000972	<i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> / <i>Pteridium aquilinum</i> Shrubland

Table 5. Associations found at Lewis and Clark National Historical Park (continued).

Alliance		
Association Code	Association Name	
A.2063	<i>Anthoxanthum odoratum</i> - <i>Holcus lanatus</i>	Ruderal Coastal Grassland Alliance
A.2061	<i>Ammophila arenaria</i> - Planted <i>Leymus mollis</i> ssp. <i>mollis</i>	Coastal Dunegrass Ruderal Grassland Alliance
CEGL003373	<i>Ammophila arenaria</i> - <i>Cardionema ramosissimum</i>	Herbaceous Vegetation
CEGL003006	<i>Ammophila arenaria</i>	Semi-natural Herbaceous Vegetation
NEW	<i>Leymus mollis</i> ssp. <i>mollis</i>	Semi-natural Herbaceous Vegetation
A.2062	<i>Cytisus scoparius</i> - <i>Ulex europaeus</i> - <i>Lupinus arboreus</i>	Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance
NEW	<i>Cytisus scoparius</i>	Shrubland
NEW	<i>Lupinus arboreus</i>	Ruderal Shrubland
NEW	<i>Ulex europaeus</i>	Ruderal Shrubland
A.2066	<i>Poa macrantha</i> - <i>Leymus mollis</i> - <i>Festuca rubra</i>	Sand Dune Herbaceous Alliance
CEGL001796	<i>Leymus mollis</i>	Herbaceous Vegetation
CEGL003349	<i>Festuca rubra</i>	Herbaceous Vegetation
NEW	<i>Festuca rubra</i> - <i>Pteridium aquilinum</i>	Sparse Herbaceous Vegetation
NEW	<i>Poa macrantha</i>	Sparse Herbaceous Vegetation
CEGL003368	<i>Carex macrocephala</i>	Herbaceous Vegetation
NEW	<i>Lupinus littoralis</i>	Sparse Vegetation
A.NCCN-NEW3	(<i>Pinus contorta</i> var. <i>contorta</i> , <i>Picea sitchensis</i> , <i>Gaultheria shallon</i>)	Stabilized Dune Shrubland Alliance
NEW	(<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i> - <i>Salix hookeriana</i> - <i>Malus fusca</i>)	Stabilized Dune Shrubland
A.2068	<i>Salix</i> spp. - <i>Malus fusca</i> - <i>Spiraea</i> spp.	Lowland Riparian & Wet Slope Shrubland Alliance
CEGL003294	<i>Malus fusca</i> - (<i>Salix hookeriana</i>) / <i>Carex obnupta</i>	Shrubland
A.NCCN-999	<i>Salix hookeriana</i>	Seasonally Flooded Shrubland Alliance
CEGL003432	<i>Salix hookeriana</i> (<i>Malus fusca</i>) / <i>Carex obnupta</i> - <i>Lysichiton americanus</i>	Shrubland
A.NCCN-997	<i>Spiraea douglasii</i>	Seasonally Flooded Shrubland Alliance
CEGL001129	<i>Spiraea douglasii</i>	Shrubland
A.1433	<i>Schoenoplectus acutus</i> (<i>Schoenoplectus pungens</i>)	Semi-Permanently Flooded Herbaceous Alliance
CEGL001840	<i>Schoenoplectus acutus</i>	Herbaceous Vegetation
CWWA000146	<i>Schoenoplectus pungens</i>	Herbaceous Vegetation (Pacific estuarine, provisional)
A.NCCN-NEW4	<i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>)	Freshwater Marsh Alliance
CEGL002010	<i>Typha</i> (<i>latifolia</i> , <i>angustifolia</i>)	Western Herbaceous Vegetation
A.2598	<i>Sparganium eurycarpum</i>	Hydromorphic Rooted Herbaceous Vegetation
CEGL001990	<i>Sparganium angustifolium</i>	Herbaceous Vegetation
A.1412	<i>Carex aquatilis</i> var. <i>dives</i>	Semi-permanently Flooded Herbaceous Alliance
CEGL001826	<i>Carex aquatilis</i> var. <i>dives</i>	Herbaceous Vegetation
A.2582	<i>Carex obnupta</i>	Seasonally Flooded Herbaceous Alliance
CEGL001820	<i>Carex obnupta</i> - <i>Argentina egedii</i>	Herbaceous Vegetation
CEGL003313	<i>Carex obnupta</i>	Herbaceous Vegetation

Table 5. Associations found at Lewis and Clark National Historical Park (continued).

Alliance		
Association Code	Association Name	
A.1375 <i>Juncus effusus</i> Semi-Natural Seasonally Flooded Alliance		
CEGL003317	<i>Juncus effusus</i> var. <i>brunneus</i>	Pacific Coast Herbaceous Vegetation
A.1342 <i>Eleocharis palustris</i> Seasonally Flooded Herbaceous Alliance		
CEGL001833	<i>Eleocharis palustris</i>	Herbaceous Vegetation
A.2622 <i>Carex lyngbyei</i> Tidal Herbaceous Alliance		
CEGL003285	<i>Carex lyngbyei</i> - (<i>Distichlis spicata</i> , <i>Triglochin maritima</i>)	Herbaceous Vegetation
CEGL003289	<i>Carex lyngbyei</i> - <i>Argentina egedii</i>	Herbaceous Vegetation
CEGL003369	<i>Carex lyngbyei</i>	Herbaceous Vegetation
A.2618 <i>Salicornia virginica</i> Tidal Herbaceous Alliance		
CEGL003466	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Jaumea carnosa</i>	Tidal Herbaceous Vegetation
CEGL003380	<i>Salicornia virginica</i>	Herbaceous Vegetation
CEGL003366	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Triglochin maritima</i> - (<i>Jaumea carnosa</i>)	Herbaceous Vegetation
A.2623 <i>Deschampsia caespitosa</i> Tidal Herbaceous Alliance		
CEGL003383	<i>Deschampsia caespitosa</i> - <i>Argentina egedii</i>	Herbaceous Vegetation
A.NCCN-NEW6 <i>Zostera</i> spp. Permanently Flooded - Tidal Herbaceous Alliance		
NEW	<i>Nanozostera japonica</i> / <i>Zostera</i>	Tidally Flooded Wetland
A.NCCN-NEW5 <i>Nuphar</i> spp. - <i>Potamogeton</i> spp. - <i>Lemna</i> spp. Freshwater Aquatic Alliance		
CEGL003017	<i>Azolla (filiculoides, mexicana)</i>	Herbaceous Vegetation
CEGL004017	<i>Ceratophyllum demersum</i>	Western Herbaceous Vegetation [Provisional]
CEGL003305	<i>Lemna minor</i>	Herbaceous Vegetation
CEGL002001	<i>Nuphar polysepala</i>	Herbaceous Vegetation
CEGL002925	<i>Potamogeton natans</i>	Herbaceous Vegetation
NEW	<i>Hydrocotyle ranunculooides</i>	Herbaceous Vegetation
A.New Temperate Mowed Lawns Alliance		
A.New Temperate Planted Trees/Gardens		

Classification Discussion

Ruderal (weedy) vegetation units within the 2008 NVC are still being developed. LEWI natural resource staff were involved in discussions of how to best map these classes to meet their needs and it was decided that map classes for these types at LEWI were needed. These transient and ruderal types are located in areas that contain high concentrations of non-native species which are of concern to LEWI staff. In response, a new macrogroup (North Pacific Coastal Ruderal Grassland & Shrubland) and several new ruderal alliances were developed (Table 5).

One major challenge with the LEWI vegetation classification was distinguishing between alder swamps and riparian vegetation in very wet, very low gradient ecosystems, as occur especially at Cape Disappointment and Fort Stevens State Parks. The plant assemblages of swamp and riparian forests are essentially identical, dominated by red alder, with Hooker's willow and occasional crab apple or elderberry, and understories of primarily slough sedge and salmonberry.

The swamps and riparian habitats occur in the same Macrogroup in the National Vegetation Classification System (NVCS), the MG035 Vancouverian Flooded & Swamp Forest Group in the Western North American Division (1.C.3.c). However, the riparian types are found in the G254 North Pacific Lowland Riparian Forest & Woodland Group, while the swamps are in the G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group. In general, riparian vegetation types and non-riparian emergent wetlands are easy to distinguish in the field and are functionally different, which is why they are separated into different groups. However, the two coastal parks at the mouth of the Columbia River are so flat, that it was almost impossible to distinguish riparian vegetation from swamps, and mapping streams in these areas, even with LiDAR, was very difficult. As a result, the final map class- Alder Swamp and Riparian, combines these at the macrogroup level (MG035 Vancouverian Flooded & Swamp Forest Macrogroup).

Several Associations present at LEWI have been identified as conservation targets by ORBIC and NatureServe (ORBIC and NatureServe 2009). These globally or locally rare associations are listed in Table 6 with their global rank (G rank) and state rank (S rank) for Oregon. The rarest association is Big-Headed Sedge Herbaceous Vegetation. Big-headed sedge was once a common species of open dunes along the Pacific coast, but its numbers have declined steeply in the past century due to dune stabilization and development. Patches of big-headed sedge occur at Fort Stevens and Cape Disappointment. The second-rarest association is Pacific Reedgrass -Blue Wildrye Perennial Grassland. This grassland occurs at the North Head headland in Cape Disappointment and is the only known locations in southwest Washington and one of three occurrences for the entire state (Washington State Parks and Recreation Commission 2004). This type is a bit more common in Oregon, and is found at Ecola State Park, although it also is often impacted by introduced perennial grasses introduced from historic livestock use (Kagan et al. 2004). Detailed discussion of these rare communities was reported in Wise and Kagan (2012).

Table 6. Rare associations present at Lewis and Clark National Historical Park.

Scientific Name	Common Name	Rank1
<i>Carex macrocephala</i> Herbaceous Vegetation	Big-Headed Sedge	G1G2S1
<i>Picea sitchensis</i> / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Forest	Sitka Spruce / Slough Sedge -Skunk Cabbage Swamp	G2G3S1
<i>Festuca rubra</i> Coastal Headland	Red Fescue Coastal Headland	G2S2
<i>Calamagrostis nutkaensis</i> - <i>Elymus glaucus</i> Perennial Grassland	Pacific Reedgrass - Blue Wildrye	G2S1
<i>Carex lyngbyei</i> - <i>Argentina egedii</i> Herbaceous Vegetation	Lyngby sedge - Pacific Silverweed Salt Marsh	G4S2
<i>Salicornia virginica</i> Herbaceous Vegetation	Glasswort Salt Marsh	G3G4S2

1. Global Ranks as reported by NatureServe. State rank for Oregon as determined by Oregon Biodiversity Information Center. Rank Definitions: G=Global, S=State, T=Taxon (variety, subspecies). 1=Critically imperiled; 2=Imperiled; 3=Rare, uncommon, or threatened; 4=Not rare and apparently secure; 5=Demonstrably widespread, abundant, and secure.

Classification Summary

Use of the 2008 NVC Standard resulted in defining the 20 groups and 29 alliances found in the park. Detailed descriptions of these types are found in Appendix A. The dichotomous key for these types is included in Appendix B. The macrogroups, groups and alliances were the basis for the development of the vegetation classes used in mapping.

Vegetation Mapping

Methods

Mapping the vegetation at LEWI started in 2009 and ended in 2011 and involved four primary steps: 1) preliminary segmentation; 2) training data collection; 3) map classification; and 4) post-processing.

Preliminary Segmentation

Imagery Data Sources

Several imagery datasets were available for the mapping project. Table 7 lists the types of imagery used in the LEWI mapping project, including the date the imagery was produced and the source of the data. Landsat satellite imagery was acquired from GLOVIS (<http://glovis.usgs.gov/>). SPOT 4 imagery was downloaded from EarthExplorer (<http://edcns17.cr.usgs.gov/NewEarthExplorer/>). Landsat imagery at 30 m resolution consists of 7 bands: 3 visible, 2 mid-infrared, 1 shortwave infrared and 1 thermal band. SPOT 4 imagery consists of 4 bands: 2 visible (10m), 1 shortwave infrared (10m), and 1 mid-infrared (20 m). Imagery used was from the summer 2008 (Landsat) and late fall 2010 (SPOT 4) to provide a phenological contrast useful in differentiating vegetation types. Every homogeneous vegetation type has a unique reflectance which is referred to as a signature. This unique signature is often more apparent and distinct in the infrared wavelengths outside of the human eye visible spectrum, enabling a remote sensing expert to use these unique satellite signature snapshots in time to differentiate various vegetation types.

Light Detection and Ranging (LiDAR) base elevation and highest hit data was made available through various sources and consisted of three separate flights in 2010 which were mosaicked. LiDAR heights were calculated by subtracting the highest hit from the base elevation. Various elevational derivatives (heat load, aspect, slope, elevation) were calculated from the base elevation data.

National Agriculture Imagery Program (NAIP) is a national program where high resolution imagery is collected in each state every two to four years and made available to the public at no cost. 4 band, Oregon and Washington NAIP imagery datasets (both collected around the same time in summer of 2009) were normalized to each other and then mosaicked. Normalized Difference Vegetation Index (NDVI), a measure of vegetation greenness, was calculated from the NAIP.

Table 7. Sources of aerial imagery used in the LEWI mapping project.

Imagery Date	Type	Scale	Products	Source
Summer 2009	NAIP	1m	NDVI	State of Oregon
2010	LiDAR	1m	Various Height Metrics	Various
07/12/2008	LANDSAT	30m	NDMI, NDVI, TCW	GLOVIS
11/10/2010	SPOT 4	20m	NDVI	USGS

Satellite Image Processing

All data sources were projected into NAD 83 UTM zone 10 N. Satellite imagery digital numbers were converted to Top of Atmosphere reflectance values and normalized for topography.

Various vegetation indices were calculated to depict vegetation characteristics not represented in single bands alone (Coppin and Bauer 1994, Jin and Sader 2005). The Normalized Difference Moisture Index (NDMI), NDVI and Tasseled Capped Wetness (TCW) were calculated (Crist and Cicone 1984). After initial pre-processing, all satellite imagery and indices were resampled to 2 meters to conform to the higher resolution NAIP and LiDAR.

Image segmentation was performed on several LiDAR-derived forest structural metrics and the NDVI was calculated from the 2009 NAIP imagery. Training data that were collected in 2009 and 2010 were digitized into a GIS shapefile format. The mean values of various variable inputs were summarized by each of the image segments in addition to the training data polygons. Results were then added into a predictive non-parametric model called RandomForest (Breiman 2001) in the statistical program called *R* (available from <http://www.r-project.org/>). Predictive results were reviewed by experts familiar with the vegetation types of the area. An iterative approach of modifying the training data, input variables and alliance classes was necessary to achieve the desired map results.

ERDAS Imagine was the main software package used for processing imagery and data layers while ArcGIS™ was primarily used to view and display the data. The eCognition, Definiens Cognition Network Technology® object-oriented classification software (Definiens <http://www.definiens.com>), was used in addition to Berkley Imaging Segmentation (BIS) to create an initial base map with a polygon structure for field crews to identify homogenous vegetation types. BIS software was used to create the final segments which were be classified into the appropriate alliance vegetation types. The user-sourced, statistical software package *R* was used to model the predictive alliance classifications.

Image Segmentation

LiDAR and NAIP imagery was resampled to 2 m prior to segmentation. Higher resolution resampling was tested, but for the scale of the LEWI project it was not found to be beneficial, particularly because the higher resolution greatly increased processing times and created data storage issues. Image segmentation using BIS software was performed on a 5-band image (Figure 12) consisting of 4 different LiDAR- derived height metrics and the NDVI band created from the 2009 NAIP. The LiDAR height metrics were key to differentiating various forest canopy types and textures (height, texture for log-transformed height, median linear height, and median log-transformed height). The NAIP NDVI was used to help separate landcover types across the landscape (Figures 13 and 14). Including the LiDAR in the segmentation process helped identify stands that were structurally similar and not just spectrally similar. The fusion of LiDAR and the NAIP in the segmentation process resulted in optimal segmentation characteristics. An iterative procedure was used in segmentation in which the BIS parameters determining threshold (how large the segments grow), shape rate (weighs the shape attributes) and compaction (weights the compactness over the smoothness or the color attribute) were adjusted until a satisfactory segmentation was created.

Initially over 60,000 polygons were created. A focal smoothing algorithm was then run on the segments dissolving small island segments and separating many of the long skinny “snake” like segments. Next, segments smaller than 1 acre (the NPS VIP standard minimum mapping unit is 2.47 acre or 0.5 ha.) were dissolved into the largest adjacent image segments. This reduced the total number of initial image polygons to around 40,000.

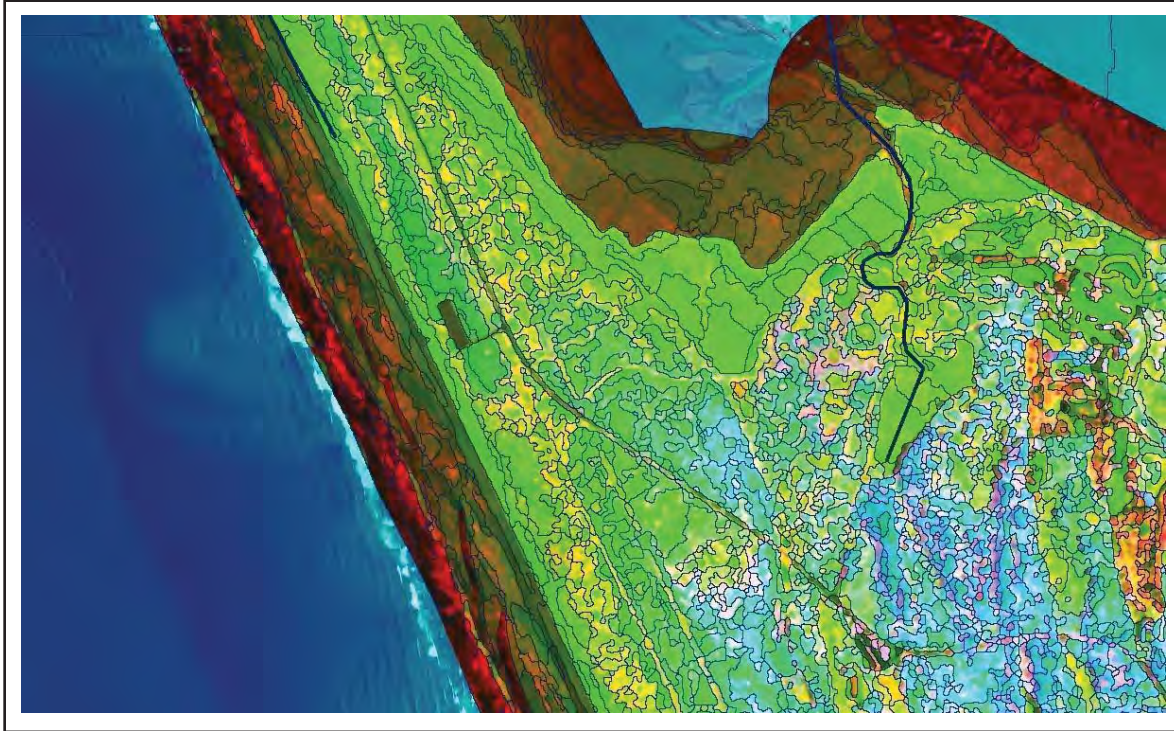


Figure 12. Segmentation based on a 5-band image (4 LiDAR-derived metrics and Normalized Difference Vegetation Index from National Agriculture Imagery Program imagery) at Fort Stevens.

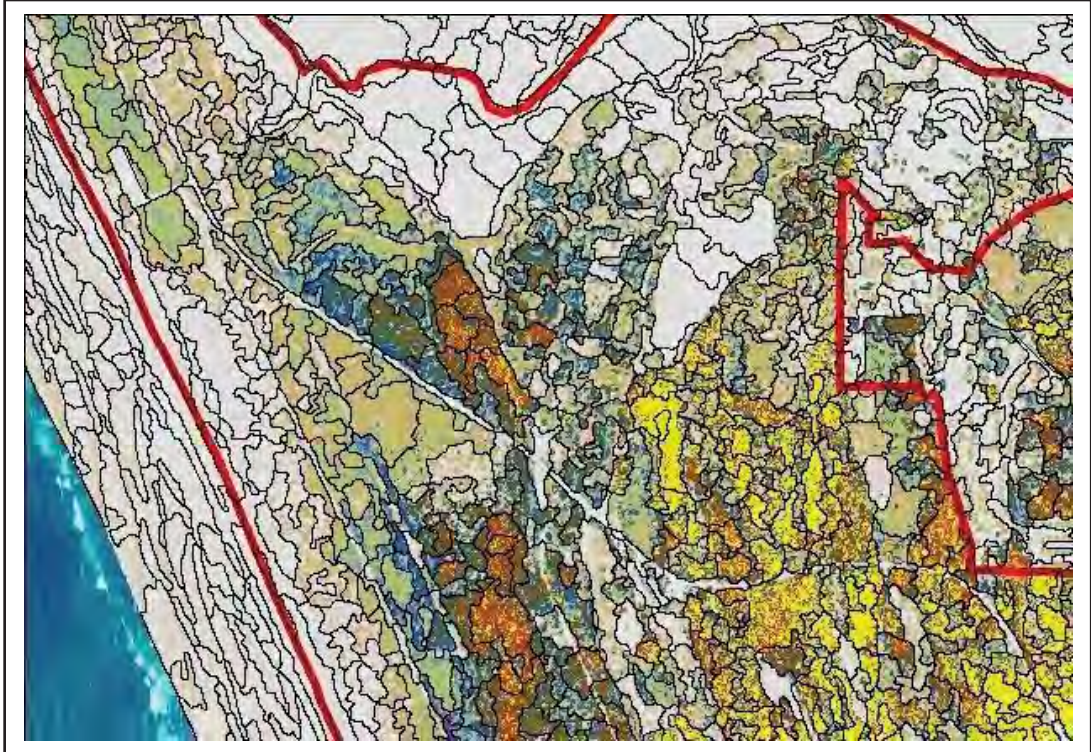


Figure 13. Segmentation overlaid on LiDAR-generated canopy metrics (vegetation height) at Fort Stevens.



Figure 14. Segmentation overlaid on color-infrared aerial photography at Fort Stevens.

Training Data Collection

Field reconnaissance occurred in the summers of 2009 and 2010. Drawing on previous experience and knowledge of vegetation types found in the region, a preliminary list of map classes was developed. A key to forest and non-forest map classes at LEWI was written to aid field staff in identifying types (Appendix E). In addition, some land cover types (e.g., beach, cliff, developed) were included to cover the non-natural or semi-natural vegetated areas of the park.

Field crews traversed each unit with print-outs of the segmented BIS polygons imposed on a satellite imagery background. In each training data polygon, the field crew assigned one of the preliminary map classes to the polygon. When polygons did not accurately depict vegetation on the ground, a new polygon was drawn on the color map print-outs and was later digitized. Clarifying comments on associated species or other details on the habitat and environment of the site were also recorded. Field staff met regularly during the field reconnaissance to discuss any modifications needed, problem classes, or data gaps.

In total 240 training data points were collected throughout the park units. Several of the initial map classes had no training samples or few samples collected and were not mapped. These unmapped types were either below the minimal mapping unit or not present in the park (e.g., we expected to find cottonwood alliances, but did not encounter any, thus this map class does not appear in our results). Similar map classes with few (<5) training samples collected were combined into a single map class. The Aquatic Bed map class (representing the NVCS group

G544 Western North American Temperate Freshwater Aquatic Bed Group) was combined with the Non-Tidal Freshwater Marsh type (MG073 Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland). The Shrub-Meadow Riparian map class (G322 Vancouverian Lowland Riparian & Wet Slope Shrubland Group) and Spiraea Swamp map class (NCCN alliance A.NCCN-997 *Spiraea douglasii* Seasonally Flooded Shrubland Alliance) were combined with the Willow Swamp map class (A.NCCN-999 *Salix hookeriana* Seasonally Flooded Shrubland Alliance).

In total 21 alliance-based map classes and three landcover-based classes were mapped (Table 8). Detailed descriptions of the map classes are found in Appendix F.

Table 8. Number of training samples per alliance mapped. Those classes not included in the final map due to the lack of sampling data or to the fact that all their occurrences were smaller than the minimum mapping unit are marked as 'N' in the third column, and the action taken with these polygons noted in the fourth column.

Map Classification	Samples	Mapped	Action taken if "N"
Alder Riparian Forest	10	Y	Merged with Deciduous Tree Swamp into Alder Swamp and Riparian
Alder Upland Forest	24	Y	
Aquatic Bed	3	N	Merged into Non-Tidal Freshwater Marsh
Beach	8	Y	
Big-leaf Maple Upland Forest	1	Y	
Conifer Swamp and Riparian	9	Y	
Deciduous Tree Swamp	8	N	Merged with Alder Riparian Forest into Alder Swamp and Riparian
Developed Herbaceous	3	N	Merged with Non-Native Herbaceous, then relabeled to Lawn and Pasture in final map
Disturbed Forest	9	Y	
Exotic	5	Y	Renamed to Non-Native Herbaceous. Some manually relabeled to Lawn and Pasture
Grass Dune	12	Y	
Herbaceous Headland	2	Y	
Impervious Surface	13	Y	
Mesic Hemlock Upland Forest	6	Y	
Non-Tidal Freshwater Marsh	8	Y	
Pine Dune	22	Y	
Sitka Spruce Dune	6	Y	
Sitka Spruce Forest	47	Y	
Willow Swamp	16	Y	
Salt Marsh	7	Y	
Shrub Dune	2	Y	
Shrub-Meadow Riparian	0	N	Merged with Willow Swamp
Spiraea Swamp	2	N	Merged with Willow Swamp
Tidal Fresh-Brackish Marsh	8	Y	
Water	3	Y	
Wet Hemlock Upland Forest	6	Y	
Total	240		

Map Classification

RandomForest modeling is an inductive modeling technique which is based on CART (Classification and Regression Tree) modeling methodology. CART evaluates a series of variables and organizes them by their ability to explain the variance or patterns. RandomForest is a machine learning algorithm that extracts a single prediction from an ensemble of classification trees (Breiman 2001). Each classification tree within the RandomForest is built from a different random subset of observations and explanatory variables. The RandomForest prediction is a summary of the predictions of the individual trees. The class predicted by the plurality of the classification trees in the RandomForest is the overall prediction. RandomForest modeling has become a popular tool to develop predictive vegetation maps because of its consistent and repeatable manner that utilizes a series of non-parametric computations, only possible through the quick processing powers of computers, to predict the likely classification of an object.

Mean pixel values of a variety of input data types were calculated for each of the polygons. The data variables selected for use in RandomForests represented key vegetation and environmental characteristics. Table 9 lists the variables used in the RandomForest model.

Table 9. Data variables used, and description of variables, in RandomForest model.

Variable	Source	Description	Date	Cell size (m)	Units
NAIP_NDVI	NAIP	NAIP, Normalized Differenced Moisture Index	Summer 2009	1/2	16bit
NAIP_CIR	NAIP	Color Infrared	Summer 2009	1/2	16bit
A1A_BE	LiDAR	Base elevation	Various	1	quarter feet
A1A_HT	LiDAR	Height	Various	1	feet
A2C_MDSD2	LiDAR	texture for log transformed height	Various	1	16bit
A2D_MD1	LiDAR	median linear height	Various	1	16bit
A2E_MD2	LiDAR	median log-transformed height	Various	1	16bit
ASP	LiDAR	aspect	Various	1	degrees
HT_LOAD	LiDAR	Potential direct incident radiation	Various	1	Radiation
SLOPEDEG	LiDAR	Slope	Various	1	degrees
STD_DEV	LiDAR	Height standard deviation	Various	1	quarter feet
WET_M	LiDAR	SAGA wetness index mean	Various	1	16bit
WET_SD	LiDAR	SAGA wetness index standard deviation	Various	1	16bit
MEDIAN	LiDAR	Woody vegetation median height	Various	1	16bit
CC	LiDAR	Tree canopy cover	Various	1	16bit
SPOTC1	SPOT	spot band 1	10/3/2011	10	16bit
SPOTC2	SPOT	spot band 2	10/3/2011	20	16bit
SPOTC3	SPOT	spot band 3	10/3/2011	10	16bit
SPOTC4	SPOT	spot band 4	10/3/2011	10	16bit
SPNDVIRF	SPOT	Spot, Normalized Differenced Moisture Index	10/3/2011	20	16bit
TM_NDMI	Landsat	Landsat, Normalize Differenced Moisture Index	7/12/2008	30	16bit
TM_NDVI	Landsat	Landsat, Normalized Differenced Vegetation Index	7/12/2008	30	16bit

Table 9. Data variables used, and description of variables, in RandomForest model (continued).

Variable	Source	Description	Date	Cell size (m)	Units
TM_TCWC1	Landsat	Brightness (measure of soil)	7/12/2008	30	16bit
TM_TCWC2	Landsat	greenness (measure of vegetation)	7/12/2008	30	16bit
TM_TCWC3	Landsat	wetness (interrelationship of soil and canopy moisture)	7/12/2008	30	16bit
TM_TOAC1	Landsat	Landsat band 1 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit
TM_TOAC2	Landsat	Landsat band 2 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit
TM_TOAC3	Landsat	Landsat band 3 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit
TM_TOAC4	Landsat	Landsat band 4 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit
TM_TOAC5	Landsat	Landsat band 5 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit
TM_TOAC6	Landsat	Landsat band 7 (Top of Atmosphere Reflectance)	7/12/2008	30	toa 16bit

A sample of RandomForest code is shown in Figure 15. Once an acceptable classification model was developed from the training data, the model was applied to the entire population of polygons. The final output from RandomForest is a table with each of the polygons' predicted alliance type (Figure 16).

```
library(randomForest)
training <- read.csv("d:/projects/lewi/gis/train.csv", TRUE)
set.seed(139)
training.rf <- randomForest(all ~ ., data=training, importance=TRUE)
testdata <- read.csv("d:/projects/lewi/gis/merge.csv", TRUE)
pred4 <- predict( training.rf, testdata )
write.csv(pred4, "d:/projects/lewi/gis/join.csv")
```

Figure 15. Sample RandomForest code.

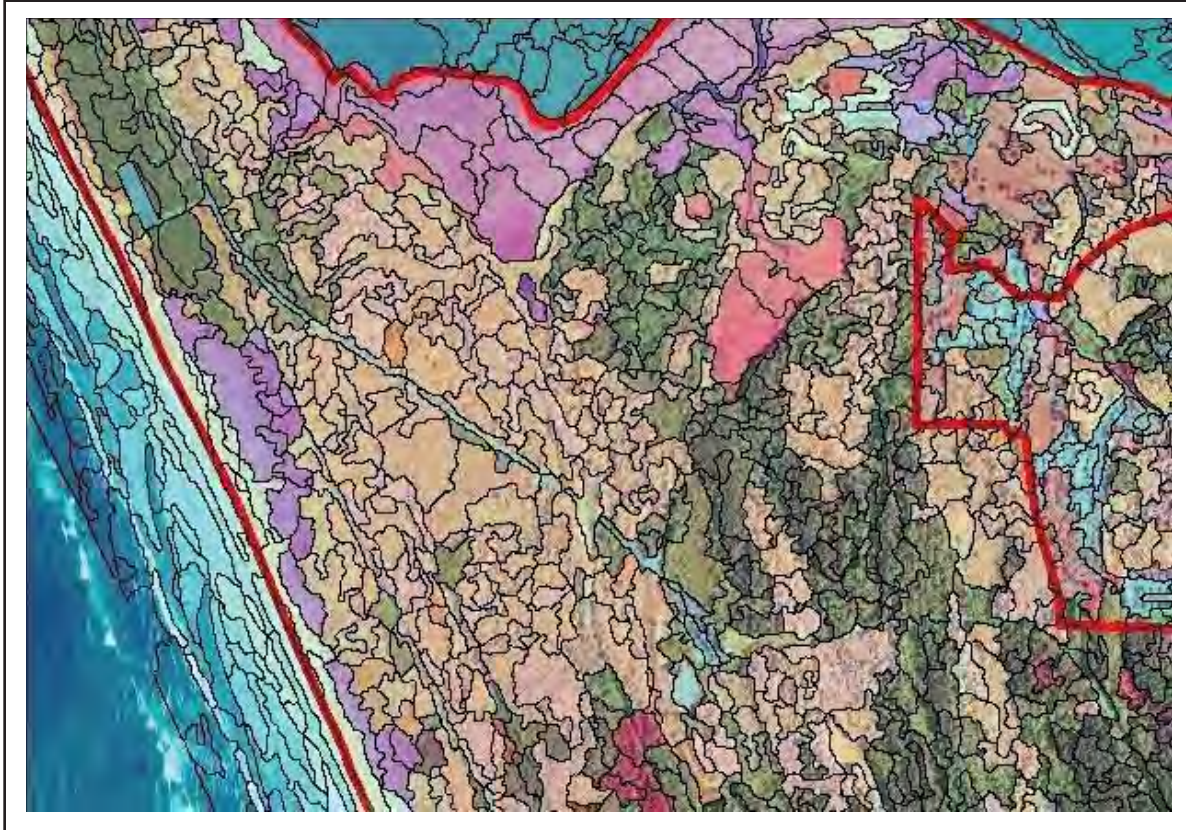


Figure 16. Initial alliance-based classification based on LiDAR and imagery at Fort Stevens.

An initial accuracy assessment was created from RandomForest, resulting in the confusion matrix shown in Figure 17. The initial alliance classification error, before expert opinion modification and alliance grouping, was 38%. The higher error rates occurred only for alliances with fewer field samples. When the sample size was greater than 10, errors were generally less than 25%.

Type of random forest: classification
Number of trees: 500
No. of variables tried at each split: 4

OOB estimate of error rate: 38.05%

Confusion matrix:

	ALNRUE	ALNRUE	BEACH	CONIFE	DECIDU	DISTUR	EXOTIC	GRASS	HERBA	IMPERV	MESIC	NONTIC	PICSIT I	PICSIT F	PINCON	SALIX S	SALT M	SHRUB	TIDAL F	WATER	WET TS	A.A.	
ALNRUE	2	4	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0.8
ALNRUE	4	15	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0.3478
BEACH	0	0	5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0.375
CONIFE	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	3	0	0	0	0	0	0	1
DECIDU	2	1	0	0	3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0.625
DISTUR	0	0	0	0	0	5	1	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0.4444
EXOTIC	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0.8
GRASS	0	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0.0833
HERBA	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IMPERV	0	0	1	0	0	0	0	1	0	6	0	1	0	0	0	1	0	0	0	0	0	0	0.4
MESIC	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1
NONTIC	0	0	0	0	0	0	1	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0.25
PICSIT I	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	1
PICSIT F	2	4	0	0	1	0	0	0	0	0	0	0	0	36	2	0	0	0	0	0	0	0	0.2
PINCON	0	0	0	0	0	1	0	0	0	0	0	0	0	5	15	1	0	0	0	0	0	0	0.3182
SALIX S	1	0	0	0	0	0	0	0	0	0	1	0	0	2	12	0	0	0	0	0	0	0	0.25
SALT M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0
SHRUB	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	4	0	0	0	0	0	0.4286
TIDAL F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	6	0	0	0	0	0.25
WATER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
WET TS	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1

Figure 17. Initial Accuracy Assessment from RandomForest classification, before expert opinion modification.

Post-Processing Map Development

The initial modeling effort created a map with a large number of polygons, which represented the dominant vegetation types at LEWI. Next, post-processing or post-modeling work was conducted in order to create the final map. In total, 21 alliance-based map classes and three land cover based classes were mapped (Table 10). Several of the initial alliances were not mapped due to the sample size of the training data. Similar alliance classes with inadequate training data were grouped together. Merging similar alliances significantly reduced the number of polygons in the map.

Table 10. List of LEWI map classes and included alliances or groups.

Map Class	Included Alliances or Groups
Impervious Surface	None
Cliff	G322 Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group
Beach	Not Yet Classified
Water	None
Tidal Fresh-Brackish Marsh	A.1433 <i>Schoenoplectus acutus</i> (<i>Schoenoplectus pungens</i>) Semi-Permanently Flooded Herbaceous Alliance
Salt Marsh	A.2622 <i>Carex lyngbyei</i> Tidal Herbaceous Alliance A.2618 <i>Salicornia virginica</i> Tidal Herbaceous Alliance A.2623 <i>Deschampsia caespitosa</i> Tidal Herbaceous Alliance
Non-tidal Freshwater Marsh	A.1412 <i>Carex aquatilis</i> var. <i>dives</i> Semi-permanently Flooded Herbaceous Alliance A.NCCN-NEW4 <i>Typha</i> (<i>angustifolia</i> , <i>latifolia</i>) Freshwater Marsh Alliance A.2582 <i>Carex obnupta</i> Seasonally Flooded Herbaceous Alliance A.2598 <i>Sparganium eurycarpum</i> Hydromorphic Rooted Herbaceous Vegetation A.1342 <i>Eleocharis palustris</i> Seasonally Flooded Herbaceous Alliance A.NCCN-NEW5. <i>Nuphar</i> spp. - <i>Potamogeton</i> spp. - <i>Lemna</i> spp. Freshwater Aquatic Alliance
Willow Swamp	A.NCCN-999 <i>Salix hookeriana</i> Seasonally Flooded Shrubland Alliance A.NCCN-997 <i>Spiraea douglasii</i> Seasonally Flooded Shrubland Alliance A.2068 <i>Salix</i> spp. - <i>Malus fusca</i> - <i>Spiraea</i> spp. Lowland Riparian & Wet Slope Shrubland Alliance
Alder Swamp and Riparian	A.NCCN-001 (<i>Acer macrophyllum</i> , <i>Alnus rubra</i>) Riparian Forest Alliance A.NCCN-002 (<i>Alnus</i> spp., <i>Fraxinus</i> spp., <i>Populus</i> spp.) / <i>Lysichiton americanus</i> Deciduous Swamp Woodland Alliance
Conifer Swamp and Riparian	A.NCCN-004 (<i>Tsuga heterophylla</i> , <i>Picea sitchensis</i> , <i>Thuja plicata</i> , <i>Abies</i> spp.) / <i>Lysichiton americanus</i> Coniferous Swamp Woodland Alliance
Alder Upland	A.NCCN-020 <i>Alnus rubra</i> - (<i>Picea sitchensis</i> , <i>Tsuga heterophylla</i>) Forest & Woodland Alliance
Big-leaf Maple Upland	A.NCCN-019 <i>Acer macrophyllum</i> - (<i>Pseudotsuga menziesii</i>) Forest Alliance
Mesic Hemlock Upland Forest	A.NCCN-042 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Cornus unalaschkensis</i> Mesic Forest Alliance
Wet Hemlock Upland Forest	A.NCCN-044 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Rubus spectabilis</i> Wet Forest Alliance

Table 10. List of LEWI map classes and included alliances or groups (continued).

Map Class	Included Alliances or Groups
Sitka Spruce Forest	A.NCCN-005 (<i>Picea sitchensis</i> , <i>Abies grandis</i> , <i>Tsuga heterophylla</i> , <i>Thuja plicata</i>)- (<i>Alnus spp.</i> , <i>Acer spp.</i>) Riparian Forest Alliance A.NCCN-027 <i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Forest Alliance
Sitka Spruce Forest-Young	A.NCCN-005 (<i>Picea sitchensis</i> , <i>Abies grandis</i> , <i>Tsuga heterophylla</i> , <i>Thuja plicata</i>)- (<i>Alnus spp.</i> , <i>Acer spp.</i>) Riparian Forest Alliance A.NCCN-027 <i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Forest Alliance
Disturbed Forest	A.NCCN-027 <i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Forest Alliance A.NCCN-042 <i>Tsuga heterophylla</i> - <i>Pseudotsuga menziesii</i> / <i>Cornus unalaschkensis</i> Mesic Forest Alliance
Sitka Spruce Dune	A.2067 North Pacific (<i>Pinus contorta var. contorta</i> - <i>Picea sitchensis</i>) Stabilized Dune Forest
Pine Dune	A.NCCN-NEW1 North Pacific (<i>Pinus contorta var. contorta</i> - <i>Picea sitchensis</i>) Stabilized Dune Forest
Shrub Dune	A.NCCN-NEW3 North Pacific (<i>Pinus contorta var. contorta</i> - <i>Picea sitchensis</i> - <i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> - <i>Cytisus scoparius</i>) Stabilized Dune Shrubland A.2062 <i>Cytisus scoparius</i> - <i>Ulex europaeus</i> - <i>Lupinus arboreus</i> Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance
Herbaceous Headland	A.2064 <i>Festuca rubra</i> - <i>Calamagrostis nutkaensis</i> Coastal Herbaceous Alliance A.2065 <i>Gaultheria shallon</i> Coastal Shrubland Alliance
Grass Dune	A.2061 <i>Ammophila arenaria</i> -Planted <i>Leymus mollis ssp. mollis</i> Coastal Dunegrass Ruderal Grassland Alliance A.2066 <i>Poa macrantha</i> - <i>Leymus mollis</i> - <i>Festuca rubra</i> Sand Dune Alliance
Non-Native Herbaceous	A.2063 <i>Anthoxanthum odoratum</i> - <i>Holcus lanatus</i> Ruderal Coastal Grassland Alliance
Lawn and Pasture	A.NEW Temperate Mowed Lawns Alliance A.NEW Temperate Planted Trees/Gardens Alliance A.1375 <i>Juncus effuses</i> Semi-Natural Seasonally Flooded Alliance

Addressing Under-represented or Missing Types

The review of the draft map indicated that a number of types were missing. For example, a cliff land cover type was not adequately covered by any of the existing map classes. A cliff map class was created and the cliff land cover type, found only in large enough polygons at Ecola and Cape Disappointment State Parks, was recoded to this new cliff map class, which corresponds to a “Group” in the National Vegetation Classification System. Herbaceous headland polygons were manually labeled using training data and the aerial photography.

There was a concern that hemlock-dominated alliances (mesic and wet hemlock forests) may have been underestimated in the draft map due to a lack of sample data. To address this concern, first, areas where hemlock was known to dominate were manually relabeled. Next, field sampling identified new locations. The hemlock alliances were found to occur very sparingly throughout the parks; this was partly due to a break in the classification for which 10% cover of

Sitka spruce in a plot resulted in a spruce alliance label. In many forested areas of the park, there is at least 10% cover of spruce in the canopy or understory.

The majority of large impervious surface areas were detected during the segmentation process but some areas were left out because they were occluded by forest canopy or were too small to detect. Some roads, buildings, and parking lots were thus included during the post-processing. These areas were digitized from 2011 NAIP photographs, buffered by 5 meters and merged into the finished vegetation map.

Confused Map Types

The initial accuracy results suggested that additional work was needed to accurately map three different alder-dominated alliances. Because the three alliances were in different NVCS groups, we resisted the initial inclination to create a single red alder map class. The three alliances were the:

1. Red Alder - (Sitka Spruce, Western Hemlock) Forest and Woodland Alliance, part of the North Pacific Red Alder -Big-leaf Maple -Douglas-fir Forest Group. Initial map class: Alder Upland Forest
2. (Big-leaf Maple, Red Alder) Riparian Forest Alliance, part of the North Pacific Lowland Riparian Forest & Woodland Group. Initial map class: Alder Riparian Forest
3. (Alder species, Ash species, Cottonwood species) / Yellow Skunk-cabbage Deciduous Swamp Alliance, part of the North Pacific Maritime Lowland Hardwood-Conifer Swamp Group. Initial map class: Alder Swamp

While these three vegetation types are all present and represent significantly different hydrological regimes, at LEWI, they are all dominated by a largely uninterrupted canopy of red alder. Additionally, elevational differences of a few feet could determine whether a site displayed upland or wetland characteristics, particularly in Fort Stevens. We had hoped that the LiDAR- based DEM might provide a high enough resolution dataset needed to capture subtle differences in hydrology, but it did not.

The first attempt to address these errors and map the alder forest types at the alliance level involved the following steps. First, alder dominated stands in upland topographic positions (e.g., hillsides) were re-classified to Alder Upland Forests map class. Then the few acres of the (Big-leaf Maple, Red Alder) Riparian Forest Alliance were mapped manually using a cost distance raster generated from the LiDAR bare earth data and a perennial streams layer from the National Hydrography Dataset (<http://nhd.usgs.gov/>). The steeper the slope and the farther from the river reduced the likelihood that the Alder Riparian type would occur. The third category, Alder Swamps, was also manually attributed in the three polygons in which it was known to occur. However, as described in the classification section, this solution, while effectively separating the upland from the two wetland alliances, was unable to separate the two alder wetland types accurately enough to meet the 80% accuracy requirement. Therefore, these two alder wetland types were combined creating a classification unit at the macrogroup level, the Vancouverian Flooded & Swamp Forest Group, and given a map class name Alder Swamp and Riparian.

Similarly, distinguishing the Conifer Swamp from the Conifer Riparian Alliances proved to be impossible at LEWI. This was partly because they were both so rare that it was difficult to get

sufficient training points, but mostly because they look so similar, both on the imagery and in the field. As a result, these types were combined and attributed manually as Conifer Swamp and Riparian.

Small Polygons or Rare Types

The only three field-verified locations of the Big-leaf Maple (Douglas-Fir) Alliance, one in Fort Clatsop, one in Cape Disappointment, and one at Fort Columbia, were manually attributed during the post-processing phase. The authors and the NPS staff are convinced that these are the only occurrences of this forest alliance in the park.

Several of the map polygons are smaller than the NPS minimum mapping unit of 0.5 hectares. Polygons that were less than 0.04 acres were dissolved into the nearest adjacent large polygon as long as it wasn't an impervious surface polygon. We believe that the remaining small-area polygons are accurate, due to the quality of the LiDAR data that allowed for the determination of small forest openings, the fact that some polygons were split into smaller sections when the roads were burned in, and as the results of the accuracy assessment were satisfactory, as described in the Accuracy Assessment section.

Final Clean Up

The last steps involved manually digitizing the roads, buildings and developed areas boundaries to reflect the most recent imagery. Once this was completed, the adjacent polygons with identical classifications were merged, which again significantly reduced the number of polygons in the final map.

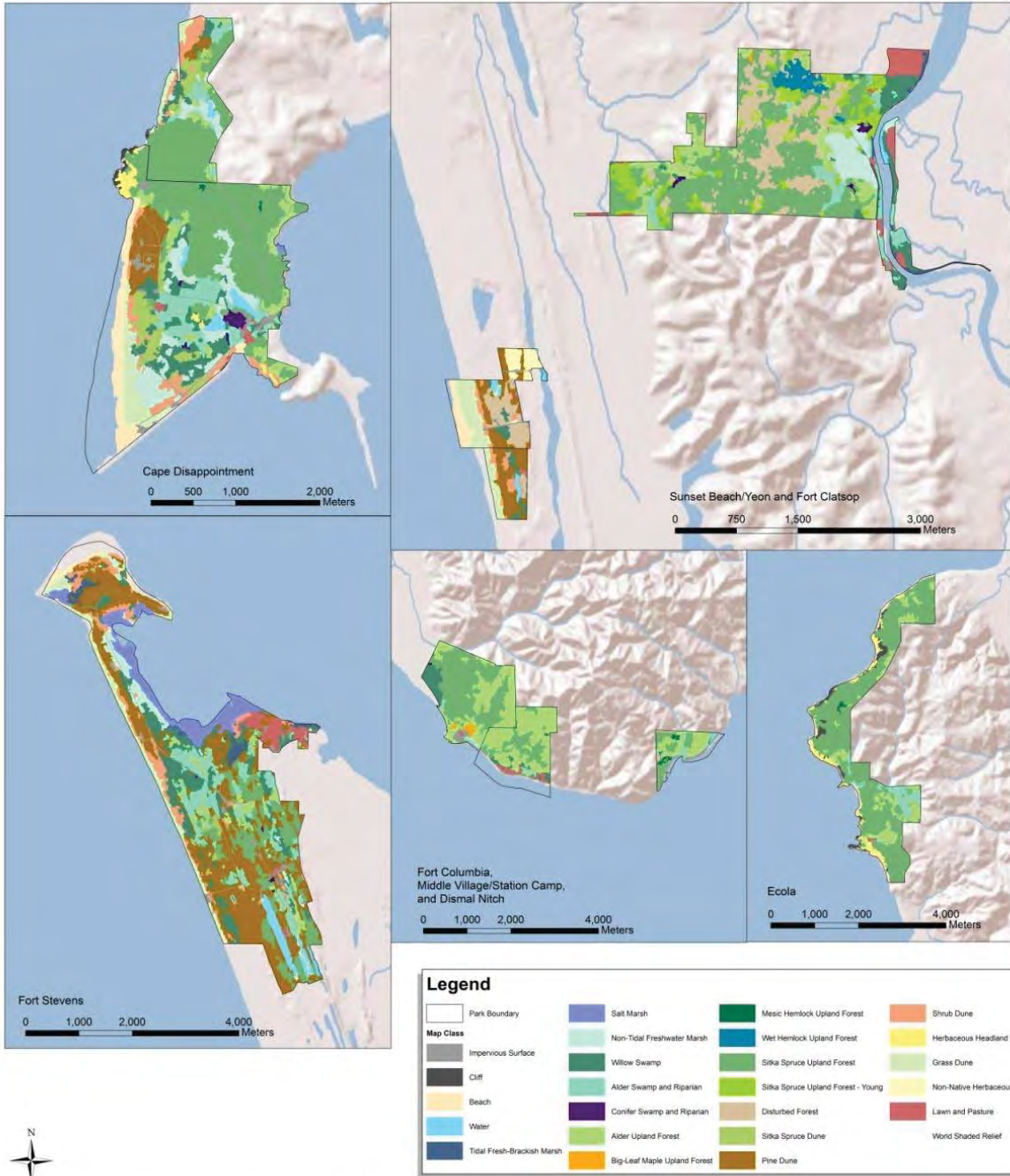
Mapping Results

A total of 1328 polygons representing twenty-one vegetation classes and three land cover types were included in the final map (Figure 18). Detailed maps for each unit are provided in Appendix G.

Table 10 lists the final map classes and the NVC alliances or groups which they contain.



Vegetation Map of the Units of Lewis and Clark National Historical Park



Produced by the Institute for Natural Resources, Portland State University
FILE: inrveg002dature.mxd

January 2012

Figure 18. Alliance-based polygon vegetation map for LEWI.

Table 11 summarizes the areas and percent covers of each of the map classes in each of the units of LEWI, as well as the total area of the classes across all the LEWI units. The land cover types mapped were: water, impervious surface (for the roads and buildings present), and beach. The beach class will eventually be included as a barren type in the National Vegetation Classification, but for the LEWI map beaches and cliffs are treated as park-specific land cover types. The cliff map class can also be considered a land cover type, though there is a NVC group describing this type, G322 Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group. Together, these four classes make up 6% of the total park area (Figure 19). The lawn and pasture and non-native herbaceous vegetation classes will also soon be included in the NVC as ruderal types. Their provisional group and alliance names are described in the classification document in Appendix A. These two classes together make up 2 % of the park area.

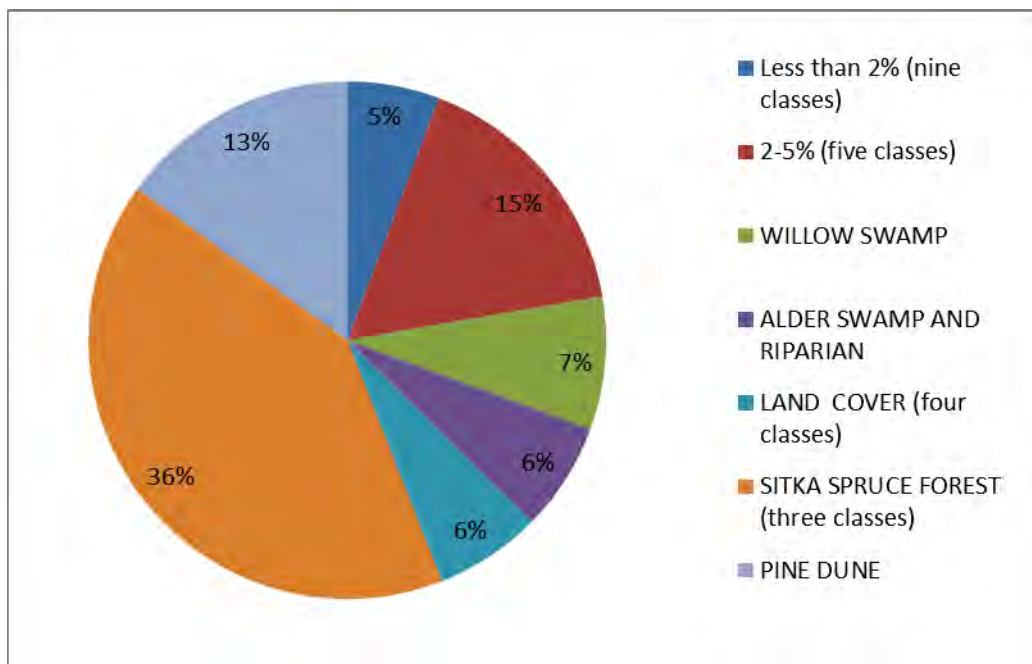


Figure 19. Pie chart showing the relative distribution of common map classes at LEWI.

Of the twenty vegetated types mapped, the most common type for LEWI as a whole and in almost all of the units was the Sitka spruce - (Western Hemlock) Forest Alliance, which covers 36% of the park (Figure 19). The Sitka spruce - (Western Hemlock) Forest Alliance alliance was mapped using three different successional/structural classes in order to assist the park with forest management plans. The stages were: 1) older forests (Sitka Spruce Upland Forest), representing forests with large trees presumed to be older than 30 years; 2) younger forests (Sitka Spruce Upland Forest - Young), primarily twenty to thirty year old forests which were recovering from past disturbance events; and 3) recent blowdown areas (Disturbed Forest) from the major windstorm in 2006 that decimated 16% of Fort Clatsop, and 3% of the total area mapped. The LiDAR data enabled these three classes within this dominant alliance to be distinguished. A fourth Sitka spruce type, Sitka Spruce Dune, represents successional spruce on the accretion areas of Cape Disappointment and Fort Stevens, and covers only 1% of LEWI.

Table 11. Area and percent cover of map classes found at the different LEWI units.

Map Classes	Cape Disappointment			Dismal Nitch			Ecola			Fort Clatsop		
	acres	ha	%	acres	ha	%	acres	ha	%	acres	ha	%
Impervious Surface	46.9	19.0	3%	15.2	6.1	9%	9.4	3.8	1%	5.7	3.2	0%
Cliff	7.0	2.8	0%	0.0	0.0	0%	57.1	23.1	4%	0.0	0.0	0%
Beach	87.1	35.3	5%	0.0	0.0	0%	57.3	23.2	4%	0.0	0.0	0%
Water	24.5	9.9	2%	1.3	0.5	1%	0.0	0.0	0%	8	3.4	1%
Tidal Fresh-Brackish Marsh	0.6	0.2	0%	0.0	0.0	0%	0.0	0.0	0%	14.5	5.9	1%
Salt Marsh	2.2	0.9	0%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%
Non-Tidal Freshwater Marsh	142.4	57.6	9%	0.0	0.0	0%	0.0	0.0	0%	0.5	0.2	0%
Willow Swamp	131.1	53.0	8%	1.0	0.4	1%	0.2	0.1	0%	69.9	28.3	6%
Alder Swamp and Riparian	115.3	46.7	7%	11.7	4.7	7%	77.4	31.3	5%	61.1	25.6	5%
Conifer Swamp	11.8	4.8	1%	0.0	0.0	0%	0.0	0.0	0%	6.7	2.7	1%
Alder Upland Forest	91.9	37.2	6%	68.1	27.6	41%	190.5	77.1	13%	120.4	48.7	10%
Big-leaf Maple Upland Forest	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	1.4	0.6	0%
Mesic Hemlock Upland Forest	1.9	0.8	0%	8.7	3.5	5%	5.5	2.2	0%	0.0	0.0	0%
Wet Hemlock Upland Forest	0.0	0.0	0%	1.0	0.4	1%	0.0	0.0	0%	37.7	15.2	3%
Sitka Spruce Forest	586.1	237.2	37%	52.3	21.2	32%	998.3	404.0	68%	490.6	198.5	40%
Sitka Spruce Forest - Young	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	127.1	51.4	10%
Disturbed Forest	0.0	0.0	0%	6.4	2.6	4%	0.0	0.0	0%	211.7	85.7	17%
Sitka Spruce Dune	83.2	33.7	5%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%
Pine Dune	74.5	30.2	5%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%
Shrub Dune	79.3	32.1	5%	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%
Herbaceous Headland	21.3	8.6	1%	0.0	0.0	0%	73.7	29.8	5%	0.0	0.0	0%
Grass Dune	73.1	29.6	5%	0.0	0.0	0%	0.3	0.1	0%	0.0	0.0	0%
Non-Native Herbaceous	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	53.1	21.5	0%
Lawn and Pasture	9.1	3.7	1%	0.0	0.0	0%	3.2	1.3	0%	61.6	24.9	5%
Grand Total	1589	643	100%	166	67	100%	1473	596	100%	1272.1	514.8	100%

Table 11. Area and percent cover of map classes found at the different LEWI units (continued).

Map Classes	Fort Stevens			Station Camp/ Fort Columbia			Sunset Beach/Yeon			Grand Total		
	acres	ha	%	acres	ha	%	acres	ha	%	acres	ha	%
Impervious Surface	94.1	38.1	3%	22.7	9.2	2%	7.9	3.2	2%	206.5	83.5	2%
Cliff	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	64.1	25.9	1%
Beach	40.8	16.5	1%	4.0	1.6	0%	23.2	9.4	7%	212.5	86.0	2%
Water	81.3	32.9	2%	1.2	0.5	0%	9.2	3.7	3%	125.7	50.9	1%
Tidal Fresh-Brackish Marsh	70.5	28.5	2%	0.9	0.4	0%	0.0	0.0	0%	86.5	35.0	1%
Salt Marsh	255.2	103.3	7%	0.0	0.0	0%	0.0	0.0	0%	257.4	104.2	3%
Non-Tidal Freshwater Marsh	169.7	68.7	5%	2.5	1.0	0%	1.6	0.6	0%	316.6	128.1	3%
Willow Swamp	398.8	161.4	12%	61.0	24.7	6%	20.2	8.2	6%	678.1	274.4	7%
Alder Swamp and Riparian	273.6	110.7	8%	10.8	4.4	1%	0.0	0.0	0%	552.1	223.4	6%
Conifer Swamp	3.6	1.4	0%	0.7	0.3	0%	0.0	0.0	0%	22.8	9.2	0%
Alder Upland Forest	123.2	49.8	4%	442.3	179.0	44%	0.0	0.0	0%	1036.3	419.4	11%
Big-leaf Maple Upland Forest	0.0	0.0	0%	12.5	5.0	1%	0.0	0.0	0%	13.9	5.6	0%
Mesic Hemlock Upland Forest	0.0	0.0	0%	0.9	0.4	0%	0.0	0.0	0%	17.0	6.9	0%
Wet Hemlock Upland Forest	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	38.6	15.6	0%
Sitka Spruce Forest	391.2	158.3	11%	420.5	170.2	42%	0.0	0.0	0%	2938.9	1189.3	32%
Sitka Spruce Forest - Young	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	127.1	51.4	1%
Disturbed Forest	2.3	0.9	0%	0.0	0.0	0%	51.2	20.7	16%	271.6	109.9	3%
Sitka Spruce Dune	20.7	8.4	1%	0.0	0.0	0%	0.0	0.0	0%	103.9	42.0	1%
Pine Dune	1066.3	431.5	31%	0.0	0.0	0%	87.0	35.2	28%	1227.8	496.9	13%
Shrub Dune	193.3	78.2	6%	0.0	0.0	0%	24.1	9.7	8%	296.6	120.0	3%
Herbaceous Headland	0.0	0.0	0%	0.0	0.0	0%	0.0	0.0	0%	95.0	38.4	1%
Grass Dune	152.3	61.6	4%	0.0	0.0	0%	61.8	25.0	20%	287.6	116.4	3%
Non-Native Herbaceous	0.0	0.0	0%	0.0	0.0	0%	28.4	11.5	9%	28.4	11.5	0%
Lawn and Pasture	94.9	38.4	3%	19.8	8.0	2%	1.6	0.7	1%	189.8	76.8	2%
Grand Total	3428	1387	100%	1000	405	100%	315	128	100%	9195	3721	100%

The Sitka Spruce Dune areas include a mix of tree and shrub species, for which we proposed a provisional alliance called North Pacific (Shore Pine, Sitka Spruce) Stabilized Dune Forest. Where lodgepole pine (*Pinus contorta*) has been planted for dune stabilization or where shore pine (*Pinus contorta* var. *contorta*) is the dominant species, a Shorepine Coastal Dune Woodland Provisional Alliance was proposed and these areas were mapped as the Pine Dune class. The Pine Dune class covers 13% of the park (Figure 19), and is mostly found at Fort Stevens and Sunset Beach. While shore pine is the most common species associated with the Pine Dune class, there are several non-native pine species planted in some areas of these two units. These non-native pines include Scots pine (*Pinus sylvestris*), Australian pine (*Pinus nigra*), and cluster pine (*Pinus pinaster*).

The only other forest alliance with significant cover at LEWI was the Red Alder (Sitka Spruce, Western Hemlock) Forest Alliance (Alder Upland Forest), covering 11% of the park area. In many areas the alder stands intergrade into the western hemlock and Sitka spruce forest alliances, making it occasionally difficult to distinguish these types in the field. Three forest alliances, the Big-leaf Maple -(Douglas-Fir) Forest (Big-leaf Maple Upland Forest), the Western Hemlock -Douglas-Fir/ Bunchberry Mesic Forest (Mesic Hemlock Upland Forest), and the Western Hemlock -Douglas-Fir / Salmonberry Wet Forest (Wet Hemlock Upland Forest) were rare but important types, having only 5.6 ha (13.9 acres), 6.9 ha (17 acres), and 15.6 ha (38.6 acres), respectively.

Fort Stevens is the flattest and wettest of all the State and National Park units, having the greatest amount of Willow Swamp and marsh types of all the park units. Together, these wetland types make up 34% of Fort Stevens. Ecola, with 68% of the park dominated by Sitka Spruce Forest and 13% by Alder Upland, is the least diverse of the units, while Cape Disappointment is the most diverse, with almost all of the alliances documented in small amounts and Sitka Spruce Forest at 37% cover. A key to the map classes is found in Appendix E. The map class descriptions and photos of the classes can be found in Appendix F, and detailed unit maps are presented in Appendix G.

Table 12 displays the numbers and size of the polygons mapped at each of the units of LEWI. There were 1,328 polygons mapped in the seven different units, with an average size of 2.8 hectares (6.8 acres).

Table 12. Numbers and areas of mapped polygons at the different LEWI units.

Map Class	Cape Disappointment			Dismal Nitch			Ecola			Fort Clatsop		
	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)
Impervious Surface	6	3.16	7.81	1	6.14	15.18	1	3.79	9.35	7	0.47	1.15
Cliff	6	0.47	1.17				26	0.89	2.20			
Beach	10	3.53	8.71				20	1.16	2.87			
Water	5	1.98	4.90	1	0.51	1.25				10	0.34	0.84
Tidal Fresh-Brackish Marsh	1	0.24	0.58							12	0.49	1.21
Salt Marsh	1	0.90	2.21									
Non-Tidal Freshwater Marsh	26	2.22	5.48							1	0.21	0.52
Willow Swamp	35	1.52	3.74	2	0.19	0.48	2	0.04	0.10	18	1.57	3.88
Alder Swamp and Riparian	22	2.12	5.24	4	1.18	2.92	11	2.85	7.04	18	1.42	3.51
Conifer Swamp	4	1.20	2.96							3	0.91	2.25
Alder Upland Forest	32	1.16	2.87	6	4.59	11.35	29	2.66	6.57	32	1.52	3.76
Big-leaf Maple Upland Forest										1	0.59	1.45
Mesic Hemlock Upland Forest	2	0.39	0.96	2	1.75	4.33	1	2.22	5.49			
Wet Hemlock Upland Forest				1	0.39	0.97				2	7.62	18.84
Sitka Spruce Forest	25	9.49	23.44	5	4.23	10.46	23	17.56	43.40	26	7.64	18.87
Sitka Spruce Forest - Young										71	0.72	1.79
Disturbed Forest				2	1.30	3.21				89	0.96	2.38
Sitka Spruce Dune	11	3.06	7.56									
Pine Dune	6	5.03	12.42									
Shrub Dune	25	1.28	3.17									
Herbaceous Headland	10	0.86	2.13				20	1.49	3.69			
Grass Dune	5	5.92	14.62				3	0.05	0.11			
Non-Native Herbaceous												
Lawn and Pasture	9	0.41	1.01				1	1.32	3.25	21	1.18	2.91
Grand Total	241	2.7	6.6	24	2.8	6.9	137	4.4	10.8	311	1.6	3.9

Table 12. Numbers and areas of mapped polygons at the different LEWI units (continued).

Map Class	Fort Stevens			Station Camp/Fort Columbia			Sunset Beach/Yeon			Totals for LEWI		
	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)	poly #	avg (ha)	avg (acres)
Impervious Surface	13	2.93	7.24	1	9.20	22.74	6	0.49	1.21	37	2.3	5.58
Cliff										32	0.8	2.00
Beach	13	1.27	3.14	5	0.33	0.81	1	9.38	23.18	49	1.8	4.34
Water	7	4.70	11.61	1	0.47	1.17	5	0.74	1.83	29	1.8	4.33
Tidal Fresh-Brackish Marsh	9	3.17	7.83	2	0.19	0.46				24	1.5	3.61
Salt Marsh	4	25.82	63.80							5	20.8	51.49
Non-Tidal Freshwater Marsh	24	2.86	7.07	1	1.00	2.46	1	0.63	1.56	53	2.4	5.97
Willow Swamp	69	2.32	5.72	12	2.06	5.08	9	0.91	2.25	147	1.9	4.61
Alder Swamp and Riparian	51	2.17	5.36	6	0.73	1.81				112	2.0	4.93
Conifer Swamp	4	0.36	0.89	1	0.27	0.66				12	0.8	1.90
Alder Upland Forest	50	1.00	2.46	12	14.92	36.86				161	2.6	6.44
Big-leaf Maple Upland Forest				2	2.52	6.24				3	1.9	4.64
Mesic Hemlock Upland Forest				1	0.37	0.92				6	1.1	2.83
Wet Hemlock Upland Forest										3	5.2	12.88
Sitka Spruce Forest	51	3.10	7.67	12	14.18	35.04				142	8.4	20.70
Sitka Spruce Forest - Young										71	0.7	1.79
Disturbed Forest	1	0.94	2.31				3	6.90	17.05	95	1.2	2.86
Sitka Spruce Dune	8	1.05	2.58							19	2.2	5.47
Pine Dune	107	4.03	9.96				9	3.91	9.66	122	4.1	10.06
Shrub Dune	56	1.40	3.45				14	0.70	1.72	95	1.3	3.12
Herbaceous Headland										30	1.3	3.17
Grass Dune	15	4.11	10.16				1	25.03	61.85	24	4.9	11.98
Non-Native Herbaceous							5	2.30	5.69	5	2.3	5.69
Lawn and Pasture	10	3.84	9.49	7	1.15	2.83	2	0.33	0.82	50	1.5	3.80
Grand Total	492	2.8	7.0	63	6.4	15.9	56	2.3	5.6	1326	2.8	6.9

Mapping Discussion

As reported in the Post-Processing Map Development section above, differentiating the various initial deciduous alliances proved challenging. Limited training data which could aid in the mapping process for these classes was obtained during field reconnaissance. The limited sample size reflected the limited distribution of the big leaf maple type and the under-sampling of the alder types. As a result, the Big-leaf Maple Upland Forest polygons were manually attributed at the three known existing locations within the parks during the post-processing.

LiDAR data was not available for the northern portions of the Middle Village/Station Camp and Dismal Nitch units. For these portions only the NAIP NDVI was used in the segmentation process. Additionally the predictor variables for the RandomForest classification were limited to those derived from the coarser resolution sensors of SPOT and Landsat, although they were resampled to the two meter final grid size. Multi-seasonal satellite imagery which differentiated hardwood from softwood was used to help compensate for the missing LiDAR metrics.

While the objective was to map at the alliance level, a few areas could have been mapped at the association level (Table 5). For example, the Sitka spruce forests at Ecola State Park are almost entirely composed of two associations: Sitka Spruce/Salal Association on the west facing slopes overlooking the ocean, and Sitka Spruce-Western Hemlock/Sword Fern Association dominating the east facing slopes, which are most of the forests. Because there were no obvious management implications, and a low level of interest from the park staff, these forests were mapped at the alliance level.

Small areas, well below the minimum mapping unit, of the other upland Sitka spruce associations in the Sitka Spruce - (Western Hemlock) Forest Alliance were present in the LEWI units. However, the Sitka spruce forests at the Fort Clatsop unit were very difficult to characterize, largely because the understory in most of the stands is poorly developed. The combination of historic windthrow damage and the logging that occurred immediately following European settlement makes it almost impossible to characterize the different Sitka spruce associations that may have been present or that will develop as the forest recovers.

In spite of having limited training data, the coastal grasslands and shrublands were accurately mapped in a majority of the units, primarily because these coastal areas were not very diverse. However, in the sandy areas at Fort Stevens State Park, the sand dune grasslands, shrublands and shorepine or Sitka spruce woodlands intermix so much that almost all of the polygons contain mixtures of two, three or four of these dune types. The majority of the polygons were mapped correctly, but in the sandy areas making up much of this park, there are hundreds of polygons that are smaller than the minimum mapping unit. Sand dune types are always successional, and the dunes at Fort Stevens have been planted with non-native pines and grasses, invaded by non-native shrubs, primarily Scots broom (*Cytisus scoparius*). Although ruderal alliances and map classes were developed for these areas, the modified sand dune portions of Fort Stevens were difficult to map accurately.

Accuracy Assessment

Methods

Field Data Collection

The VIP accuracy assessment guidelines described in Lea and Curtis (2010) were followed. Sample size targets were determined by map class area (Table 13).

Table 13. NPS recommended accuracy assessment sample size (Lea and Curtis 2010).

Map Class Total Area	Number of Observations Per Map Class
>50 hectares	30
8.33 to 50 hectares	0.6 per hectare
<8.33 hectares	5

After post-processing map updates were made by Portland State University (PSU) and NPS staff, a blind, random sample accuracy assessment was carried out in August 2011 by two crews of field technicians familiar with coastal Oregon and Washington vegetation. Accuracy assessment points were placed 35 meters within boundaries of homogenous vegetation polygons to avoid plots falling in portions of multiple alliances or map classes. Randomly-generated points were located at least 100 m apart from nearby points to prevent oversampling in one particular area. There was no consistent trails shapefile for all the park units to ensure assessment points were within reasonable and accessible travel distances. Therefore, extra sample points were generated for each alliance or map class. Assessment points that were inaccessible due to dense vegetation, steep slopes, or long distances from trails or roads were not sampled.

The field crew used hand-held Garmin eTrex GPS units to navigate to accessible points. A minimum of four locked on satellites and an accuracy of 3 m or less was required before a plot center could be established. A 30m radius assessment plot was centered on the random point. In this plot, crews used the LEWI Classification Key (Appendix B) to select the alliance label for the vegetation within the plot. Most commonly, the vegetation alliance was obvious to the observers and alternate alliance choices were not recorded. When necessary, they also recorded a first, second, and third closest alliance match. These alternates provided additional information to determine which vegetation alliances were being confused with another alliance, and helped determine which alliances could be combined to improve map accuracy. Some plots were located on private or fenced lands; when these plots could be visually inspected from a distance with very high confidence they were included in the accuracy assessment. Similarly there were plots that were inaccessible inside the park boundaries due to long distances, extremely thick vegetation, marshes, cliffs and steep slopes. Crews used their own discretion when evaluating plots when they were unable to reach plot center. If there was high confidence in the distance assessment, the plot was included in the assessment.

One hundred seventy five, randomly located accuracy assessment points were collected, as shown in Figure 20. When there was disagreement, the points were reviewed in the office to determine the nature of the error.

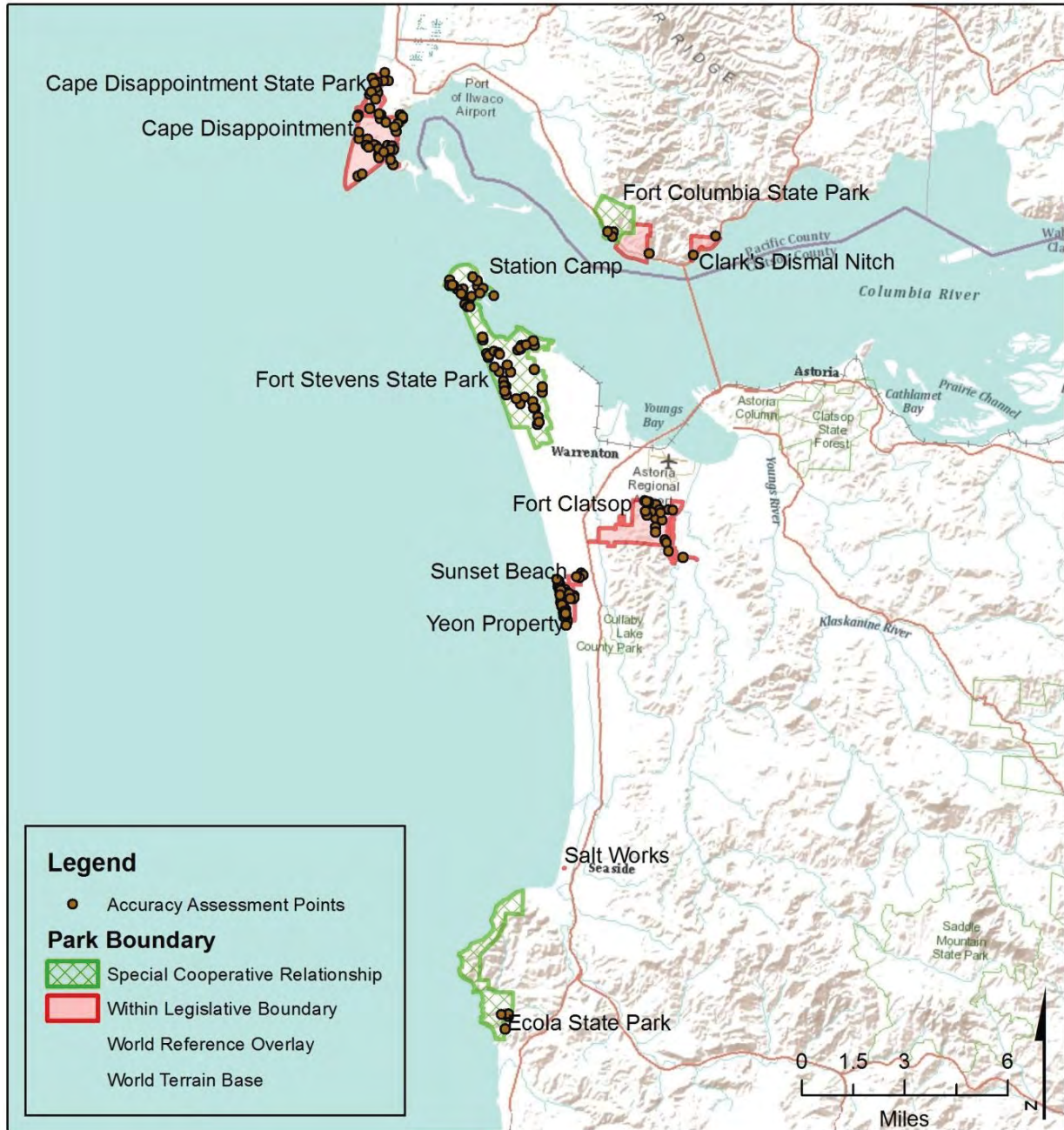


Figure 20. Accuracy assessment points collected at Lewis and Clark National Historical Park.

Data Analyses

An error matrix was developed using the randomly selected sample points visited in the field. The error matrix included the overall agreement representing the correctly classified interpretation points divided by the total number of interpretation points (Figure 21, Equation A.1). Omission error related to the producer's accuracy (Figure 21, A.2), and commission error (Figure 21, A.3), related to the user's agreement were calculated to provide additional statistics about the sources of error and the reliability of individual map classes (Congalton 1991, Congalton and Green 1999).

Omission error (errors of exclusion) represents the occurrence that a predicted class is actually represented by another class and thus omitted from the correct class. Commission error (errors of inclusion) represents the inclusion of a class in a category to which it does not truly belong.

Equation A.1. Overall agreement

$$= \frac{\sum_{i=1}^k n_{ii}}{n} \text{ where } n_{ii} = \text{the points correctly classified}$$

Equation A.2. Producer's agreement

$$= \frac{n_{jj}}{n_{(+)j}} \text{ where } n_{jj} = \text{value in diagonal and } n_{(+)j} = \text{column total}$$

Equation A.3. User's agreement

$$= \frac{n_{ii}}{n_{(i+)}} \text{ where } n_{ii} = \text{value in diagonal and } n_{(i+)} = \text{row total}$$

Figure 21. Accuracy assessment equations: Equations A.1, A.2, A.3.

Results

The error matrix table displays the individual alliance mapping accuracies along with overall, producer's and user's accuracies (Figure 22). The overall accuracy of the map is 88.9%, which exceeds the VIP's accuracy goal.

All of the dominant vegetation types were mapped to VIP accuracy requirements. The overall accuracy of the Sitka Spruce- (Western Hemlock) Alliance was 96%. Producer's accuracy for the recent blowdown areas in this type (map class Disturbed Forest) was 100%. However, it was more difficult to distinguish between the young and older forests, as well as between the young forests and recently blowdowns, given their obvious similarities.

Three map classes did not meet the required 80% accuracy required by the VIP. The Alder Swamp and Riparian class was mapped at 74% accuracy. The majority of errors were caused by confusion with this class and the Alder Upland class, a type dominated by the same species. The two alder-dominated map classes were easily distinguished at all of the park units except for Fort Stevens State Park, which is so flat that the slopes and elevations used to differentiate between upland and wetland alder stands in the other units could not be used with the same accurate results. The second map class that was below the 80% requirement was the Pine Dune map class, mapped at 75% accuracy. The errors for this type also occurred at Fort Stevens State Park, between shrub-dominated dunes and recently disturbed forests. Shrub dunes at Fort Stevens always contain some shorepine.

MAPPED	Tidal Fresh-Brackish Marsh	Salt Marsh	Nontidal Freshwater Marsh	Willow Swamp	Alder Swamp and Riparian	Alder Upland	Sitka Spruce Upland Forest	Sitka Spruce Upland Forest-Young	Disturbed Forst	Pine Dune	Shrub Dune	Grass Dune	Non-Native Herbaceous	Grand Total	COMMISSION (Users Accuracy)	90% Confidence Interval -	90% Confidence Interval +
Tidal Fresh-Brackish Marsh	9		2											11	82%	58%	105%
Salt Marsh		8												8	100%	94%	106%
Nontidal Freshwater Marsh			16											16	100%	97%	103%
Willow Swamp				3	1					1				5	60%	14%	106%
Alder Swamp and Riparian					20	3				1		1		25	80%	65%	95%
Alder Upland					4	14	1							19	74%	54%	93%
Sitka Spruce Upland Forest							12							12	100%	96%	104%
Sitka Spruce Upland Forest-Young							1	5						6	83%	50%	117%
Disturbed Forst								1	9	1				11	82%	58%	105%
Pine Dune					2					12				14	86%	67%	105%
Shrub Dune			1		1					2	6	1		11	55%	25%	84%
Grass Dune												31		31	100%	98%	102%
Non-Native Herbaceous													9	9	100%	94%	106%
Grand Total	9	8	19	3	27	17	14	6	9	16	6	33	9	178			
OMISSION (Producers Accuracy)	100%	100%	84%	100%	74%	82%	86%	83%	100%	75%	100%	94%	100%				
90% Confidence Interval -	94%	94%	68%	83%	58%	64%	67%	50%	94%	54%	92%	86%	94%				
90% Confidence Interval +	106%	106%	101%	117%	90%	101%	105%	117%	106%	96%	108%	102%	106%				
									Overall Spruce Accuracy:	90%							
Overall Accuracy: 88.9%, Lower Interval 85.0%, Upper Interval 92.8%																	
Kappa Index 85.8%, Lower Kappa Index 90% Confidence Interval 81.1%, Upper Kappa Index 90.4%																	

Figure 22. Accuracy assessment table showing errors of commission and omission.

The third class with lower than 80% accuracy was the Willow Swamp map class. Only 5 accuracy assessment points were sampled for this type. At these points there were no errors of omission (100% accuracy), but two errors of commission (60% accuracy). One of these errors was a red alder swamp that had significant amounts of willow and short alders. The vegetation height cut-off used to distinguish these two types was responsible for the mistake. The other error occurred in a mixed polygon at Fort Stevens State Park, where some patches of Hooker's willow deflation plain occurred in a mostly shrub-dominated dune habitat causing the area to be mapped incorrectly.

Discussion

As was noted in the vegetation classification section, distinguishing between the alder-dominated swamp and riparian settings and the alder-dominated uplands proved difficult, since the upper canopy is identical, and many of the understory species, such as salmonberry (*Rubus spectabilis*) and sword fern (*Polystichum munitum*) are also the same. Thus a lower accuracy rate for the alder upland compared to most other types was expected.

Although separate accuracy matrices were not developed for each unit, almost all of the errors found in the accuracy assessment occurred at Fort Stevens State Park and at Cape Disappointment. The Cape Disappointment errors were locations in which the random point occurred within narrow riparian areas, which were smaller than the minimum mapping unit and were located within a corrected mapped polygon typically of a non-riparian type. Although the errors were retained in the accuracy assessment, during final map cleanup, additional small Alder Swamp and Riparian polygons were mapped at these locations.

Most of the mapping errors resulted from the misidentification of the vegetation types that occurred in the very flat areas at Fort Stevens State Park where it was difficult to distinguish between wetland and upland areas. Many of the map polygons at Fort Stevens are very close to or just above the minimum mapping unit (0.5 ha) and have only 74% accuracy for Alder Swamp and Riparian class and a 75% accuracy of the Pine Dune class. These are lower accuracy rates than in any of the other areas, and warrants caution in the use of the map to identify specific wetland locations.

The accuracy assessment did not include four map classes that were manually mapped based on field visits. These included:

Big-leaf Maple Upland Forest (*Acer macrophyllum* - (*Pseudotsuga menziesii*) Forest Alliance)
Herbaceous Headland (Southern Vancouverian Shrub & Herbaceous Bald & Bluff Group)
Mesic Hemlock Upland Forest (*Tsuga heterophylla* -*Pseudotsuga menziesii* / *Rubus spectabilis*
Wet Forest Alliance)
Wet Hemlock Upland Forest (*Tsuga heterophylla* -*Pseudotsuga menziesii* / *Rubus spectabilis*
Wet Forest Alliance)

The first two of these are both quite rare in the park, and exceptionally easy to map, and we are confident that all of the polygons are mapped correctly. The two western hemlock types were mapped only in areas dominated by western hemlock, so there are no errors of commission. However, in many of the very young forest stands, or areas with recent windthrow, it is possible that there could be some errors of omission, especially within the Fort Clatsop unit. However,

since Sitka Spruce will likely dominate all of the forest areas over time, the spruce alliance was always used when no mature trees were seen. Over time, when these forests develop further, these polygons can be easily updated.

In general, the combination of having access to LiDAR, multiple imagery sources, a relatively small area to map, and many roads and trails making much of the mapped areas accessible resulted in very accurate and meaningful results. Following the accuracy assessment, all of the polygons which had been identified as being mapped incorrectly were updated, so the final product has no known errors and should be very useful to support natural resource research and management at LEWI.

Project deliverables include the geospatial information used to derive the maps and assess accuracy. These data are organized in one project geodatabase, with associated FGDC-compliant metadata. The geospatial information is presented in two sections; one which encompasses the area inside the parks and a second which covers the area within the 50m buffer outside the park boundaries. Additional project products include mosaicked NAIP imagery, a historic vegetation layer and graphic files in pdf format for the maps for each of the units, and the park as a whole.

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Appendix A: Plant Community Descriptions

As part of the Lewis and Clark National Historical Park vegetation classification, mapping, and inventory projects, local plant alliance descriptions and lists of associations were collated or described where new or provisional alliances were present. This document was a joint project between ORBIC, NatureServe, and NPS, drawing on previous classification documents and descriptions completed by the North Coast and Cascades Network, Washington Natural Heritage Program, ORBIC, and NatureServe. The classification follows the National Vegetation Classification Standard 2008 as set by the Federal Geographic Data Committee.

**NCCN ALLIANCE DESCRIPTIONS:
Forested and Non-Forested Alliances
from
Lewis and Clark National Historic Park**

NCCN USGS-NPS Vegetation Mapping
Cooperative Agreement No.: H8W07060001
Task Agreement No.: PR#9504009007

Provided by

**Institute for Natural Resources, Portland State University and Oregon State
University
with Assistance from NatureServe**

June 2, 2011
Revised July 12, 2012



This subset of the International Ecological Classification Standard covers vegetation macrogroups, groups, alliances and associations attributed to the multiple units of the Lewis and Clark National Historic Park. This classification has been developed from a larger vegetation classification for the North Coast and Cascades Network developed under agreement by NatureServe and the Washington Natural Heritage Program. It was created in consultation with many individuals and agencies and incorporates information from a variety of publications and other classifications. Comments and suggestions regarding the contents of this subset should be directed to James S. Kagan, Director, Institute for Natural Resources – Portland (jimmy.kagan@oregonstate.edu) and/or Gwen Kittel, Regional Vegetation Ecologist, Boulder, CO (gwen_kittel@natureserve.org).

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Introduction

This document contains descriptions for 30 Alliances and 18 Groups identified in the Lewis and Clark Vegetation Mapping and Botanical Inventory Projects that represent natural and ruderal (weedy) vegetation. Alliances and Groups are part of the hierarchical structure of the Federal Geographic Data Committee (FGDC 2008) standard called the National Vegetation Classification (NVC). The Lewis and Clark National Historical Park classification was developed from a larger vegetation classification for the North Coast and Cascades Network created under agreement by NatureServe and the Washington Natural Heritage Program (Crawford et al. 2009). Alliance codes beginning with NCCN were described in the NCCN Alliance Descriptions document (NatureServe 2010) and many of these descriptions are repeated in this document. Detailed descriptions of some Associations listed in this Appendix may be found on NatureServe Explorer (NatureServe 2011); those with association codes beginning with PNWCOAST and some of the provisional types can be found in Crawford et al. 2009.

Each Alliance or Group description in the report lists the Division, Macrogroup, and Group hierarchy levels followed by the Alliance scientific and common names, a local summary of what the type and in which park units the type is found. This information is followed by a table which lists the plant Associations found in Lewis and Clark National Historical Park. A range-wide summary description of the Alliance is also provided, followed by a mapping rule section which was written to facilitate vegetation mapping work. The mapping rule section provides for each Alliance its environmental context, typical shape and dimensions, canopy dominants, and associated species. The map class used to depict this alliance in the LEWI vegetation map is given, followed by any pertinent references for the alliance description.

National Vegetation Classification

The National Vegetation Classification (NVC) is the system used in National Park Service vegetation mapping projects, and is based on the National Vegetation Classification Standard adopted by the Federal Geographic Data Committee (FGDC 2008). The NVC evolved from work conducted primarily by The Nature Conservancy (TNC), NatureServe, and the Natural Heritage Program network over more than two decades (Grossman et al. 1998). The USNVC is based on a partnership between nongovernmental organizations, the Ecological Society of America's Vegetation Panel and NatureServe, and federal partners, through the auspices of the Federal Geographic Data Committee Vegetation Subcommittee.

Vegetation classification systems attempt to recognize and describe repeating assemblages of plants in similar habitats. The NVC is a hierarchical system that incorporates physiognomic characters and floristic data to define eight levels of terrestrial vegetation classification. The six upper levels (class, subclass, formation, division, macrogroup, and group) are based on physiognomic features. The two lower levels (alliance and association) are distinguished by differences in floristic composition. The physiognomic units have a broad geographic perspective and the floristic units have utility in local and site-specific applications (Grossman et al. 1998). The physiognomic levels of the NVC are based on physical, structural, and environmental characteristics identifiable from satellite imagery, aerial photography, or ground

observations. Specific criteria defining these physiognomic units are based on ecologic characteristics that vary among major vegetation groups (FGDC 1997).

The standard breaks new ground on how to approach vegetation classification of existing vegetation. Floristic and physiognomic criteria are the primary properties of vegetation used to define all units of the classification. The choice of how these criteria are used is integrated with ecological and biogeographic considerations. The USNVC Standard includes criteria for all of the new and revised levels, as shown in Table 1. Table 2 gives an example of the NVC hierarchy of an association found at Lewis and Clark National Historical Park.

The variety of vegetation criteria can be summarized as follows (FGDC 2008, see also Mueller-Dombois and Ellenberg 1974: 154-155). *Physiognomic and structural criteria* include (1) Diagnostic combinations of growth forms; (2) Ecological patterns of either dominant growth forms or combinations of growth forms (growth forms of similar ecological (habitat) and dynamic significance, or growth forms of similar geographical distribution), and (3) Vertical stratification (layering) of growth forms (complexity in structure as produced by arrangement of growth forms). *Floristic criteria* include (1) Diagnostic combinations of species (differential and character species, constant species, dominant species), (2) Ecological combinations of species (indicator species of similar ecological (habitat) and/or dynamic significance, species of similar geographical distribution), (3) Vertical stratification (layering) of species (species patterns found in the dominant growth forms or strata, species patterns found between strata (overstory/understory), and (4) Numerical relation criteria (community coefficients, such as indices of similarity among plots within a type).

Table A-1. Summary of United States National Vegetation Classification revised hierarchy levels and criteria for natural vegetation.

Hierarchy level	Criteria
<i>Upper</i>	<i>Physiognomy plays a predominant role.</i>
L1–Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and substrate/aquatic conditions.
L2–Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate/aquatic conditions.
L3–Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.
<i>Middle</i>	<i>Floristics and physiognomy play predominant roles</i>
L4–Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant species that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.

L5–Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms, that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.
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Table A-1. Summary of National Vegetation Classification revised hierarchy levels and criteria for natural vegetation (continued).

L6–Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes.
<i>Lower</i>	<i>Floristics plays a predominant role</i>
L7–Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate, substrates, hydrology, moisture/nutrient factors, and disturbance regimes.
L8–Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes

Table A-2. Example of the National Vegetation Classification hierarchy for the *Picea sitchensis* - *Tsuga heterophylla* / *Polystichum munitum* Forest Association (following Faber-Langendoen et al. 2011).

Hierarchy level	Code	Name
L1–Formation Class	1	Forest & Woodland (Mesomorphic Tree Vegetation)
L2–Formation Subclass	1.C	Temperate Forest
L3–Formation	1.C.2	Cool Temperate Forest
L4–Division	1.C.2.b	Western North American Cool Temperate Forest
L5–Macrogroup	MG024	Vancouverian Lowland & Montane Rainforest
L6–Group	G239	North Pacific Maritime Sitka Spruce Forest Group
L7–Alliance	A.NCCN-027	<i>Picea sitchensis</i> -(<i>Tsuga heterophylla</i>) Forest Alliance
L8–Association	CDGL00378 7	<i>Picea sitchensis</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i> Forest

Alliance Descriptions

1.C.1.c Western North American Warm Temperate Forest

MG019 Californian-Vancouverian Foothill & Valley Forest & Woodland

G205 Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group

**A.NCCN-NEW1 *Pinus contorta* var. *contorta* Coastal Dune Woodland Alliance
Shorepine Coastal Dune Woodland Alliance**

Local Summary: These dune woodlands occur primarily in Fort Stevens State Park and Sunset Beach State Park with the Yeon addition, although small patches can be found in sandy areas at Cape Disappointment. Historically they occurred in small patches in the open sandy areas between Ecola and Cape Disappointment, but as the dunes were stabilized, and the area received more and more human use, they have become dominated by non-native species.

LEWI Associations

CEGL002605	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Arctostaphylos uva-ursi</i> Woodland
CEGL000150	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Gaultheria shallon</i> Woodland
CEGL000151	<i>Pinus contorta</i> var. <i>contorta</i> - <i>Pseudotsuga menziesii</i> / <i>Morella californica</i> - <i>Vaccinium ovatum</i> Forest
NEW	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i> Semi-natural Forest

Range-wide Summary: This shorepine dominated conifer woodland alliance occurs on stabilized to semi-stabilized dunes along the coast of Oregon and northern California. It is best represented in natural conditions in the Oregon Dunes National Recreation Area (NRA), where small but numerous stands of open shorepine occur. At the NRA, shorepine woodlands include areas with dense and tall ericaceous shrublands where *Rhododendron occidentale*, *Gaultheria shallon*, *Morella californica*, and *Vaccinium ovatum* dominate, more open areas with *Arctostaphylos columbiana* or *A. uva-ursi* in the understory, usually with dense lichen cover on much of the sand, and barely stabilized dunes with *Fragaria chiloensis*, *Lupinus littoralis*, *Pteridium aquilinum* and some *Poa macrantha* present.

Mapping Rule: These are short statured trees (~3-5 m, 10-16 feet) , forming open, coniferous woodlands occurring within 10 km of the coast and below 1000 m in elevation. The alliance forms stands that are small patch, between 0.5 -50 acres in size, usually in a matrix of open dune and closed canopy *Picea sitchensis*, *Tsuga heterophylla*, and *Pseudotsuga menziesii* dominated forests. The presence of *Pinus contorta* var. *contorta* as the dominant tree in the stand, the sandy soils, and the proximity to the ocean are the indicators for this alliance.

Map Class: Pine Dune.

1.C.2.b Western North American Cool Temperate Forest

MG024 Vancouverian Lowland & Montane Rainforest

G237 North Pacific Red Alder -Bigleaf Maple -Douglas-fir Forest Group

A.NCCN-019 *Acer macrophyllum* - (*Pseudotsuga menziesii*) Forest Alliance

Bigleaf Maple - (Douglas-fir) Forest Alliance

Local Summary: This alliance is widespread in the Oregon and Washington Coast Ranges, but occurs in patches that are mostly too small to be mapped at Cape Disappointment, Fort Columbia, Middle Village/Station Camp and Dismal Nitch. There are probably only about 20 big leaf maple trees located at all the sites combined. There are a few small patches at Fort Clatsop and Fort Columbia that have been included in the vegetation map.

LEWI Associations

NEW	<i>Acer macrophyllum</i> -(<i>Pseudotsuga menziesii</i>)/ <i>Polystichum munitum</i> Forest
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Range-Wide Summary: This alliance occurs along the Pacific Coast from southwestern Oregon to northwestern Washington, and into the lowland valleys of the Puget Trough and Willamette Valley. This maritime-influenced region receives annual precipitation ranging from 75-400 cm, mostly as winter rain. Vegetation within this alliance usually occurs along low-elevation (0-1000 m) valley slopes and lower mountain slopes, often forming a seral community in moist coniferous forests. This alliance is usually found within *Tsuga heterophylla* - *Thuja plicata* forests, but also grows within *Pseudotsuga menziesii* forests. This mix of deciduous and evergreen trees, dominated by *Acer macrophyllum* and *Pseudotsuga menziesii*, occurs on sites that were burned or on old hillslope landslides or inactive debris aprons. Soils can be rocky. This alliance is also common in cleared forests near human development and on the edges of farm fields and pastures. Communities within this alliance may represent early seral communities within the major coniferous forests of the region, which have been favored by past logging or other disturbances. Communities are usually strongly dominated by *Acer macrophyllum*, which forms a diffuse canopy. Some conifers, such as *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, *Picea sitchensis*, or *Abies grandis*, may be present and can usually be found growing in the understory or as occasional canopy trees. Deciduous trees, such as *Alnus rubra*, *Cornus nuttallii*, and *Betula papyrifera* (which is sometimes codominant in northwestern Washington), may also be present in the tree stratum. The forest understory is usually species-rich and well-developed compared to adjacent conifer forests in the same area. Common shrub species in stands of this alliance include *Acer circinatum* (which is always present), *Sambucus racemosa* var. *melanocarpa*, *Rubus spectabilis*, *Rubus parviflorus*, *Gaultheria shallon*, *Vaccinium membranaceum*, and *Mahonia nervosa*. The herbaceous layer is often well-developed, with ferns being the most important component. Species include *Polystichum munitum*, *Athyrium filix-femina*, and *Pteridium aquilinum*.

Mapping Rule: Small-patch (<2 acres) deciduous forests at low elevations (<1000m), often surrounded by coniferous forest, on landslides and other steep slopes, common in

cleared forests near human development and on the edges of farm fields and pastures. The type may be difficult to distinguish from *Alnus rubra* - (*Picea sitchensis*, *Tsuga heterophylla*) Forest and Woodland Alliance (A.NCCN-020).

Map Class: Big-leaf Maple Upland Forest.

References: Crawford et al. 2009.

A.NCCN-020 *Alnus rubra* - (*Picea sitchensis*, *Tsuga heterophylla*) Forest & Woodland Alliance

Red Alder - (Sitka Spruce, Western Hemlock) Forest & Woodland Alliance

Local Summary: These red alder woodlands have been mapped at most of the units at LEWI except for Sunset Beach/Yeon. This mesic upland type has a very gentle gradient between it and the red alder-dominated wetland types from the Vancouverian Flooded & Swamp Forest Macrogroup. In natural conditions, these upland alder dominated types mostly represent areas with frequent landslides, although can also include recent blowdowns or areas that were clearcut and not reestablished by conifers.

LEWI Associations

CEGL000638	<i>Alnus rubra</i> / <i>Polystichum munitum</i> Forest
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Range-Wide Summary: The vegetation within this alliance occurs along the Pacific Coast from central California north through Oregon and Washington, usually along low-elevation (0-1000 m) toe slopes, hillsides or valley bottoms, often forming a seral community of mixed deciduous and evergreen trees in moist coniferous forests. They are successional forests, where the deciduous component has come in due to natural (wildfires, landslides in unmodified landscapes) or human-caused disturbance (such as logging, clearing, road building/widening and other development). Human activity makes these "successional" forests a permanent part of the landscape. These are neither riparian nor wetland sites. The surrounding forest can be hypermaritime, inland lowland or lower montane dominated by *Tsuga heterophylla*, *Pseudotsuga menziesii*, and/or *Picea sitchensis*. It is a very common coastal forest type on unstable slopes above eroding coastlines and beaches. Stands are generally found at lower elevations (<1000 m) on a variety of aspects. Substrates reflect soil instability and are rocky or have lower organic content. *Alnus rubra* is well-adapted to wet soil conditions and is highly shade-intolerant. Communities within this alliance are usually strongly dominated by mixed stands of *Alnus rubra*, *Picea sitchensis*, and/or *Tsuga heterophylla*. The forest undergrowth is usually species-rich and well-developed compared to adjacent conifer forests. Common shrub species in stands of this alliance include *Rubus spectabilis*, *Sambucus racemosa* var. *melanocarpa*, *Acer circinatum*, and *Menziesia ferruginea*. The herbaceous layer is often well-developed, with *Oxalis oregana*, *Polystichum munitum*, and *Stachys mexicana* particularly common. Stands that occur on continually saturated soils (hillside springs or riparian areas) would be considered part of *Alnus rubra* Seasonally Flooded Woodland Alliance.

Mapping Rule: These are large-patch (2-100 acres), distinct deciduous forests, often surrounded by coniferous forests, or in a matrix of rural and urban infrastructure. They are generally found at lower elevations (<1000 m) and may be difficult to distinguish from other deciduous forests.

Map Class: Alder Upland.

G239 North Pacific Maritime Sitka Spruce Forest Group

A.NCCN-027 *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance

Sitka Spruce - (Western Hemlock) Forest Alliance

Local Summary: This is the dominant forest alliance found at the Lewis and Clark National Historic Park. It occurs throughout Ecola and Fort Clatsop, and is the dominant conifer type at Fort Columbia State Park, Cape Disappointment, Middle Village/Station Camp, and Dismal Nitch. Much of the area has been heavily impacted by a series of windstorms in which many to occasionally all of the trees have blown over. As a result, these forests at LEWI range from young, relatively short forests, to giant, mature old growth forests. Three conditions (recent blowdown or disturbed forest, young recovering forest, and older forests) were mapped for this alliance.

LEWI Associations

CEGL003266	<i>Picea sitchensis/Calamagrostis nutkaensis</i> Woodland
CEGL000401	<i>Picea sitchensis/Gaultheria shallon</i> Forest
CELG00XXXX	<i>Picea sitchensis/Maianthemum dilatatum</i> Forest
CEGL000056	<i>Picea sitchensis/Menziesia ferruginea-Vaccinium parvifolium</i> Forest
PNWCOAST_06 0	<i>Picea sitchensis/Vaccinium ovatum</i> Forest
CEGL003787	<i>Picea sitchensis-Tsuga heterophylla/Polystichum munitum</i> Forest

Range-Wide Summary: This conifer forest alliance is found within the maritime climate-influenced region of the Pacific Northwest, from northern California to southern Alaska, usually within 50 km of tidewater and below 1000 m in elevation. Stands typically occur on coastal terraces, but extend up river valleys and seaward slopes of coastal mountains. Stands occur on moderate to steep slopes with shallow to moderately deep soils and on stabilized coastal dunes with sandy soils. Forests of this alliance are dominated by *Picea sitchensis*, but *Tsuga heterophylla* and *Pseudotsuga menziesii* may codominate the canopy, especially at sites farther inland. Other common trees include *Thuja plicata* and *Abies grandis*. *Chamaecyparis nootkatensis* can be found in northern stands, while *Chamaecyparis lawsoniana* or *Sequoia sempervirens* occur in southern stands.

The alliance includes more open forests or woodlands that occur on steep, ocean-facing slopes. Broad-leaved trees include the shade-tolerant *Acer macrophyllum*, which may form a sparse subcanopy in older stands. An ericaceous tall-shrub layer is common, with *Vaccinium parvifolium* or *Menziesia ferruginea* abundant at moist sites, and

Rhododendron macrophyllum, *Vaccinium ovatum*, or *Gaultheria shallon* more important at drier sites. *Rubus spectabilis* is common and persistent following disturbance, and *Oplopanax horridus* is common at very wet sites. The herbaceous layer is dominated by mesic, shade-tolerant ferns and forbs such as *Polystichum munitum*, *Oxalis oregana*, *Maianthemum dilatatum*, *Blechnum spicant*, and *Athyrium filix-femina*. More open stands can have high cover of *Calamagrostis nutkaensis*. Mosses and lichens are abundant on logs, snags, trees, or the ground surface. The presence of an upper tree canopy that is dominated by *Picea sitchensis* is diagnostic of this forest alliance.

Mapping Rule: These are tall (>5 m), coniferous forests well within 50 km of the coast and below 1000 m in elevation. If stands occur inland, they are confined to valley bottoms where sea fog can penetrate. The alliance forms stands that are large patch, between 2-100 acres in size. The upper canopy is usually a mix of *Picea sitchensis*, *Tsuga heterophylla*, and *Pseudotsuga menziesii*. The presence of *Picea sitchensis* in the stand, along with the proximity to the zone of maritime climate influence, are the indicators for this alliance.

Map Classes: Sitka Spruce Upland Forest: *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance. Sitka Spruce Upland Forest- Young : *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance. Disturbed Forest: *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance - recent blowdown area.

A.2067 North Pacific (*Picea sitchensis*- *Pinus contorta* var. *contorta*) Stabilized Dune Forest

North Pacific (Sitka Spruce, Shore Pine) Stabilized Dune Forest

Local Summary: This is a provisional alliance. This type is found primarily on the areas of dunes formed by the creation of the North and South Jetties at Cape Disappointment and Fort Stevens where Sitka spruce is a significant component. It can be difficult to classify due to the variety of species present, but is characterized by the presence of mid- or early-seral Sitka spruce on sandy soils.

LEWI Associations

CEGL000403	<i>Picea sitchensis</i> - <i>Pinus contorta</i> / <i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> Forest
NEW	(<i>Picea sitchensis</i> - <i>Alnus rubra</i>)/ <i>Carex obnupta</i> Stabilized Dune Forest
NEW	<i>Picea sitchensis</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i> Semi-natural Shrubland

Range-Wide Summary: This is an early successional provisional type that occurs on sandy soils along the ocean. This type occurs as native and non-native species colonize the new land areas, creating a type with a diverse mix of trees and shrubs. *Picea sitchensis* is always present but *Alnus rubra* or *Pinus contorta* may also be present. The shrub layer is diverse and well developed and includes *Morella californica*, *Vaccinium ovatum*, *Gaultheria shallon*, *Salix hookeriana*, and *Malus fusca*. *Carex obnupta* or *Ammophila* spp. may also be present. This type may represent transitions between the

Shrub Dune map class and the red alder forest or Sitka spruce forest depending on the species present and hydrography.

Mapping Rule: Trees are short (3-5 m) in large patches of open to partially closed woodlands on sandy soils within 1 km of the ocean characterized by Sitka spruce but with a large mix of other species present.

Map Class: Sitka Spruce Dune.

References: Christy et al. 1998.

G240 North Pacific Maritime Douglas-fir - Western Hemlock Forest Group
A.NCCN-044 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Rubus spectabilis*
Wet Forest Alliance
Western Hemlock - Douglas-fir / Salmonberry Wet Forest Alliance

Local Summary: This forest alliance occurs in relatively small patches at the Ecola State Park, Fort Columbia State Park, Dismal Nitch, and Middle Village/Station Camp. Some of these are too small to be mapped. The areas at Fort Clatsop that lack mature spruce all show spruce regeneration, and clearly belong in the Sitka spruce forest group.

LEWI Associations

PNWCOAST_1 58	<i>Pseudotsuga menziesii</i> -(<i>Alnus rubra</i> - <i>Tsuga heterophylla</i>)/ <i>Rubus spectabilis</i> Forest
PNWCOAST_1 95	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /(<i>Acer circinatum</i>)/ <i>Polystichum munitum</i> Forest
PNWCOAST_1 91	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Mahonia nervosa</i> - <i>Polystichum munitum</i> Forest

Range-Wide Summary: This coniferous forest alliance occurs at low elevations (0-1500 m) in all the maritime-influenced regions of the Pacific Northwest, from north coastal California to the Kenai Peninsula in Alaska. Throughout the range of this alliance, much of the annual precipitation occurs as rain. Where snow does occur, it can generally be melted by rain during warm winter storms. In all settings, this alliance occurs where environmental conditions are moderated by the marine influence, with moderate drought and frost. Stands are best represented on lower slopes of the Coast Ranges with high precipitation, long frost-free periods, and low fire frequencies. Stands of the alliance generally occur on very moist, water-receiving slopes, usually north-facing or otherwise protected sites that are subirrigated but well-drained. Soils remain wet year-round, but are not saturated, and are not wetland or riparian in nature.

These forests are characterized by a mixed canopy of *Tsuga heterophylla* and *Pseudotsuga menziesii* and can have a complex, multi-tiered structure of multiple age classes. *Thuja plicata* may codominate on valley bottom sites with poorly drained soils, and *Tsuga heterophylla* is generally the dominant regenerating tree species. Other

common tree associates include *Abies grandis*, *Picea sitchensis*, *Taxus brevifolia*, *Alnus rubra*, and *Abies amabilis*. Understory species are generally intolerant of drought. Neither *Abies grandis* nor *Abies amabilis* are found at LEWI.

The shrub layer is commonly composed of *Acer circinatum*, *Cornus sericea*, *Mahonia nervosa*, *Menziesia ferruginea*, *Rubus spectabilis*, or *Gaultheria shallon*. The herbaceous layer is dominated by ferns, including *Pteridium aquilinum*, *Polystichum munitum*, *Gymnocarpium dryopteris*, *Athyrium filix-femina*, and *Blechnum spicant*. Moisture-loving forbs include *Oxalis oregana*, *Achlys triphylla*, and *Tiarella trifoliata*. Diagnostic of this alliance is an upper tree canopy dominated by *Tsuga heterophylla* and *Pseudotsuga menziesii* and moist, well-drained sites.

Mapping Rule: These are large-patch forests, approximately 2-100 acres in size. These forests occur at low to moderate (0-460 m [0-1500 feet]) elevations, usually north-facing or otherwise protected sites that are on water-receiving topography, subirrigated or otherwise quite moist yet well-drained. They are not found on saturated soils and do not manifest as riparian or wetland in shape or species composition. The canopy is a mixture of coniferous tree species *Pseudotsuga menziesii* and *Tsuga heterophylla*.

Map Class: Wet Hemlock Upland.

A.NCCN-042 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Cornus unalaschkensis* Mesic Forest Alliance

Western Hemlock - Douglas-fir / Western Cordilleran Bunchberry Mesic Forest Alliance

Local Summary: Small patches of these dry forests characterized by western hemlock and Douglas-fir are found scattered through the park. There are patches present at Dismal Nitch, Ecola, Cape Disappointment, and Middle Village/Station Camp.

LEWI Associations

NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> / <i>Polystichum munitum</i> Forest
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> - <i>Vaccinium parvifolium</i> Forest

Range-Wide Summary: This alliance occurs in all the maritime-influenced regions of the Pacific Northwest, from north coastal California to the Kenai Peninsula in Alaska. Throughout the range of this alliance, much of the annual precipitation occurs as rain. Where snow does occur, it can generally be melted by rain during warm winter storms. In all settings, this alliance occurs where environmental conditions are moderated by the marine influence, with moderate drought and frost. Stands of the alliance generally occur on all slopes and aspects, on drained mesic sites that do not become very dry by summer's end. The associations in this alliance are found throughout the range. Although associations may be moister in the north and more mesic in the south, all are

generally in the mid-range of moisture settings, and are never considered consistently very dry or very wet by local ecologists. Soils remain moist year-round, but are not subirrigated or saturated. The overstory canopy is dominated by *Pseudotsuga menziesii* and *Tsuga heterophylla*. Understory species such as *Mahonia nervosa*, *Vaccinium membranaceum*, and *Gaultheria shallon* are intolerant of drought. Other common tree associates include *Thuja plicata*, *Abies amabilis*, and *Abies grandis*. Rarely, *Picea sitchensis* may appear, and *Chamaecyparis nootkatensis* has been documented with up to 28% cover, but neither is typically present. Shrub species are variable and include *Acer circinatum*, *Chimaphila umbellata*, *Gaultheria shallon*, *Linnaea borealis*, *Mahonia nervosa*, *Menziesia ferruginea*, *Vaccinium alaskaense*, and *Vaccinium parvifolium*. The herbaceous layer is highly variable. The following species each occur in about one-third of documented stands: *Goodyera oblongifolia*, *Polystichum munitum*, *Achlys triphylla*, *Cornus unalaschkensis*, *Tiarella trifoliata*, *Trillium ovatum*, *Clintonia uniflora*, and *Blechnum spicant*. The diagnostic characteristic of this alliance is an overstory of both *Pseudotsuga menziesii* and *Tsuga heterophylla*, with an understory that is neither wet nor dry throughout the growing season.

Mapping Rule: These are large-patch forests, approximately 2-100 acres in size, more often at the upper end of this size range. These forests occur at low to moderate (0-460 m [0-1500 feet]) elevations and generally occur on all slopes and aspects, but on locations that do not become very dry by summer's end. This alliance occurs on midslopes that are neither drier nor wetter than the prevailing climate moisture regime. The canopy is a mixture of the coniferous trees *Pseudotsuga menziesii* and *Tsuga heterophylla*.

Map Class: Mesic Hemlock Upland and Disturbed Forest.

1.C.3.c Western North American Flooded & Swamp Forest

MG035 Vancouverian Flooded & Swamp Forest

G254 North Pacific Lowland Riparian Forest & Woodland Group

A.NCCN-001 (*Acer macrophyllum*, *Alnus rubra*) Riparian Forest Alliance

(Bigleaf Maple, Red Alder) Riparian Forest Alliance

Local Summary: These are hardwood riparian forests dominated by *Alnus rubra* at the park, but can occur as mixed hardwoods without cottonwood elsewhere in the Coast Ranges. They are very common at low elevations throughout western Oregon and Washington. These are the only riparian forests mapped in the park, found in most of the units. The NCCN associations mostly come from a new classification of riparian forests from Northwestern Oregon by Cindy McCain of the Siuslaw National Forest (McCain & Diaz 2002), and some have not been fully integrated into the National Vegetation Classification.

LEWI Associations

CEGL003298	<i>Alnus rubra/Acer circinatum/Claytonia sibirica</i> Forest
CEGL003401	<i>Alnus rubra/Petasites frigidus</i> Forest
CEGL003402	<i>Alnus rubra/Rubus parviflorus</i> Forest
CEGL000639	<i>Alnus rubra/Rubus spectabilis</i> Forest
CEGL003403	<i>Alnus rubra/Stachys chamissonis</i> var. <i>cooleyae</i> - <i>Tolmiea menziesii</i> Forest
CEGL003398	<i>Alnus rubra/Elymus glaucus</i> Forest

Range-Wide Summary: This alliance represents riparian forests and woodlands dominated by *Acer macrophyllum* or *Alnus rubra* or both in the upper canopy. *Populus balsamifera* ssp. *trichocarpa* is not present. Conifer species, if present, are not more than 10-20% of the total cover. This alliance is found along low-elevation streams and riparian areas, large and small rivers, but more often on steeper gradient streams.

Mapping Rule: These are low-elevation riparian streams dominated by deciduous trees or tall shrubs without cottonwoods. Streams can have *Alnus rubra*, *Acer macrophyllum*, or a mixture.

Map Class: Alder Swamp and Riparian

A.NCCN-005 (*Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*) - (*Alnus* spp., *Acer* spp.) Riparian Forest Alliance
(Sitka Spruce, Grand Fir, Western Hemlock, Western Red-cedar) - (Alder species, Maple species) Riparian Forest Alliance

Local Summary: These are conifer-dominated riparian forests with a potential mix of conifer and deciduous species, often found within a matrix of lowland forest types, located along rivers and streams. Due to the variable nature and small area of these forest types they were not split out as a separate map class but instead were subsumed into upland conifer or deciduous forest types.

LEWI Associations

CEGL000060	<i>Picea sitchensis-(Alnus rubra)/Rubus spectabilis/Polystichum munitum</i> Forest
Unclassified	<i>Picea sitchensis/Scirpus microcarpus</i> Woodland

Range-Wide Summary: These lowland riparian forests are dominated by conifer trees that may have *Alnus rubra* or *Acer macrophyllum* present in the upper canopy. This alliance also includes stands with just conifers present. They may or may not codominate in the upper canopy. They can be dominated by *Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*, and *Pseudotsuga menziesii*, individually or in any combination. This broad alliance is necessary as streams run through various lowland forests and can have any of these species in the overstory canopy. It is necessarily broad as these associations intermix and intermingle, and it is difficult to split them into distinct sets. *Alnus rubra* or *Acer macrophyllum* may be present or

absent. What these forests have in common is a similar suite of riparian wet soil-dependent understory species, found adjacent to streams, creeks, or rivers. Understory species include *Polystichum munitum*, *Rubus spectabilis*, *Scirpus microcarpus*, and others. Soils may be saturated but are also well-aerated.

Mapping Rule: These are lowland riparian forests dominated by conifer trees that may have up to 50% of the upper canopy codominated by *Alnus* or *Acer* spp. Elevations run from sea level to 30.5m (0-100 feet).

Map Class: Sitka Spruce Upland Forest

G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group
A.NCCN-002 (*Alnus* spp., *Fraxinus* spp., *Populus* spp.) / *Lysichiton americanus*
Deciduous Swamp Woodland Alliance
(Alder species, Ash species, Cottonwood species) / Yellow Skunk-cabbage
Deciduous Swamp Woodland Alliance

Local Summary: These are lowland deciduous forested swamps dominated by red alder at LEWI, with slough sedge, salmonberry, and skunk cabbage often present. Soils are seasonally flooded and saturated year-round. Large areas are present in Cape Disappointment and Fort Stevens, with some patches present in Middle Village/Station Camp.

LEWI Associations

CEGL00338 8	<i>Alnus rubra</i> / <i>Athyrium filix-femina</i> - <i>Lysichiton americanus</i> Forest
NEW	<i>Alnus rubra</i> / <i>Glyceria striata</i> Forest
NEW	<i>Alnus rubra</i> / <i>Rubus spectabilis</i> / <i>Chrysosplenium glechomifolium</i> Forest
CEGL00338 9	<i>Alnus rubra</i> / <i>Rubus spectabilis</i> / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Woodland

Range-Wide Summary: This alliance occurs throughout the northern Puget Trough lowlands and in low-lying valleys near the Oregon and northern California coasts. It typically occurs along low-elevation (0-1000 m) streams or valley bottoms, along the upland margins of wetlands, or on the floodplains of streams and rivers. These forests are seasonally flooded by spring snowmelt and rains much of the winter, spring, and occasionally into early summer, and by permanent springs. Soils are saturated year-round and are comprised of muck or peat, silts or clays with poor drainage, and gleying is often evident. Scour and active flooding are not features of these saturated woody wetlands. If this alliance is found on the active floodplains, it occurs around oxbow lakes, swales and other backwater/slackwater areas, and less frequently along the active streambanks. Forests are dominated by *Alnus rubra*, *Fraxinus latifolia*, or *Populus balsamifera* ssp. *trichocarpa* which are well-adapted to wet soil conditions, highly shade-intolerant and form a diffuse canopy. Overstory cover ranges from 40-80%. The forest undergrowth is usually dominated by a deciduous shrub layer in which *Rubus spectabilis* can be the only species (30-60% cover). Other shrub species are not

common, but when present may include *Crataegus douglasii*, *Spiraea douglasii*, *Symphoricarpos albus*, *Rosa eglanteria*, and *Rubus ursinus*. The herbaceous layer may be well-developed, with species such as *Athyrium filix-femina*, *Equisetum hyemale*, *Galium trifidum*, *Lonicera involucrata*, *Lysichiton americanus*, *Rubus ursinus*, *Tiarella trifoliata*, and *Tolmiea menziesii*. Graminoids include *Carex obnupta*, *Carex deweyana*, *Carex unilateralis*, *Carex ovalis* (= *Carex leporina*), and *Eleocharis acicularis*. Common forbs include *Galium trifidum*, *Galium aparine*, *Ranunculus uncinatus*, *Veronica* spp., and *Geum macrophyllum*. Adjacent vegetation can be upland forests of *Quercus garryana* or wet prairie dominated by *Deschampsia caespitosa* and/or *Hordeum brachyantherum*.

According to Christy (2004), habitat for the Red Alder / Salmonberry / Slough Sedge - Yellow Skunk-cabbage association is forested wetland (swamp). Some sites are silted-in beaver ponds, and others are in peatlands where the association occurs in nutrient-rich lags adjacent to uplands. Stands along streams may be flooded for brief periods after winter storms. Stands are dominated by *Alnus rubra* between 20-50 years old and have relatively few species in the shrub and herb layers. *Thuja plicata*, *Picea sitchensis*, and *Tsuga heterophylla* are sparsely represented in both mature and reproducing layers, where they are peripheral or limited to elevated microsites. The scanty shrub layer may include *Rubus ursinus*, *Salix hookeriana*, *Spiraea douglasii*, *Lonicera involucrata*, or *Rubus spectabilis* in wet areas and may have *Gaultheria shallon* and *Acer circinatum* on stumps and logs. The herb layer is dominated by *Carex obnupta* and *Lysichiton americanus*. *Athyrium filix-femina* has a constancy of 23%, but cover never exceeds 10%. *Polystichum munitum* may be abundant on logs and stumps. Expanses of treacherously deep muck frequently occur between clumps of *Carex* and *Lysichiton*. *Sphagnum* does not occur in this association but *Eurhynchium praelongum* is common.

Mapping Rule: Small patch (<2 acres) located on hillslopes (springs) or around open water on flat floodplains, dominated by deciduous trees.

Map Class: Alder Swamp and Riparian.

References: Christy 2004.

**A.NCCN-004 (*Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata*, *Abies* spp.) / *Lysichiton americanus* Coniferous Swamp Woodland Alliance
(Western Hemlock, Sitka Spruce, Western Red-cedar, Fir species) / Yellow Skunk-cabbage Coniferous Swamp Woodland Alliance**

Local Summary: These are coastal conifer forested swamps, dominated by Sitka spruce at LEWI. Soils are seasonally flooded and saturated year-round. Slough sedge and skunk cabbage are often present. This type is present at Fort Clatsop, Fort Stevens, and Cape Disappointment.

LEWI Associations

CEGL00040 0	<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Forest
CEGL00267 0	<i>Tsuga heterophylla</i> -(<i>Thuja plicata</i> - <i>Alnus rubra</i>)/ <i>Lysichiton americanus</i> - <i>Athyrium filix-femina</i> Forest

Range-Wide Summary: Vegetation within this alliance occurs in marine-influenced regions of mountains of the coastal Pacific Northwest. Near the coast, much of the annual precipitation occurs as rain, but at higher elevations, winter snow can be substantial. Where snow occurs, it can occasionally be melted by rain during warm winter storms. These forests occur on riparian, toe slope, or valley bottom sites that are flooded for a substantial portion of the growing season. These forests are seasonally flooded by snowmelt and rains much of the winter, spring, and occasionally into early summer, and by permanent springs. The seasonal flooding originates mostly from precipitation and snowmelt collecting in basins, with a small amount of streamside flooding. The soils are organic and saturated for part of the growing season. Vegetation is characterized by a relatively open to nearly closed forest canopy (40-80%) dominated by *Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata*, and *Abies amabilis* or a mix of any of these species. *Thuja plicata* is a typical associate in these stands. *Pseudotsuga menziesii* and *Abies grandis* may also share the upper tree canopy, and the former species may grow to exceptional size. Soils are saturated year-round and are comprised of muck or peat, silts or clays with poor drainage, and gleying is often evident. Scour and active flooding from active floodplains are not the rule with these saturated woody wetlands. If they occur on floodplains, they occur around oxbow lakes, swales and other backwater/slackwater areas, and less frequently along the active streambanks. Forests are dominated by conifer species which are well-adapted to wet soil conditions and highly shade-intolerant. The forest undergrowth is usually dominated by herbaceous species only, with little shrub layer. The herbaceous layer may be well-developed, with species such as *Athyrium filix-femina*, *Equisetum hyemale*, *Galium trifidum*, *Lonicera involucrata*, *Lysichiton americanus*, *Rubus ursinus*, *Tiarella trifoliata*, and *Tolmiea menziesii*. Graminoids include *Carex obnupta*, *Carex deweyana*, *Carex unilateralis*, *Carex ovalis* (= *Carex leporina*), and *Eleocharis acicularis*. Common forbs include *Galium trifidum*, *Galium aparine*, *Ranunculus uncinatus*, *Veronica* spp., and *Geum macrophyllum*. Adjacent vegetation can be upland forests of *Quercus garryana* or wet prairie dominated by *Deschampsia caespitosa* and/or *Hordeum brachyantherum*.

Mapping Rule: These are small-patch (<2 acres) coniferous wetlands and will be difficult to see/differentiate from surrounding upland forests. They may have a more open canopy, and infrared imagery may show much more biomass in the understory visible between the trees. If occurring on flat wide floodplains, they may appear as isolated tree islands surrounding open water.

Map Class: Conifer Swamp and Riparian.

2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland
MG050 Southern Vancouverian Lowland Grassland & Shrubland

G488 Southern Vancouverian Shrub & Herbaceous Bald & Bluff Group

A. 2064 Provisional *Festuca rubra* -*Calamagrostis nutkaensis* Coastal Headland Herbaceous Alliance

Red Fescue -Nootka bentgrass Herbaceous Alliance (PROVISIONAL)

Local Summary: These are vegetated rocky headlands found along or near the coast that are dominated by grasses, most often red fescue or Pacific reedgrass. This type may host ocean-bluff bluegrass (*Poa unilateralis*), a species noted as rare by LEWI. These systems are threatened by non-native species encroachment, trampling by visitors, and loss of headlands to accretion. They are present at Cape Disappointment and Ecola.

LEWI Associations

CEGL001567	<i>Festuca rubra</i> Coastal Headland Herbaceous Vegetation
CEGL003349	<i>Calamagrostis nutkaensis</i> - <i>Elymus glaucus</i> Herbaceous Vegetation
NEW	<i>Lomatium martindalei</i> Sparse Vegetation

Range-Wide Summary: This provisional alliance occurs on coastal headlands, bluffs and open grassy balds (non-forested grassy areas). These can be on ocean bluffs, coastal headlands, tops of low hills, on crests of ridgelines or the shoulders of foothills. Elevation ranges from sea level to 1550 m (0-5100 feet). Aspect varies but is generally south or southwest. Balds are usually the consequence of a rock outcrop combined with a hot and dry exposure that is unable to support tree growth. The soils are thin, shallow and often rocky. They may be loamy, gravelly or sandy. Sites are often on very steep slopes. This open grassland vegetation is dominated by *Festuca rubra*, *Calamagrostis nutkaensis*, *Elymus glaucus*, *Festuca roemerii*, *Agrostis pallens*, and/or *Koeleria macrantha* (= *Koeleria cristata*). Low shrubs may be abundant, such as *Mahonia aquifolium*, *Lomatium martindalei*, *Gaultheria shallon* or *Empetrum nigrum*. A variety of other grasses and forbs are commonly present, including *Vulpia myuros* (= *Festuca myuros*), *Bromus* spp., *Achillea millefolium*, and *Plectritis congesta*. Moss and mosslike plants such as *Cryptogramma acrostichoides* (= *Cryptogramma crispa*), *Racomitrium canescens*, and *Selaginella wallacei* are often abundant.

Mapping Rule: Coastal headlands, or former headlands, with low herbaceous vegetation, exposed to salt spray, with thin soils.

Map Class: Herbaceous Headland.

References: Chappell 2006a, Chappell 2006b, Crawford et al. 2009

**A.2065 Provisional *Gaultheria shallon* Coastal Shrubland Alliance
Salal Shrubland Alliance (PROVISIONAL)**

Local Summary: These are vegetated rocky headlands found along the coastline, or former coastline, that are dominated by low shrubs such as salal, coastal wormwood, or black crowberry. This type may host species noted as rare by LEWI such as ocean-bluff bluegrass (*Poa unilateralis*) or coyotebrush (*Baccharis pilularis*). These systems are threatened by non-native species encroachment, trampling by visitors, and loss of headlands to accretion. They are present at Cape Disappointment and Ecola.

LEWI Associations

New	<i>Baccharis pilularis</i> - <i>Vaccinium ovatum</i> Coastal Headland Herbaceous Vegetation
CEGL000971	<i>Empetrum nigrum</i> - <i>Gaultheria shallon</i> Dwarf-Shrubland
Provisional	<i>Artemisia suksdorfii</i> Coastal Headland Shrubland
CEGL000972	<i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> / <i>Pteridium aquilinum</i> Shrubland

Range-Wide Summary: This alliance is composed of diverse coastal shrublands, including evergreen dwarf-shrubland, tall shrublands, and deciduous shrublands occurring on wind-swept coastal headlands and promontories along the southern Washington, the entire Oregon, and the northern California coasts. This community occurs as a thin band, maintained by heavy offshore winds, or by shallow soils. *Empetrum nigrum* is the primary dominant, making up 50-80% of the vegetation cover. *Gaultheria shallon* is always present, although the cover is variable and ranges from very low to almost 50%. *Vaccinium ovatum* and *Baccharis pilularis* also can be codominant. Forbs (*Maianthemum dilatatum*, *Erigeron glaucus*, *Angelica* spp., *Lathyrus* spp.) and *Calamagrostis nutkaensis*) are often found popping up through the fairly dense shrub cover. Inland, the *Empetrum nigrum* community is replaced by taller shrublands dominated by *Vaccinium ovatum* or *Baccharis pilularis*, or by forests of *Picea sitchensis* or *Pinus contorta* var. *contorta*. On the steep coastal bluffs, the community is replaced by *Festuca rubra* or forb-dominated headland communities.

Mapping Rule: Coastal headlands, or former headlands, with low shrub cover, exposed to salt spray, with thin soils.

Map Class: Herbaceous Headland.

MNEW Southern Vancouverian Lowland RUDERAL Grassland & Shrubland MacroGroup

GNEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group

A.2063 *Anthoxanthum odoratum* -*Holcus lanatus* Ruderal Coastal Grassland Alliance

Local Summary: Areas in Sunset Beach/Yeon that are dominated by non-native species such as sweet vernalgrass and velvetgrass, either as abandoned pastures, road-side verge, or other weedy places, not mowed or otherwise maintained. These were coded as map class Non-native Herbaceous.

Range-Wide Summary: Grasslands dominated by non-native perennial introduced or invasive species, abundant in waste areas and disturbed land throughout the coastal areas Pacific Northwest region.

Mapping Rule: Grasslands dominated by non-native species were identified in field reconnaissance.

Map Class: Non-native Herbaceous.

2.C.3.b Pacific North American Coast Scrub & Herb Vegetation

M058 Cool Pacific Coastal Beach, Dune & Bluff Vegetation

G498 North Pacific Maritime Coastal Sand Dune Scrub & Herb Vegetation Group

A.2066 *Poa macrantha* -*Leymus mollis* -*Festuca rubra* Sand Dune Herbaceous Alliance

Seashore bluegrass -American dunegrass -Red fescue Herbaceous Alliance

Local Summary: These are dry coastal dune communities dominated by native grasses. Examples of this type are uncommon and occur in very small patches at LEWI. Most of the dunes present at LEWI are dominated by non-native or planted graminoids including extensive plantings of American dunegrass (*Leymus mollis*) and the American and European beachgrasses (*Ammophila* spp.), and would be characterized as the previous ruderal alliance. Where historically dune vegetation would have been open and sparse in places with shifting sands, most dunes are now almost entirely covered by non-native beach grasses (*Ammophila* sp.), dramatically altering dune dynamics. These remnant, open, natural dune habitats are present at Cape Disappointment, Fort Stevens, and Sunset Beach/Yeon in small patches, all smaller than the minimum mapping unit, and thus are lumped with the GRASS DUNE map class.

LEWI Associations

CEGL001796	<i>Leymus mollis</i> Herbaceous Vegetation
CEGL003349	<i>Festuca rubra</i> Herbaceous Vegetation
NEW	<i>Festuca rubra</i> - <i>Pteridium aquilinum</i> Sparse Herbaceous Vegetation
NEW	<i>Poa macrantha</i> Sparse Herbaceous Vegetation
NEW	<i>Lupinus littoralis</i> Sparse Vegetation

Range-Wide Summary: This alliance represents upland, herbaceous coastal sand dune communities found from central Washington south to Point Reyes near San Francisco. They are restricted to coastal areas, generally within 2 km of the ocean, although some extensive dune areas such as the Oregon Dunes NRA can extend inland up to 10 km. Elevation ranges from sea level to 200 meters (0-600 feet). Aspect varies, and the dunes can move seasonally. Sand represents the substrate, ranging from low foredunes along the ocean, coastal plains, and giant, often moving dunes. In most areas, planting of European beachgrass (*Ammophila arenaria*) has stabilized areas and dramatically simplified the vegetation, as has the introduction of Scots broom, gorse, and tree lupine, all which have the capacity to dominate areas. The herbaceous areas are often open and only slightly stabilized, although the *Festuca rubra* communities can be partially stabilized. These stabilized meadows rarely persist, as they are rapidly invaded by *Arctostaphylos uva-ursi*, *Gaultheria shallon*, *Vaccinium ovatum* and other typical dune shrubs, followed by *Pinus contorta* var. *contorta*. *Fragaria chiloensis*, *Lathyrus japonicus*, *Lathyrus littoralis*, *Glehnia littoralis*, *Polygonum paronychia* and *Argentina egedii* are commonly found in this alliance. A combination of non-native sand binding plant introductions, and a significant reduction of sand input due to extensive dams on major rivers, has altered natural conditions and threatened most examples of this alliance. Large remnants of the natural systems are found at the Oregon Dunes NRA and in Arcata, California.

Mapping Rule: Grass-dominated areas on sandy soils along the coast characterized by native species and areas of open sand with minimal shrub cover.

Map Class: Grass Dune.

References: Chappell 2006a, Chappell 2006b, Crawford et al. 2009

**A.NCCN-NEW3 North Pacific (*Pinus contorta* var. *contorta* - *Picea sitchensis* - *Gaultheria shallon* - *Vaccinium ovatum* -) Stabilized Dune Shrubland
North Pacific (Shore pine -Sitka Spruce -Salal -Evergreen Huckleberry)
Stabilized Dune Shrubland**

Local Summary: This is a provisional alliance, representing a relatively common but unnatural situation featuring native and introduced small-stature trees and/or shrubs on sand. Shorepine or Sitka spruce in this system remains stunted due to poor soils and coastal winds. Beachgrass, dunegrass, or slough sedge also may be abundant. This type is found at Cape Disappointment, Fort Stevens, Sunset Beach/Yeon, and Ecola.

LEWI Associations

NEW	(<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i> - <i>Salix hookeriana</i> - <i>Malus fusca</i>) Stabilized Dune Shrubland
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Range-Wide Summary: This alliance encompasses a variety of shrub and tree species that colonize accretion zones along the Pacific Coast. These areas are often created behind jetties from deposited sand, or occasionally behind foredunes created by introduced European beachgrass. These are early successional vegetation communities due to the new land surface, and are composed of a mix of surrounding vegetation types and species. Cover can be sparse to fairly dense. Tree species may or may not be present and are often short of stature (less than 3 m) due to sandy soils and exposure to strong coastal winds.

In the Pacific Northwest common tree and shrub species include *Pinus contorta* var. *contorta*, *Picea sitchensis*, *Salix hookeriana*, *Vaccinium ovatum*, and *Malus fusca*. *Carex obnupta* is a common component; *Ammophila* spp. may be abundant at sites closer to the ocean. This alliance is very similar to the North Pacific (*Pinus contorta* var. *contorta* -*Picea sitchensis*) Stabilized Dune Forest, but differs in having fewer trees of shorter height, fewer shrub species present, and a higher cover of graminoids. Where Scots broom has formed dense thickets, or is mixed with pine and spruce, or forms monocultures in some areas if it becomes established before native vegetation, these are include in the **A. NEW Provisional North Pacific Sand Dune Ruderal Shrubland and Dwarf Tree Alliance**, within the GNEW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group.

Mapping Rule: These are low-stature shrublands or stunted woodlands below three meters tall found within 1 km of the ocean on sandy soils. Areas dotted or dominated by Scots broom are mapped within this class.

Map Class: Shrub Dune.

MG0NEW North Pacific Coastal Ruderal Grassland & Shrubland Vegetation

GNEW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group

A. 2061 *Ammophila arenaria* - Planted *Leymus mollis* ssp. *mollis* Coastal Dunegrass Ruderal Grassland Alliance

Local Summary: This is a provisional alliance. This type represents areas of introduced species such as near-monoculture of *Ammophila arenaria* (European beachgrass) present throughout the park. Both *A. arenaria* and *A. breviligulata* (American beachgrass, native to the east coast of the US) have been introduced to the Pacific coast for dune stabilization, significantly altering dune dynamics and vegetation types. The native west coast dunegrass (*Leymus mollis*) has also been intentionally planted for dune stabilization, creating a second modified high cover, near-monoculture dune type

often located just inland from the beachgrass dune types. Some native species are still present within these dune systems. This type is found at Cape Disappointment, Fort Stevens, Ecola, and Sunset Beach/Yeon. See the Seashore bluegrass -American dunegrass -Red fescue Herbaceous Alliance section for discussion of the natural types that may be interspersed within these introduced dune grasslands.

LEWI Associations

CEGL003373	<i>Ammophila arenaria</i> - <i>Cardionema ramosissimum</i> Herbaceous Vegetation
CEGL003006	<i>Ammophila arenaria</i> Semi-natural Herbaceous Vegetation
NEW	<i>Leymus mollis</i> ssp. <i>mollis</i> Ruderal (Restoration) Herbaceous Vegetation

Range-Wide Summary: Dune systems modified by the introduction of non-native beachgrasses (*Ammophila arenaria* and *Ammophila breviligulata*) or over planting of native dunegrass (*Leymus mollis* ssp. *mollis*). These modified, high-cover, near-monoculture dunes create taller dunes due to reduced sand movement. Native species may be interspersed in these types in small amounts and include *Lathyrus japonicus*, *Lathyrus littoralis*, *Heracleum maximum* (= *Heracleum lanatum*), *Vicia americana*, *Vicia nigricans* ssp. *gigantea*, and *Achillea millefolium*. Other non-native species include *Holcus lanatus*, *Senecio jacobaea*, *Daucus carota*, and *Sonchus asper*.

Mapping Rule: Large patch, beachgrass dominated dunes within 1 km of the coast.

Map Class: Grass Dune.

References: Faber-Langendoen et al. 2011.

A.2062 *Cytisus scoparius* - *Ulex europaeus* - *Lupinus arboreus* Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance

Local Summary: This is a provisional alliance. This type represents areas of introduced shrub species on stabilized dunes. At LEWI the primary non-native and invasive shrub species is scotch broom (*Cytisus scoparius*), often occurring with an invasive grass understory of *Ammophila arenaria* (European beachgrass). These areas can be dense shrublands totally comprised of one or more of these species, or they can be more open grassland -shrubland mosaics. This type, dominated primarily by scotch broom, is found primarily at Fort Stevens and Sunset Beach/Yeon, with small patches present at Cape Disappointment and Ecola.

LEWI Associations

NEW	<i>Cytisus scoparius</i> ruderal Shrubland
NEW	<i>Lupinus arboreus</i> ruderal Shrubland
NEW	<i>Ulex europaeus</i> ruderal Shrubland

Range-Wide Summary: Dune systems modified by the introduction of non-native beachgrasses (*Ammophila arenaria* and *Ammophila breviligulata*) are often rapidly invaded by introduced invasive shrubs. Non-native and invasive shrub species in this alliance include scotch broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), and yellow bush lupine (*Lupinus arboreus*, native to central California but introduced and invasive in northern California, central Oregon and north), which usually dominate these areas, often with an invasive grass understory of *Ammophila arenaria* (European beachgrass). This type represents areas of introduced shrub species on stabilized dunes found along the Pacific coast from British Columbia to northern California.

Mapping Rule: Large patch, beachgrass dominated dunes within 1 km of the coast.

Map Class: Shrub Dune.

References: Faber-Langendoen et al. 2011.

2.C.5.b Western North American Freshwater Wet Meadow & Marsh

MG073 Western North American Lowland Freshwater Wet Meadow, Marsh & Shrubland

G322 Vancouverian Lowland Riparian & Wet Slope Shrubland Group

A.NCCN-999 *Salix hookeriana* Seasonally Flooded Shrubland Alliance

Hooker's Willow Seasonally Flooded Shrubland Alliance

Local Summary: This is a seasonally flooded shrubland alliance found in deflation planes and wetter areas within 3 km of saltwater. They can be small areas within small wet depressions in deflation planes or large saturated areas surrounding ponds and lakes. Hooker's willow is the dominant shrub and the indicator for this type. Small amounts of red alder, Oregon crab apple, and California wax myrtle are often present. This type is found in all the LEWI units.

LEWI Associations

CEGL003432	<i>Salix hookeriana</i> - (<i>Malus fusca</i>) / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> shrubland
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Range-Wide Summary: Communities within this cold-deciduous, seasonally flooded shrubland alliance seldom occur more than 3 km from saltwater, often in stabilized dunes just behind the open beach. They are limited to the wetter areas where water stands to some extent during the year on deflation (wind erosion) plains and swales. These associations are found in habitats that are seasonally flooded and saturated with freshwater. Information on soils was not available. They are dominated by *Salix hookeriana*. Other codominant shrubs can include *Populus balsamifera*, *Populus fremontii*, and *Alnus rubra*. The understory is sparse but can include *Rubus ursinus*, *Baccharis pilularis*, and *Morella californica* (= *Myrica californica*). Adjacent upslope

communities typically are dominated by *Picea sitchensis* with *Cornus sericea* in the understory. This alliance is limited to the western coast from southern British Columbia, Canada, to northern California.

Mapping Rule: These are wet, seasonally flooded shrublands dominated by Hooker's willow, usually located within 3 km of the ocean.

Map Class: Willow Swamp.

References: Chappell et al. 1997, Christy et al. 1998, Sawyer and Keeler-Wolf 1995, Wiedemann 1984.

A. 2068 *Salix* spp. -*Malus fusca* - *Spiraea* spp. Lowland Riparian & Wet Slope Shrubland Alliance

Willow -Crabapple-Spiraea Lowland Riparian & Wet Slope Shrubland Alliance

Local Summary: This provisional alliance is under review. These open willow or crab apple shrublands with dominant slough sedge herb layer are found in wet dune areas of Cape Disappointment and Fort Stevens. They are often found within a matrix of the provisional North Pacific (Shore Pine, Sitka Spruce) Stabilized Dune Forest and North Pacific (Shore pine -Sitka Spruce -Salal -Evergreen Huckleberry -Scots Broom) Stabilized Dune Shrubland types.

LEWI Associations

CEGL003294	<i>Malus fusca</i> - (<i>Salix hookeriana</i>) / <i>Carex obnupta</i> Shrubland
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Range-Wide Summary: This association occurs in depressions in both deciduous and coniferous forests. All trees are peripheral to the wetlands. Depending on hydroperiod, the understory ranges from nearly 100% cover of *Carex obnupta* to very low cover of any other vegetation because of prolonged seasonal ponding. The association may have been more widespread historically, as large expanses of swamp vegetation once occurred in the northern Willamette and Tualatin valleys. These wetlands have not been sampled adequately.

Mapping Rule: Shrublands dominated by Hooker's willow or Oregon crab apple with open canopy and thick slough sedge herb layer in wet dune areas.

Map Class: Willow Swamp.

References: Christy 2004.

**A.NCCN-997 *Spiraea douglasii* Seasonally Flooded Shrubland Alliance
Douglas' Meadowsweet Seasonally Flooded Shrubland Alliance**

Local Summary: These seasonally flooded wetlands are dominated by rose spiraea and are found in deflation planes and around ponds and lakes. The Hooker's willow type is more common at LEWI, but there are patches of spiraea shrubland at Cape Disappointment, Fort Stevens, Sunset Beach/Yeon and Middle Village/Station Camp. Many patches are below the minimal mapping unit. Because of this and the similarity to the Hooker's willow mapping characteristics, this type was lumped with the Willow Swamp map class.

LEWI Associations

CEGL001129	<i>Spiraea douglasii</i> Shrubland
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Range-Wide Summary: Vegetation in this seasonally flooded shrubland occurs widely in the Pacific Northwest, from British Columbia south to California, and east to Montana. Stands are located along seasonally flooded stream terraces and lake shores. The dense, short-shrub layer that is dominated by *Spiraea douglasii*. Other shrub species generally have sparse cover. Soils are saturated in the early growing season but dry out by late summer. Soils range from fine sand to silty clay. In coastal areas, occasional individuals of *Salix hookeriana* or *Sambucus racemosa* can be found. In Washington and Oregon common shrubs may include *Alnus incana*, *Crataegus douglasii*, *Rubus ursinus*, *Rubus lasiococcus*, *Salix* spp., *Symphoricarpos albus*, *Vaccinium caespitosum*, and *Vaccinium uliginosum*. The herbaceous layer is sparse to dense. If dense, it is likely dominated by perennial graminoids such as *Agrostis humilis* (= *Agrostis thurberiana*), *Calamagrostis canadensis*, *Carex* spp., and *Phalaris arundinacea*. Other herbaceous species may include *Heracleum maximum* (= *Heracleum lanatum*), *Ligusticum grayi*, *Mertensia* spp., *Parnassia fimbriata*, *Comarum palustre* (= *Potentilla palustris*), *Senecio triangularis*, and *Trifolium longipes*. Adjacent stands include herbaceous wetlands dominated by *Phalaris arundinacea* or *Carex* spp., riparian forests, and other riparian shrublands.

Mapping Rule: Low elevation wetlands dominated by *Spiraea douglasii*, in dune wetlands or around ponds and lakes.

Map Class: Willow Swamp.

References: Boggs et al. 1990, Chappell et al. 1997, Christy et al. 1998, Hansen et al. 1995, Hemstrom et al. 1987, Kovalchik 1987, Kovalchik 1993.

G518 Western North American Temperate Interior Freshwater Marsh Group

**A.NCCN-NEW4 *Typha (angustifolia, latifolia)* Freshwater Marsh Alliance
Broad or Narrow Cattail Freshwater Marsh Alliance**

Local Summary: This is a provisional alliance. Cattail marshes were grouped with other freshwater marsh types in the LEWI map classification. However, large areas are present in Cape Disappointment and Fort Clatsop.

LEWI Associations

CEGL002010	<i>Typha (latifolia, angustifolia)</i> Western Herbaceous Vegetation
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Range-Wide Summary: This association is widespread across the western United States and western Great Plains occurring near streams, rivers, and ponds. The soil is flooded or saturated for at least part of the growing season. The alluvial soils have variable textures ranging from sand to clay and usually with a high organic content. The dominant species, *Typha latifolia* or *Typha angustifolia*, often form dense, almost monotypic stands. Other species typical of wetlands may be found in lesser amounts in this community; among these are shallower water emergents such as *Carex* spp., *Eleocharis macrostachya*, *Eleocharis palustris*, *Glyceria* spp., *Juncus balticus*, *Juncus torreyi*, *Mentha arvensis*, *Schoenoplectus acutus*, and *Veronica* spp. In deeper water, *Lemna minor*, *Potamogeton* spp., *Sagittaria* spp., *Azolla filiculoides*, and other aquatics may be present in trace amounts. This community is a common element found in many wetland systems, but has received little attention. Consequently, the diagnostic features and species of this community are not well known. Many ecologists (Hansen et al. 1995, Kittel et al. 1999) have included *Typha angustifolia* as a codominant in this association. More classification work is needed to clarify the concept of this association.

Mapping Rule: Freshwater marshlands dominated by cattail species.

Map Class: Non-Tidal Freshwater Marsh.

References: Christy 2004, Hansen et al. 1995, Kittel et al. 1999b.

**A.1433 *Schoenoplectus acutus (Schoenoplectus pungens)* Semi-Permanently Flooded Herbaceous Alliance
Bulrush Semi-Permanently Flooded Herbaceous Alliance**

Local Summary: Small patches of these bulrush marshes are present along the Lewis and Clark River at Fort Clatsop.

LEWI Associations

CEGL001840	<i>Schoenoplectus acutus</i> Herbaceous Vegetation
CWWA000146	<i>Schoenoplectus pungens</i> Herbaceous Vegetation (Pacific estuarine, provisional)

Range-Wide Summary: This association is a common emergent herbaceous wetland found mostly in the interior western U.S. ranging from the Puget Sound of Washington to Montana south to California, Nevada and Utah. Stands occur along low-gradient, meandering, usually perennial streams, river floodplain basins, and around the margins of ponds and shallow lakes especially in backwater areas. Some sites are flooded most of the year with about 1 m of fresh to somewhat saline or alkaline water. Other sites, however, dry up enough in late summer to where the water table drops below the ground surface, though the soils are still partially saturated. Soils are generally deep, organic, alkaline, poorly drained and fine-textured, but range in soil textures from sand to clay to organic muck. The soils may be normal or saline. Vegetation is characterized by a dense tall herbaceous vegetation layer 1-3 m tall that is dominated by *Schoenoplectus acutus* (= *Scirpus acutus*), often occurring as a near monoculture. Associated species include low cover of *Mentha arvensis*, *Polygonum amphibium*, *Sagittaria latifolia*, and species of *Carex*, *Eleocharis*, *Rumex*, and *Typha*. Early in the growing season or at permanently flooded sites, aquatic species such as *Potamogeton* spp. and *Lemna minor* may be present to abundant. Stands of this association contain no tree or shrub layer, but a few sites have been invaded by the introduced shrub *Tamarix* spp. Additional research is needed to determine if the different hydrological regimes indicate a need to split out new associations.

Mapping Rule: Marshes with an influx of both tidal saltwater and freshwater dominated by bulrush. All occurrences of this alliance at LEWI were below the minimum mapping unit.

Map Class: Tidal Fresh-Brackish Marsh.

**A.2598 *Sparganium eurycarpum* Hydromorphic Rooted Herbaceous Vegetation
Giant Bur-reed Hydromorphic Rooted Herbaceous Vegetation**

Local Summary: Areas of shallow lakes, ponds, and sloughs dominated by narrowleaf bur-reed (or the European bur-reed *Sparganium emersum*, also present and in some places more common in the park). Patches are smaller than the minimal mapping unit. Found in Cape Disappointment, Fort Stevens, and Fort Clatsop.

LEWI Associations

CEGL001990	<i>Sparganium angustifolium</i> Herbaceous Vegetation
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Range-Wide Summary: This aquatic association has been found in California, Oregon, Washington and Colorado. It likely also occurs in many other montane, subalpine, alpine and boreal parts of North America, as this circumboreal species is reported from

all over the northern half of North America. This hydromorphic-rooted vegetation occurs in shallow water to 1 m deep. Stands occur in saturated or inundated sites such as swales and wet meadows and marshes, shallow ponds and near the shoreline of deeper ponds and lakes. Sites are generally permanently flooded but can be semi-permanently flooded areas that lack standing water towards the end of the growing season. If the stand has dried, then bare soil and small rocks are exposed. The ponds are often located in mountain parks or meadows and are the result of stream oxbows or glacial basins in broad valleys. Soils are typically very poorly drained muck or peat and can contain embedded cobbles or rocks. Stands grow equally well on either gravelly or muddy bottoms. Salinity of water varies with the different parent materials. Diagnostic of this aquatic community is the strong dominance of *Sparganium angustifolium*. Vegetation consists of moderately dense mats of the hydromorphic-rooted plant *Sparganium angustifolium*. These vegetation mats are rarely over 0.6 m thick and may be much less depending on the depth of the pond. Stunted individuals may be less than 10 cm tall. Associated species with low cover include *Alisma triviale*, *Beckmannia syzigachne*, *Carex utriculata*, *Cicuta douglasii*, *Eleocharis palustris*, *Equisetum fluviatile*, *Galium trifidum*, *Glyceria borealis*, *Hippuris vulgaris*, *Lemna minor*, *Sium suave*, or *Typha* spp. Diagnostic of this aquatic association is the dominance of *Sparganium angustifolium*.

Mapping Rule: Lowland freshwater lakes, ponds, and sloughs dominated by narrowleaf or European bur-reed. Below minimal mapping unit.

Map Class: Non-Tidal Freshwater Marsh.

References: Christy 2004, Faber-Langendoen et al. 2011, NatureServe 2011.

G517 Vancouverian Freshwater Coastal Marsh & Meadow Group

A.1412 *Carex aquatilis* var. *dives* Semi-permanently Flooded Herbaceous Alliance

Sitka sedge Semi-permanently Flooded Herbaceous Alliance

Local Summary: Freshwater marshes or swamps characterized by Sitka sedge. This type is known from one small area at the north end of O’Neil Lake in Cape Disappointment (Sayce & Eid 2004).

LEWI Associations

CEGL001826	<i>Carex aquatilis</i> var. <i>dives</i> Herbaceous Vegetation
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Range-Wide Summary: Habitat is usually montane fens. However along the coast it forms freshwater marshes without deep (>40 cm) peat accumulation. The association is widespread and important in the Cascade Range and, like *Carex aquatilis* Herbaceous Vegetation (CEGL001802), includes a heterogeneous mix of species that do not segregate in any meaningful way. Trees and shrubs are scarce, although many different species are present. The herb layer is astonishingly diverse with more than 120 species

recorded, but most of these have relatively low constancy and reflect the patchy distribution of many different taxa. *Carex aquatilis* var. *dives* is the primary species, averaging 54% cover, and many stands occur as monotypic reed swamp with cover ranging from 5 to 99%. Some of these stands intergrade with *Carex utriculata* Herbaceous Vegetation (CEGL001562) in seasonally flooded depressions. *Dodecatheon jeffreyi*, *Carex utriculata*, and *Hypericum anagalloides* are the only other species with constancy higher than 20%. Species with significant patches include *Caltha leptosepala* ssp. *howellii*, *Eleocharis quinqueflora*, *Equisetum fluviatile*, *Viola macloskeyi*, *Cicuta douglasii*, and *Agrostis humilis* (= *Agrostis thurberiana*). Stands may occur on old beaver terraces on seepage slopes and also in sag ponds on slopes prone to slumping. *Carex aquatilis* var. *dives* can intermix with forest ecotone or meadow taxa as long as enough soil moisture is present. Plants become progressively dwarfed as conditions become drier.

Mapping Rule: Freshwater marshes or swamps characterized by Sitka sedge. Below minimum mapping unit.

Map Class: Non-Tidal Freshwater Marsh.

References: Christy 2004.

A.2582 *Carex obnupta* Seasonally Flooded Herbaceous Alliance
Slough sedge Seasonally Flooded Herbaceous Alliance

Local Summary: These are freshwater marshes dominated by slough sedge with few other species present. Slough sedge can be up to six feet tall. Pacific silverweed, skunk cabbage, rose, and spiraea are occasionally present. It is often found within a mosaic of red alder woodlands or Hooker’s willow shrublands, or in wet areas of dunes. This type is common at Cape Disappointment and Fort Stevens, and patches are present at Fort Clatsop and Sunset Beach/Yeon.

LEWI Associations

CEGL001820	<i>Carex obnupta</i> - <i>Argentina egedii</i> Herbaceous Vegetation
CEGL003313	<i>Carex obnupta</i> Herbaceous Vegetation

Range-Wide Summary: These are small patch, widespread and very distinct wetlands that occur in poorly drained depressions adjacent to streams, lakes and ponds along the coast and throughout the Oregon and Washington Coast Ranges. This type is flooded seasonally, and saturated in the summer by water just below the ground surface. The hydrology is often mediated by beaver dams. These stands typically have enormous *Carex obnupta* plants growing in deep, perennially-wet muck soils, often with little other vegetation present. *Spiraea douglasii* is occasionally found, and it can be co-dominant with *Argentina egedii* or *Lysichiton americanus*. The slough sedge can range from 3-6 feet tall, often with 80-95% cover, with individual plants forming tussocks up to 6 feet in diameter, though plants can be shorter (1-3 ft). The herb layer is sparse, averaging 5%

or less, except in the *Argentina* or *Lysichiton* communities, with *Athyrium filix-femina* or *Galium* species occasionally found. Trees are mostly peripheral. *Alnus rubra* and *Fraxinus latifolia* are the primary species but have low constancy and cover.

Mapping Rule: Slough sedge dominated marshes saturated or seasonally flooded by freshwater, but without saltwater influence.

Map Class: Non-Tidal Freshwater Marsh.

References: Christy et al. 1998, Hansen et al. 1995, Hemstrom et al. 1987.

A.1375 *Juncus effusus* Semi-Natural Seasonally Flooded Alliance
Lamp rush Semi-Natural Seasonally Flooded Alliance

Local Summary: This type represents meadows or former pastures where *Juncus effusus* is dominant. Large tufts of lamp rush characterize these marshes. Two subspecies are present in the park: the native *J. effusus* ssp. *pacificus* and the non-native *J. effusus* ssp. *effusus*. In areas that were exposed to grazing pressure, as in the South Slough area of Fort Clatsop, the non-native subspecies is dominant.

LEWI Associations

CEGL003317	<i>Juncus effusus</i> var. <i>brunneus</i> Pacific Coast Herbaceous Vegetation
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Range-Wide Summary: Habitat is meadows, fens, and old pastures. This association is generally thought of as a disturbance type resulting from grazing, but some occurrences suggest that it is native in some places because they are unlikely to have ever been heavily grazed. It is widespread at a variety of elevations but is especially abundant at low elevations in western Oregon. Known plots are from the Coast Range and Cascade Range. Trees are nearly absent but may include *Alnus rubra*, *Fraxinus latifolia*, *Quercus garryana*, or conifers peripheral to the wetland. Eight shrub species are recorded, with *Salix sitchensis* being most abundant, but their cover is negligible. The herb layer includes about 60 different species, with *Juncus effusus* being most abundant with an average cover of 52% and ranging from 20 to 85%. *Juncus ensifolius* (= *Juncus xiphioides* var. *triandrus*) is a consistent associate but has very low cover, while *Hypericum anagalloides* is much more abundant but present with slightly lower constancy. Other species occurring in significant patches include *Scirpus microcarpus*, *Equisetum arvense*, *Oenanthe sarmentosa*, and *Athyrium filix-femina*, and five species are non-natives. Old pastures at low elevations may also have large amounts of *Ranunculus repens*, but this species was not recorded in NCCN plots.

Mapping Rule: Present on lowland, seasonally flooded marshes.

Map Class: Lawn and Pasture

References: Christy 2004, Zika 2003.

G523 Western North American Temperate Maritime Lowland Wet Meadow & Seep Herbaceous Group

**A.1342 *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance
Common Spikerush Seasonally Flooded Herbaceous Alliance**

Local Summary: Alliances in this group are under review. These spikerush marshes are found in small patches throughout LEWI along freshwater streams, ponds, and wet depressions. They are below the minimal mapping unit.

LEWI Associations

CEGL001833	<i>Eleocharis palustris</i> Herbaceous Vegetation
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Range-Wide Summary: This spikerush wet meadow community is found in the central Great Plains of the United States and Canada and in the western United States. Elevations range from near sea level to 3050 m (0-10,000 feet). Stands occur in small depressions in intermittent streambeds or depression ponds that flood early in the season and may dry out by summer. Most stands are seasonally to permanently flooded. Soils are generally fine-textured. Stands are composed of submersed and emergent rooted vegetation less than 1 m tall that is dominated by *Eleocharis palustris*, often in nearly pure stands. Vegetative cover can be sparse to dense (10-90%), but *Eleocharis palustris* is the dominant species, and the only species with 100% constancy. Other species, when present, can contribute as much as 40% cover, but never exceed that of the *Eleocharis palustris* cover. Co-occurring species in low-elevation stands on the western slope can include *Phalaris arundinacea* (= *Phalaroides arundinacea*), *Juncus balticus*, *Hordeum jubatum*, *Equisetum* spp., *Pascopyrum smithii*, *Schoenoplectus americanus* (= *Scirpus americanus*), *Sparganium angustifolium*, species of *Lemna* and *Potamogeton*, as well as the introduced *Melilotus officinalis* and *Bromus inermis*.

Mapping Rule: Lowland wet meadows, streambeds, or ponds dominated by common spikerush. At LEWI, all sites were below minimal mapping unit.

Map Class: Non-Tidal Freshwater Marsh.

References: Faber-Langendoen et al. 2011, NatureServe 2011.

2.C.6.c - Temperate & Boreal Pacific Coastal Salt Marsh

MG081 North American Pacific Coastal Salt Marsh

G499 Temperate Pacific Tidal Salt & Brackish Marsh Group

A.2622 *Carex lyngbyei* Tidal Herbaceous Alliance

Lyngbye's Sedge Herbaceous Vegetation

Local Summary: All of the alliances in this group are under review. Several types of salt marsh are present at LEWI but almost all of them are in patches smaller than the minimal mapping unit. Because of their small size and the difficulty distinguishing the dominant species using the imagery alliances within this group were merged into a single salt marsh map class. Salt marshes are present at Cape Disappointment, Fort Stevens, and Fort Clatsop with Fort Stevens having the largest areas.

LEWI Associations

CEGL003285	<i>Carex lyngbyei</i> - (<i>Distichlis spicata</i> , <i>Triglochin maritima</i>) Herbaceous Vegetation
CEGL003289	<i>Carex lyngbyei</i> - <i>Argentina egedii</i> Herbaceous Vegetation
CEGL003369	<i>Carex lyngbyei</i> Herbaceous Vegetation

Range-Wide Summary: This group consists of the intertidal salt marshes and brackish marshes found throughout the North American Pacific Coast, from Kodiak Island and south-central Alaska, south along the coast throughout British Columbia, Washington, Oregon, California, Baja California and the Sonoran coast along the Gulf of California, including coastal marshes along the Colorado River Delta and other river deltas such as the Rio Yaqui. Primarily associated with estuaries or coastal lagoons, salt marshes are limited to bays, behind sand spits or other locations protected from wave action. Vegetation ranges from very dense thickets to open and sparse. Dominant plant species change from north to south, but communities have many species in common which include *Batis maritima*, *Carex lyngbyei*, *Carex ramenskii*, *Cochlearia groenlandica* (= *Cochlearia officinalis*), *Distichlis spicata*, *Eleocharis palustris*, *Glaux maritima*, *Jaumea carnosa*, *Limonium californicum*, *Monanthochloe littoralis*, *Hippuris tetraphylla*, *Honckenya peploides*, *Plantago maritima*, *Puccinellia* spp., *Salicornia virginica*, *Salicornia* spp., *Spergularia canadensis*, *Suaeda* spp., *Triglochin maritima*, and/or *Triglochin* spp.

Mapping Rule: These are graminoid-dominated marshes with regular salt water inundation and little freshwater influence.

Map Class: Salt Marsh.

References: Faber-Langendoen et al. 2011.

A.2618 *Salicornia virginica* Tidal Herbaceous Alliance
Virginia Glasswort Tidal Herbaceous Alliance

Local Summary: Tidal salt marshes dominated by Virginia glasswort. A large area is present in Fort Stevens. This constitutes a rare type in the Pacific Northwest. Associations within this alliance are under review and may be combined in the future; therefore it is not certain which association listed below would best describe the Fort Stevens marsh. *Distichlis spicata* and *Jaumea carnosa* are both present at Fort Stevens, with *Jaumea* being a common codominant in areas less frequently submerged by the tide.

LEWI Associations

CEGL003466	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Jaumea carnosa</i> Tidal Herbaceous Vegetation
CEGL003380	<i>Salicornia virginica</i> Herbaceous Vegetation
CEGL003366	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Triglochin maritima</i> - (<i>Jaumea carnosa</i>) Herbaceous Vegetation

Range-Wide Summary: These high salinity wetlands occur on flat to gently sloped ground at low elevations between 0 and 6 m in tidal marshes. Characterized at Suisun Marsh in California by the codominance of *Salicornia virginica* and *Distichlis spicata* with either species having greater than or equal to 30% relative cover. All plots had small numbers of *Jaumea carnosa* and *Triglochin maritima*. It is suspected that this is the same association as is currently defined herein. The only difference appears to be the higher cover of *Distichlis* that is reported from Suisun Marsh. Another association defined from Suisun Marsh was called the *Salicornia* / *Distichlis* association and was characterized by strong dominance of *Salicornia* with *Distichlis* ranging from 4-20% cover. Most plots of this type contained some non-native species and were found in managed wetlands. None of those plots had any *Jaumea carnosa* plants.

Mapping Rule: Tidal marshes dominated by Virginia glasswort.

Map Class: Salt Marsh.

References: Keeler-Wolf et al. 2000.

A.2623 *Deschampsia caespitosa* Tidal Herbaceous Alliance
Tufted hairgrass Tidal Herbaceous Alliance

Local Summary: The alliances in this group are also under review. These marshes are often adjacent to salt marshes, but are slightly higher in elevation further inland, or otherwise separated from regular inundation by salt water. They receive a mix of salt and fresh water. These marshes are present in Cape Disappointment, Fort Stevens, Middle Village/Station Camp, and Fort Clatsop.

LEWI Associations

CEGL003383	<i>Deschampsia caespitosa</i> - <i>Argentina egedii</i> Herbaceous Vegetation
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Range-Wide Summary: This alliance is often classified as a high marsh, because it experiences less saltwater influence than the other salt march alliances in this group, due to slightly higher elevation zones that flood less frequently. These marshes form when there is a freshwater source that mixes with coastal ocean saltwater. Occurrences can be small or large patch, and individual associations are confined to specific environments defined by ranges of salinity, tidal inundation regime, and soil texture. These marshes are dominated by medium-tall graminoids and low forbs, especially *Argentina egedii*, *Deschampsia caespitosa*, *Festuca rubra*, *Juncus balticus*, *Poa eminens* and *Symphotrichum subspicatum* (= *Aster subspicatus*). Slightly brackish marshes are often dominated by *Atriplex prostrata* (= *Atriplex triangularis*), *Cordylanthus* spp., *Juncus mexicanus*, *Lilaeopsis masonii*, *Phragmites* spp., *Schoenoplectus acutus*, and *Typha* spp. The invasive species *Lepidium latifolium* is a problem in many of these marshes.

Mapping Rule: Graminoid-dominated marshes with tidal influence but without regular salt water inundation and with greater freshwater influence.

Map Class: Tidal Fresh-Brackish Marsh

References: Faber-Langendoen et al. 2011.

5.A.1.e Temperate Seagrass Aquatic Vegetation

MG184 Temperate Pacific Seagrass Vegetation

G373 Temperate Pacific Seagrass Group

A.NCCN-NEW6 *Zostera* spp. Permanently Flooded - Tidal Herbaceous Alliance Eelgrass/Seawrack Permanently Flooded -Tidal Herbaceous Alliance

Local Summary: As is the case with other Pacific coast saltmarsh and estuarine alliances, all alliances in this group are under review. Sub-tidal surveys were not completed for this project, but the native seawrack, *Zostera marina*, is known to be present at Ecola and Fort Stevens (Hinton & Emmett 2000). This group was not mapped.

LEWI Associations

NEW	<i>Nanozostera japonica</i> / <i>Zostera</i> Tidally Flooded Wetland
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Range-Wide Summary: These aquatic beds occur in the subtidal zone along coastlines.

Mapping Rule: Tidal eelgrass or seawrack beds below tide line.

Map Class: None.

5.B.1.a North American Freshwater Aquatic Vegetation

MG109 Western North American Freshwater Aquatic Vegetation

G544 Western North American Temperate Freshwater Aquatic Bed Group

A.NCCN-NEW5 *Nuphar* spp. - *Potamogeton* spp. - *Lemna* spp. Freshwater Aquatic Alliance

Spatterdock -Pondweed -Duckweed Freshwater Aquatic Alliance

Local Summary: Alliances in this group are under review. Many of these sites at LEWI are smaller than the minimal mapping unit. These freshwater aquatic bed types were subsumed into the nontidal freshwater marsh map class. They occur in all LEWI units in lagoons, lakes, ponds, and slow-moving waters. The Mexican mosquitofern (*Azolla mexicana*) type is present at Fort Stevens. The floating marsh-pennywort (*Hydrocotyle ranunculoides*) association is found at Middle Village/Station Camp; the species is present in several units in smaller numbers. Coontail is common in the lakes at Fort Stevens and Cape Disappointment.

LEWI Associations

CEGL003017	<i>Azolla (filiculoides, mexicana)</i> Herbaceous Vegetation
CEGL004017	<i>Ceratophyllum demersum</i> Western Herbaceous Vegetation [Provisional]
CEGL003305	<i>Lemna minor</i> Herbaceous Vegetation
CEGL002001	<i>Nuphar polysepala</i> Herbaceous Vegetation
CEGL002925	<i>Potamogeton natans</i> Herbaceous Vegetation
NEW	<i>Hydrocotyle ranunculoides</i> Herbaceous Vegetation

Range-Wide Summary: These freshwater aquatic beds occur at low to mid elevations in permanently flooded ponds and lakes, though water levels may vary substantially throughout the year. Soils are organic and mucky.

Mapping Rule: These are beds of floating vegetation in lakes, ponds, slow-moving waters.

Map Class: Non-tidal Freshwater Marsh.

References: Christy 2004.

6.B.2.b Western North American Temperate Cliff, Scree & Rock Vegetation

MG114 Vancouverian Cliff, Scree & Rock Vegetation

G322 Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group

Local Summary: Alliances in this group have not been classified. This type is found in fairly large areas at both Ecola and Cape Disappointment Parks, as well as in small patches at Dismal Nitch and Middle Village/Station Camp, and the large patches were manually mapped. While being quite noticeable from the ground, because these areas are so vertical, none of the areas come close the minimum mapping unit. Along the coast, these can be either barren, forb dominated, or have occasional shrubs or trees. Determining cover for these areas can be difficult.

Range-Wide Summary: Near-vertical rocky cliff-sides, may be barren, with forb cover, or with scattered shrubs or short trees, often adjacent to the ocean but may include former headlands and rocky hillsides. These were hand-mapped from imagery where evident, as the vertical nature makes programmatic mapping from imagery difficult.

Mapping Rule: These are generally small, open, steep rocky areas < 2 acres along the shoreline that may or may not be vegetated. Adjacent alliances include *Alnus rubra* - (*Picea sitchensis*, *Tsuga heterophylla*) Forest and Woodland Alliance and *Alnus rubra* Forest and *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance along the tops of the cliffs.

Map Class: Cliff.

References: Faber-Langendoen et al. 2011.

8.1. Developed Herbaceous & Woody Vegetation

MG491 Temperate and Tropical Lawn Macrogroup

G622 Cool Season, Warm Season, Dry Season Lawn Group

A.New Temperate Mowed Lawns Alliance

MG492 Temperate & Tropical Planted Landscaping & Garden MacroGroup

G623 Treed Landscaping

A.New Temperate Planted Trees/Gardens

Local Summary: This type includes all landscaped vegetation within the Park, including mowed lawns, treed landscaping, and areas along roads or parking lots that are mowed. This type is present in all the park units, with the largest concentrations being at Fort Stevens (around historical buildings, campgrounds, and parking areas). Lawns and

landscaped areas were coded as LAWN AND PASTURE. Where campgrounds were found within forested, semi-natural areas and not visible under the canopy of native trees, these were mapped as their natural alliance rather than these modified types. Visible campsites were mapped in this class.

Range-Wide Summary: Human maintained landscape vegetation, this includes mowed lawns, planted trees and shrubs that may or may not be irrigated. Generally these are in very close proximity to buildings, parking lots, and other facilities.

Mapping Rule: Vegetated areas around roads, parking lots, and buildings were identified through heads-up digitizing using NAIP imagery.

Map Classes: Lawn and Pasture.

References: Faber-Langendoen et al. 2011.

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Appendix B: Key to Groups and Alliances within LEWI

- 1a.** Vegetation dominated by tall trees, either as forest or woodland. *Alnus rubra* forests are included here..... **Section I.**
- 1b.** Vegetation dominated by shrubs or herbaceous plants. Shrubs can be tall or dwarf. Dwarf or stunted trees (< 5 meters tall) on sand dune environments key as shrublands. **Section II.**

Section I. FORESTED GROUPS

- 2a.** Forested Uplands (dry to mesic forests)**3**
- 2c.** Forested Wetlands (riparian and swamps).....**6**

3a. Dry forests of low elevations . Primarily dominated by *Pseudotsuga menziesii*, *Arbutus menziesii*, *Pinus contorta*, *Acer macrophyllum*, or *Abies grandis* are local dominant or codominant species. Introduced *Pinus* spp. may also be dominant to co-dominant. Sites often rocky, thin soils or on sand dunes with *Gaultheria shallon*, *Holodiscus discolor* and other drought tolerant shrubs. These sites are too dry and warm or have been too frequently and extensively burned for anything more than small amounts of *Tsuga heterophylla* or *Thuja plicata* to be present as regeneration.

**G205 Vancouverian Dry Coastal and Lowland (Douglas-Fir, Shore Pine, Madrone)
Forest and Woodland Group**

A.NCCN-NEW1 *Pinus contorta* var. *contorta* Woodland Alliance

3b. More mesic forests dominated by deciduous trees, western hemlock, western red cedar, Sitka spruce, and/or Douglas-fir; and not like above in all respects**4**

4a. *Alnus rubra*, *Acer macrophyllum* dominant or co-dominant with Douglas-fir. Forests occur on steep slopes and bluffs, flat areas, upper terraces of river valleys, the component species are indicators of recent and past disturbance, both human-induced and natural. Conifers, including *Pseudotsuga menziesii*, *Thuja plicata*, *Tsuga heterophylla*, or *Picea sitchensis* can be codominant. However if associated with springs, stands should fall in a wetland group (see 1c).

[MG024 Vancouverian Lowland and Montane Rainforest]

G237 North Pacific Red Alder-Bigleaf Maple-Douglas-fir Forest Group

4a1. Stands dominated by *Acer macrophyllum*. Often on disturbed sites, such as landslides or burns. May have some conifers present.

A.NCCN-019 *Acer macrophyllum* - (*Pseudotsuga menziesii*) Forest Alliance

4a2. Stands dominated by *Alnus rubra*. Often on disturbed sites, such as landslides or burns. May have some conifers present.

**A.NCCN-020 *Alnus rubra* - (*Picea sitchensis*, *Tsuga heterophylla*) Forest and
Woodland Alliance**

4b. Forests may include some *Acer macrophyllum* or *Alnus rubra*, but these are not dominant nor strongly co-dominant. Stands are dominated by *Tsuga heterophylla*, *Thuja plicata*, or *Picea sitchensis* usually with *Pseudotsuga menziesii*.....**5**

5a. Stands mostly below 300 m elevation. Stands are typically dominated or codominated by *Picea sitchensis* but often have a mixture of other conifers present, such as *Tsuga heterophylla* or *Thuja plicata*. *Tsuga heterophylla* is very often codominant.

[MG024 Vancouverian Lowland and Montane Rainforest]

G239 North Pacific Maritime Sitka Spruce Forest Group

5a1. Stands not on old stabilized dunes 7

A.NCCN-027 *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance

5a2. Stands on stabilized dunes 8

A.2067 North Pacific (*Picea sitchensis* -*Pinus contorta* var. *contorta*)

Stabilized Dune Forest

5b. Overstory canopy is dominated by *Pseudotsuga menziesii* with *Tsuga heterophylla* or *Thuja plicata*. *Pseudotsuga menziesii* is usually at least present to more typically codominant or dominant. *Acer macrophyllum* and *Alnus rubra* are commonly found as canopy or subcanopy codominants. Mesic stands have a variety of understory species such as *Gaultheria shallon*, *Vaccinium parvifolium* and *Polystichum munitum*. Very wet sites are dominated by *Polystichum munitum*, *Oxalis oregana*, or *Rubus spectabilis*. Indicator species include *Tsuga heterophylla*, *Polystichum munitum*, *Achlys triphylla*, *Gaultheria shallon* and *Mahonia nervosa*.

[MG024 Vancouverian Lowland and Montane Rainforest]

G240 North Pacific Maritime Douglas-fir -Western Hemlock Forest Group

5b1. Dry-mesic stands 7

A.NCCN-042 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Cornus unalaschensis*

Mesic Forest Alliance

5b2. Mesic to Wet stands 8

A.NCCN-044 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Rubus spectabilis*

Wet Forest Alliance

2c. FORESTED WETLANDS (Riparian and Swamp)

6a. Wetland forest not a depression swamp but occupying stream bank or riparian area. Roots are wet but well oxygenated 7

6b. Wetland forest in a depression or slope, spring, hill slope failure or other but not riparian area 8

7a. Riparian forest canopy dominated by deciduous trees other than cottonwoods, such as *Acer* or *Alnus*. [MG035 Vancouverian Flooded & Swamp Forest]

G254 North Pacific Lowland Riparian Forest & Woodland Group

A.NCCN-001 (*Acer macrophyllum*, *Alnus rubra*) Riparian Forest Alliance

7b. Lowland riparian forest dominated by conifer trees. Stands may or may not have co-dominant *Alnus* or *Acer* in the upper canopy. Stands can be dominated by *Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*, or *Pseudotsuga menziesii*, individually or in any combination.

[MG035 Vancouverian Flooded & Swamp Forest]

G254 North Pacific Lowland Riparian Forest & Woodland Group

A.NCCN-005 (*Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*) - (*Alnus* spp., *Acer* spp.) Riparian Forest Alliance

8a. Open forest canopy dominated by *Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata* or *Pseudotsuga menziesii*, or a mix of any of these species, which may often be confined to higher microsites such as buttress roots, stumps and nurse logs. *Thuja plicata* is a typical associate in these stands. *Lysichiton americanus* is always present and very few to no shrubs are present. ...

[MG035 Vancouverian Flooded & Swamp Forest]

G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group

A.NCCN-004 (*Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata*, *Abies* spp.) / *Lysichiton americanus* Coniferous Swamp Woodland Alliance

8b. Overstory canopy dominated by *Alnus rubra*, *Fraxinus latifolia* or *Populus balsamifera* ssp. *trichocarpa*. Depression swamp wetland forest with the indicator herbaceous species *Lysichiton americanus* nearly always present.

[MG035 Vancouverian Flooded & Swamp Forest]

G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group

A.NCCN-002 (*Alnus* spp., *Fraxinus* spp., *Populus* spp.) / *Lysichiton americanus* Deciduous Swamp Woodland Alliance

Section II. Dichotomous Key to Non-Forested NVC units

Key to Class 2 Temperate Shrubland & Grassland

1a. Upland grassland meadows or shrublands, including bluffs, dunes, beaches and developed areas **2**

1b. Aquatic and wetland sites, wet meadows, salt and freshwater marshes, tall shrub swamps, sloping wetlands, riparian zones, and floating or rooted aquatic plant beds..... **8**

1.a UPLANDS

2a. Vegetation on sand dunes, including very open, active dunes, or well vegetated back dunes **3**

2b. Herbaceous or shrubland areas generally not associated with sand dunes, including slopes, mowed road verges, sparsely vegetated cliffs, and beaches..... **4**

3a. Vegetation on sand dunes, dominated by native herbaceous or shrub species. May have stunted tree species. Herbaceous grasslands, meadows, or shrublands, generally associated with sand dunes.

[M058 Cool Pacific Coastal Beach, Dune & Bluff Vegetation]

G498 North Pacific Maritime Coastal Sand Dune Scrub & Herb Vegetation Group

3a1. Herbaceous
A.2066 *Poa macrantha* -*Leymus mollis* -*Festuca rubra* Sand Dune Herbaceous Alliance

3a2. Shrubland.....
A.NCCN-NEW3 (*Pinus contorta* var. *contorta* -*Picea sitchensis* /*Gaultheria shallon*) Stabilized Dune Shrubland Alliance

- 3b.** Vegetation on sand dunes, dominated by non-native introduced herbaceous or shrub species. Herbaceous grasslands or shrublands generally associated with sand dunes.....
[MGNEW North Pacific Coastal RUDERAL Grassland & Shrubland]
GNW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub and Herb Vegetation Group
- 3b1.** Herbaceous, usually dominated by grasses and forbs.....
A.2061 *Ammophila arenaria* - Planted *Leymus mollis* ssp. *mollis* Coastal Dunegrass Ruderal Grassland Alliance
- 3b2.** Shrubland.....
..... A.2062 *Cytisus scoparius* - *Ulex europaeus* - *Lupinus arboreus* Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance
- 4a.** Sea cliffs or beaches with very little vegetation (<10% vascular plant cover).....
[MG114 Vancouverian Cliff, Scree & Rock Vegetation]
G322 Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group
No alliances defined
- 4b.** Areas with >10% vegetative cover **5**
- 5a.** Vegetation of balds and bluffs, slopes or fields, native or non-native species present **6**
- 5b.** Vegetation near buildings and roads, generally mowed or with maintained landscaping **7**
- 6a.** Coastal and maritime- influenced lowland grasslands, balds and low shrublands. Dominated by native species. Often dominated or characterized by *Festuca rubra*, *Calamagrostis nutkaensis*, or *Gaultheria shallon*.
[MG050 Southern Vancouverian Lowland Grassland & Shrubland]
G488 Southern Vancouverian Shrub & Herbaceous Bald and Bluff (replaces Groups 278 & 279)
- 6a1.** Herbaceous, usually dominated by grasses and forbs
A.2064 *Festuca rubra* - *Calamagrostis nutkaensis* Coastal Herbaceous Alliance
- 6a2.** Shrublands
A.2065 *Gaultheria shallon* Coastal Shrubland Alliance
- 6b.** Meadows or fields dominated by non-native species
[MGNEW Southern Vancouverian Lowland RUDERAL Grassland & Shrubland]
GNW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group
A.NEW *Anthoxanthum odoratum* - *Holcus lanatus* Ruderal Coastal Grassland Alliance
- 7a.** Mowed lawns, road sides and medians
[M491 Temperate & Tropical Lawn]
G622 Cool-Season, Warm-Season, Dry-Season Lawn
A.New Temperate Mowed Lawns Alliance
- 7b.** Trees, shrubs or herbaceous beds near buildings and parking lots, maintained (trimmed, watered etc.) landscaping, or garden beds.....
[M492 Temperate & Tropical Planted Landscaping & Gardens]
G623 Treed Landscaping
A.New Temperate Planted Trees/Gardens Alliance

1.b WETLANDS

8a. Freshwater wetlands and marshes, woody swamps and riparian shrublands, floating aquatic plants in freshwater, including slightly brackish areas9

8b. Saltwater wetlands and marshes, including seagrass areas in shallow ocean waters near the seashore11

9a. Wetlands dominated by shrubs. Herbaceous plants may be present but overall area is shaded by tall or short shrubs

G322 Vancouverian Lowland Riparian & Wet Slope Shrubland Group

9a1. Area dominated by a mix of several species such as willows, crab apple and *Spiraea*

A.NCCN-NEW11 *Salix* spp. -*Malus fusca* -*Spiraea* spp. Lowland Riparian & Wet Slope Shrubland Alliance

9a2. Area dominated by willows only

A.NCCN-999 *Salix hookeriana* Seasonally Flooded Shrubland Alliance

9a3. Area dominated by *Spiraea* only

A.NCCN-997 *Spiraea douglasii* Seasonally Flooded Shrubland Alliance

9b. Wetlands dominated by herbaceous plants.....10

10a. Marshes with emergent or floating plants and deep (>1 foot) open water

G518 Western North American Temperate Interior Freshwater Marsh Group

10a1. Area dominated by bulrush

A.1433 *Schoenoplectus acutus* (*Schoenoplectus pungens*) Semi-Permanently Flooded Herbaceous Alliance

10a2. Areas dominated by cattails.....

A.NCCN-NEW4 *Typha* (*angustifolia*, *latifolia*) Freshwater Marsh Alliance

10a3. Area dominated by floating but rooted aquatic plants.....

A.2598 *Sparganium eurycarpum* Hydromorphic Rooted Herbaceous Vegetation

10a4. Areas dominated by floating plants not rooted

G544 Western North American Temperate Freshwater Aquatic Bed Group

(this is a very cosmopolitan alliance occurring throughout North America, so it is in a broader group)

A.NCCN-NEW5 *Nuphar* spp. - *Potamogeton* spp. - *Lemna* spp. Freshwater Aquatic Alliance

10b. Wet meadows that may be flooded with shallow standing water

G517 Vancouverian Freshwater Coastal Marsh & Meadow Group

10b1. Areas dominated by sedges

A.1412 *Carex aquatilis* var. *dives* Semi-permanently Flooded Herbaceous Alliance

A.2582 *Carex obnupta* Seasonally Flooded Herbaceous Alliance

10b2. Areas dominated by rushes.....

A.1375 *Juncus effusus* Semi-Natural Seasonally Flooded Alliance

10b3. Areas dominated by spike rush.....

G523 Western North American Maritime Lowland Wet Meadow, Marsh & Seep Herbaceous Group

(this alliance is in a different Group as it is very widespread and occurs from Mexico to Canada)

A.1342 *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance

- 11a. Salt water marshes influenced by tides
 - G499 Temperate Pacific Tidal Salt & Brackish Marsh Group**
 - 11a1. Tidal areas dominated by Lyngby's sedge
 - A.2622 *Carex lyngbyei* Tidal Herbaceous Alliance**
 - 11a2. Sandy, salty tidal areas dominated by pickleweed (glasswort)
 - A.2618 *Salicornia virginica* Tidal Herbaceous Alliance**
 - 11a3. High marsh area dominated by hairgrass
 - A.2623 *Deschampsia caespitosa* Tidal Herbaceous Alliance**
 - 11b. Near-shore shallow water on sandy substrates dominated by seagrass
 - G373 Temperate Pacific Seagrass Group**
 - A.NCCN-NEW6 *Zostera* spp. Permanently Flooded - Tidal Herbaceous Alliance**
-

Appendix C: Training Data Maps

The following five maps show the location of the training data collected to develop the LEWI map. Training data plots are attributed with the initial map classes assigned to them.

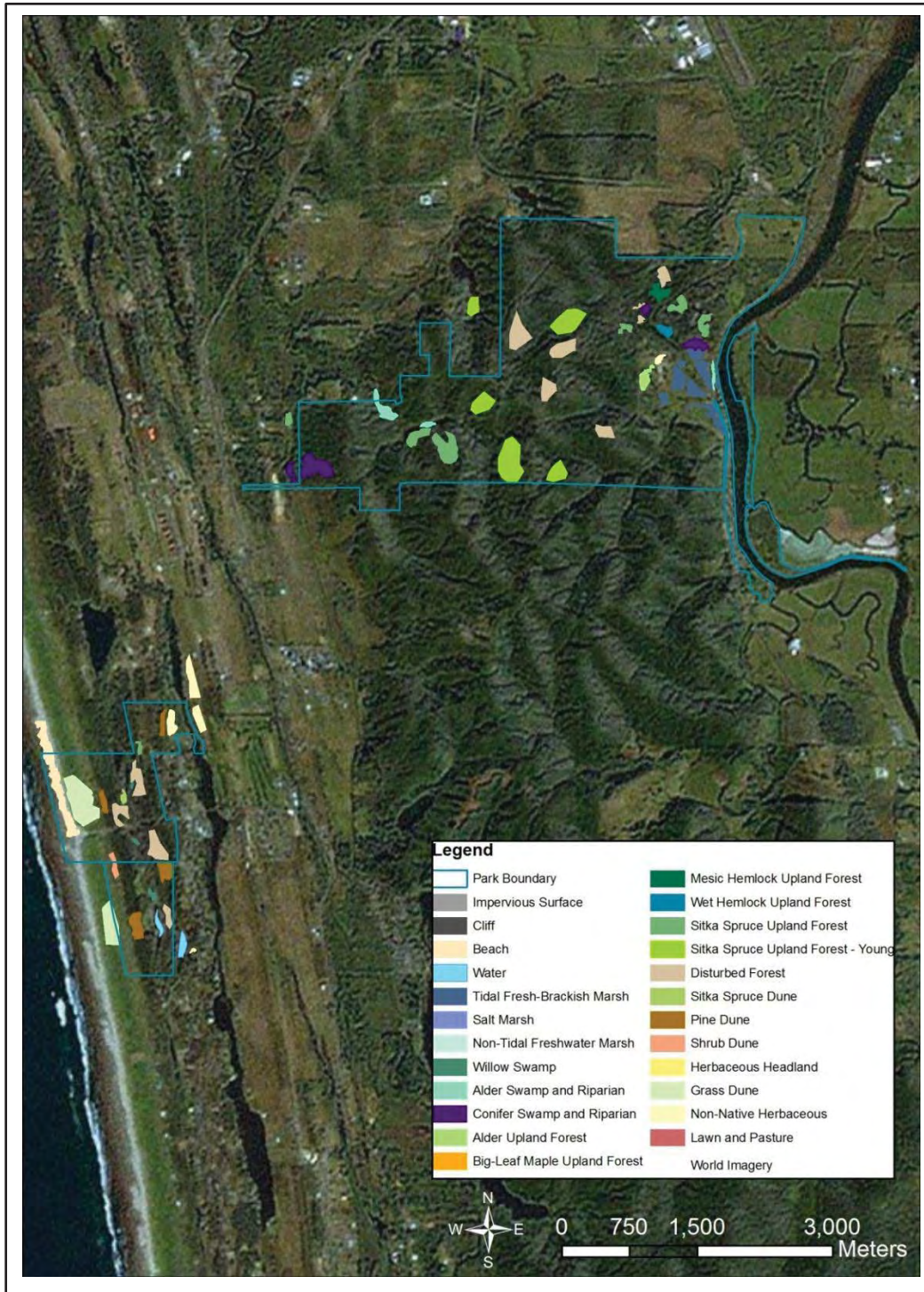


Figure C-1. Training data for Fort Clatsop and Sunset Beach/Yeon.

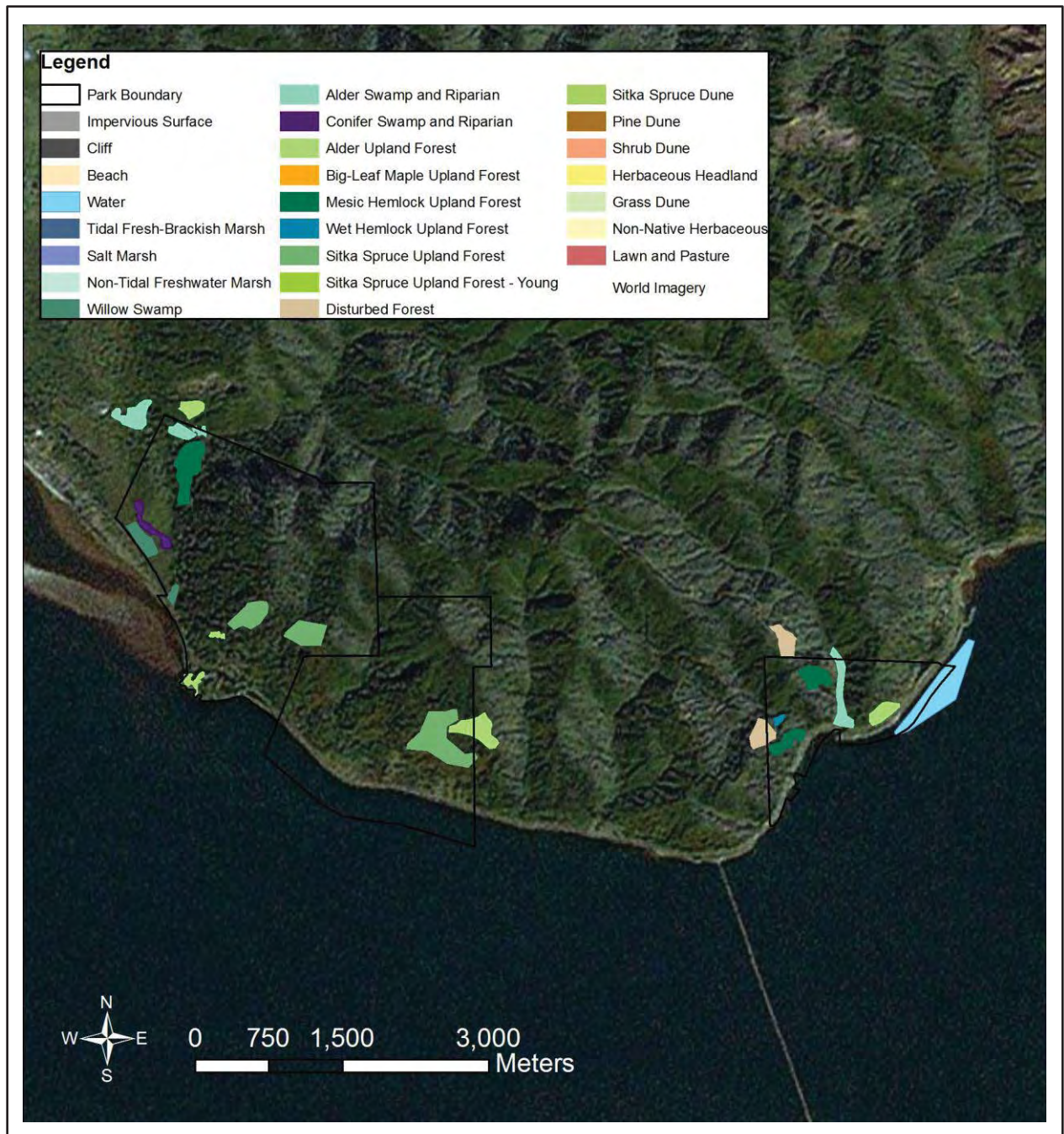


Figure C-2. Training data for Fort Columbia, Middle Village/Station Camp, and Dismal Nitch (from left to right).

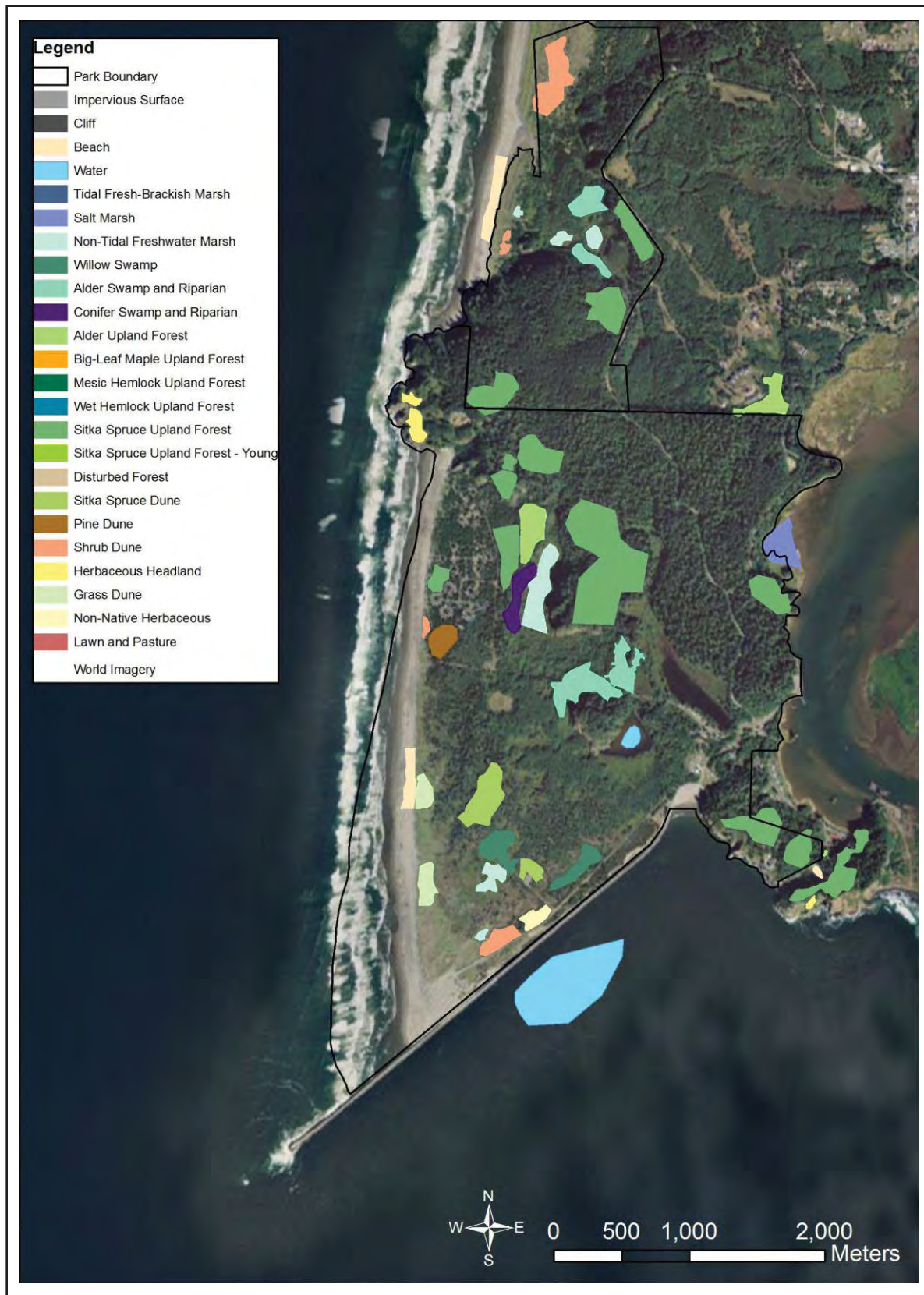


Figure C-3. Training data for Cape Disappointment.



Figure C-4. Training data for Fort Stevens.

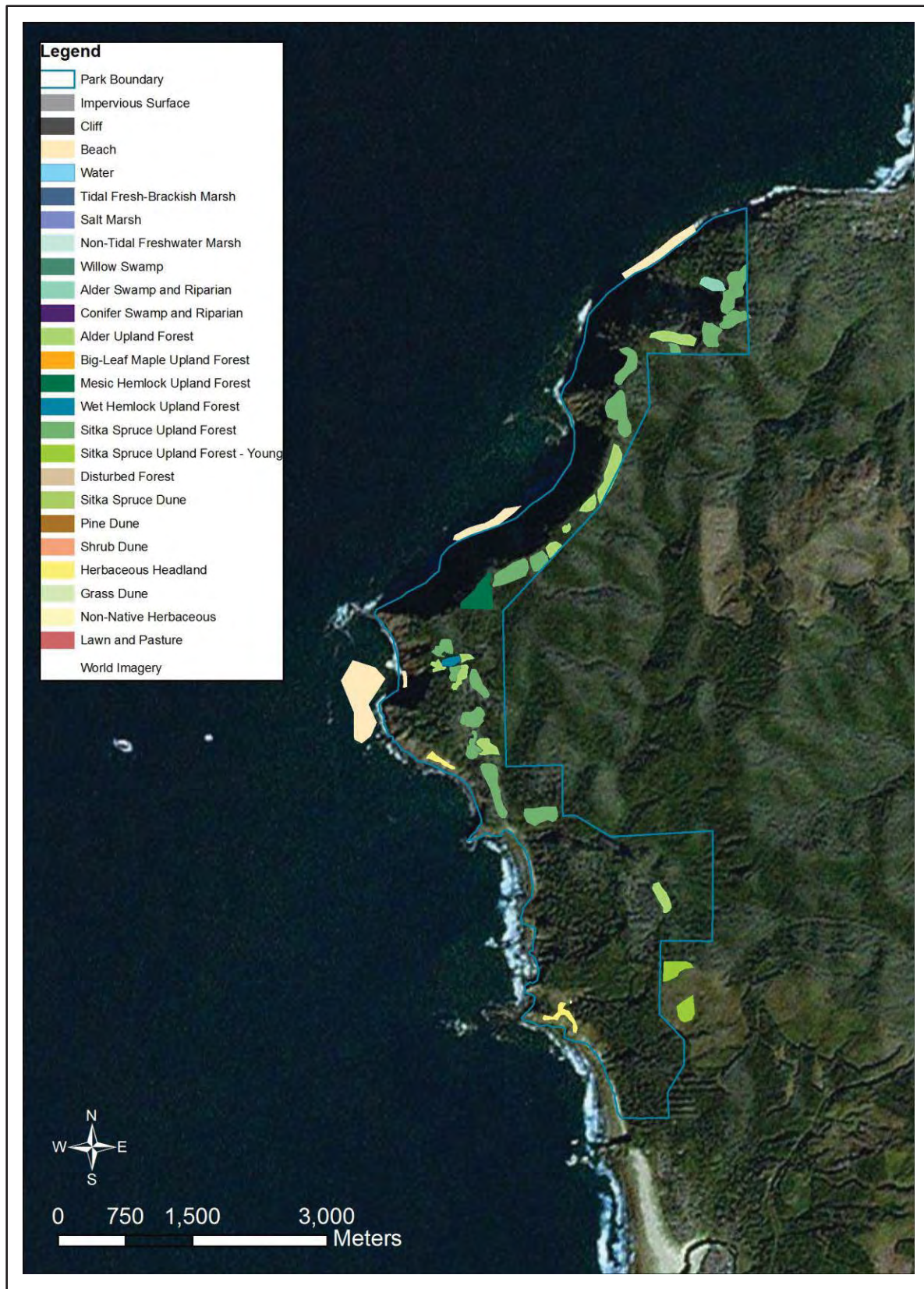


Figure C-5. Training data for Ecola.

Appendix D: Vascular Plant Species List

The following table lists vascular plant taxa at LEWI that have been documented by specimen voucher, reliable observation, or official reports as published in the LEWI Vascular Plant Inventory Report (Wise and Kagan 2012). This list pertains to the legislative units of LEWI, which include Fort Clatsop, Sunset Beach, Dismal Nitch, Middle Village/Station Camp, and Cape Disappointment. The Fort Stevens, Ecola, and Fort Columbia units were not thoroughly inventoried as the Park Service does not directly manage the natural resources at these partner units and they are not within the legislative boundaries of LEWI, though much of the flora of these units will overlap with the species in this list. See Wise and Kagan (2012) for further information on these species and the methods used in their documentation.

Species are listed alphabetically by family then scientific name. Nomenclature and concepts follow the Integrated Taxonomic Information System (ITIS), except where recent taxonomic changes were incorporated following the Flora of North America. The Native field indicates whether a species is native to Oregon and/or Washington (academically accepted as naturally occurring in the Pacific Northwest for hundreds or thousands of years) or non-native (introduced through human interference in recent, post-European settlement history). Nativity is based on the Oregon Flora Project and the USDA PLANTS database. Abundance describes the frequency of a species in the park. Abundant (Abun) taxa have large populations and are often key components in one or more vegetation types, or are widely distributed across the park. Common (Com) taxa have large populations but may be restricted in their habitats or only occur in a few locations in the park. Uncommon (Unc) taxa have small to medium sized populations and are found in few vegetation communities or have a low occurrence in several community types. Rare (Rare) taxa have low populations within the park and are not often encountered. Taxa that were present historically but that do not have an extant population within the park are noted as (NA), not applicable.

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name.

Family	Scientific name	Common name	Native	Abundance
Aceraceae	<i>Acer circinatum</i>	vine maple	Y	Unc
Aceraceae	<i>Acer macrophyllum</i>	bigleaf maple	Y	Rare
Aceraceae	<i>Acer platanoides</i>	Norway maple	N	Rare
Alismataceae	<i>Alisma triviale</i>	northern water-plantain	Y	Unc
Alismataceae	<i>Sagittaria latifolia</i>	common arrowhead	Y	Unc
Apiaceae	<i>Angelica genuflexa</i>	kneeling angelica	Y	Unc
Apiaceae	<i>Angelica lucida</i>	seacoast angelica	Y	Unc
Apiaceae	<i>Cicuta douglasii</i>	western water hemlock	Y	Unc
Apiaceae	<i>Conioselinum gmelinii</i>	Pacific hemlockparsley	Y	Unc
Apiaceae	<i>Daucus carota</i>	Queen Anne's lace	N	Unc
Apiaceae	<i>Heracleum maximum</i>	common cowparsnip	Y	Com
Apiaceae	<i>Hydrocotyle ranunculoides</i>	floating marsh pennywort	Y	Com
Apiaceae	<i>Lilaeopsis occidentalis</i>	western grasswort	Y	Com
Apiaceae	<i>Oenanthe sarmentosa</i>	water parsely	Y	Com
Apiaceae	<i>Osmorhiza purpurea</i>	purple sweetroot	Y	Unc
Apiaceae	<i>Sium suave</i>	common waterparsnip	Y	Rare
Apocynaceae	<i>Vinca minor</i>	common periwinkle	N	Com
Aquifoliaceae	<i>Ilex aquifolium</i>	English holly	N	Com

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Araceae	<i>Lysichiton americanus</i>	American skunkcabbage	Y	Com
Araliaceae	<i>Hedera helix</i>	English ivy	N	Unc
Araucariaceae	<i>Araucaria araucana</i>	monkeypuzzle tree	N	Rare
Asteraceae	<i>Achillea millefolium</i>	common yarrow	Y	Com
Asteraceae	<i>Anaphalis margaritacea</i>	common pearleverlasting	Y	Com
Asteraceae	<i>Anthemis cotula</i>	chamomile	N	Unc
Asteraceae	<i>Artemisia suksdorfii</i>	coastal wormwood	Y	Unc
Asteraceae	<i>Baccharis pilularis</i>	coyotebrush	Y	Rare
Asteraceae	<i>Bellis perennis</i>	English daisy	N	Com
Asteraceae	<i>Bidens cernua</i>	nodding beggarticks	Y	Com
Asteraceae	<i>Bidens frondosa</i>	devils beggartick	Y	Unc
Asteraceae	<i>Cirsium arvense</i>	Californian thistle	N	Unc
Asteraceae	<i>Cirsium brevistylum</i>	clustered thistle	Y	Unc
Asteraceae	<i>Cirsium edule</i>	edible thistle	Y	Rare
Asteraceae	<i>Cirsium vulgare</i>	bull thistle	N	Com
Asteraceae	<i>Conyza canadensis</i>	Canada horseweed	Y	Com
Asteraceae	<i>Cotula coronopifolia</i>	brassbuttons	N	Rare
Asteraceae	<i>Crepis capillaris</i>	smooth hawksbeard	N	Com
Asteraceae	<i>Erechtites glomerata</i>	Australian fireweed	N	Unc
Asteraceae	<i>Erechtites minima</i>	Australian fireweed	N	Unc
Asteraceae	<i>Gnaphalium palustre</i>	cudweed	Y	Unc
Asteraceae	<i>Gnaphalium uliginosum</i>	low cudweed	N	Unc
Asteraceae	<i>Hieracium albiflorum</i>	whiteflower hawkweed	Y	Unc
Asteraceae	<i>Hypochaeris glabra</i>	smooth cat's ear	N	Unc
Asteraceae	<i>Hypochaeris radicata</i>	spotted cat's ear	N	Com
Asteraceae	<i>Lapsana communis</i>	common nipplewort	N	Com
Asteraceae	<i>Leontodon taraxacoides</i> ssp. <i>taraxacoides</i>	lesser hawkbit	N	Com
Asteraceae	<i>Leucacantha cyanus</i>	Bachelor's button	N	Rare
Asteraceae	<i>Leucanthemum vulgare</i>	ox-eye daisy	N	Unc
Asteraceae	<i>Matricaria discoidea</i>	pineapple weed	N	Unc
Asteraceae	<i>Mycelis muralis</i>	wall-lettuce	N	Unc
Asteraceae	<i>Petasites frigidus</i> var. <i>palmatius</i>	arctic sweet coltsfoot	Y	Unc
Asteraceae	<i>Senecio jacobaea</i>	ragwort	N	Unc
Asteraceae	<i>Senecio sylvaticus</i>	woodland ragwort	N	Unc
Asteraceae	<i>Senecio triangularis</i>	arrowleaf ragwort	Y	Unc
Asteraceae	<i>Senecio vulgaris</i>	common groundsel	N	Unc
Asteraceae	<i>Solidago canadensis</i>	Canada goldenrod	Y	Rare
Asteraceae	<i>Solidago canadensis</i> ssp. <i>salebrosa</i>	Canada goldenrod	Y	Unc
Asteraceae	<i>Solidago simplex</i> var. <i>spathulata</i>	Dune goldenrod	Y	Unc
Asteraceae	<i>Soliva sessilis</i>	field burrweed	N	Unc
Asteraceae	<i>Sonchus asper</i>	prickly sowthistle	N	Com
Asteraceae	<i>Sonchus oleraceus</i>	annual sowthistle	N	Com
Asteraceae	<i>Symphotrichum subspicatum</i> var. <i>subspicatum</i>	Douglas aster	Y	Com
Asteraceae	<i>Tanacetum camphoratum</i>	dune tansy	Y	Rare
Asteraceae	<i>Taraxacum officinale</i>	dandelion	N	Unc
Balsaminaceae	<i>Impatiens capensis</i>	jewelweed	N	Com

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Balsaminaceae	<i>Impatiens ecalcarata</i>	spurless touch-me-not	Y	Com
Balsaminaceae	<i>Impatiens x pacifica</i>	Pacific jewelweed	Y	Unc
Berberidaceae	<i>Berberis aquifolium</i>	hollyleaved barberry	Y	Rare
Betulaceae	<i>Alnus rubra</i>	red alder	Y	Abun
Blechnaceae	<i>Blechnum spicant</i>	deer fern	Y	Com
Boraginaceae	<i>Myosotis discolor</i>	changing forget-me-not	N	Unc
Boraginaceae	<i>Myosotis laxa</i>	bay forget-me-not	Y	Unc
Brassicaceae	<i>Barbarea orthoceras</i>	erectpod wintercress	Y	Unc
Brassicaceae	<i>Brassica rapa</i>	turnip rape	N	Unc
Brassicaceae	<i>Cakile edentula</i>	American searocket	Y	Com
Brassicaceae	<i>Cakile maritima</i>	Eurpoean searocket	N	Com
Brassicaceae	<i>Cardamine angulata</i>	seaside bittercress	Y	Unc
Brassicaceae	<i>Cardamine breweri</i> var. <i>orbicularis</i>	Sierra bittercress	Y	Unc
Brassicaceae	<i>Cardamine hirsuta</i>	hairy bittercress	N	Com
Brassicaceae	<i>Cardamine oligosperma</i> var. <i>oligosperma</i>	little western bittercress	Y	Com
Brassicaceae	<i>Draba verna</i>	spring draba	Y	Com
Brassicaceae	<i>Rorippa curvisiliqua</i>	curvepod yellowcress	Y	Rare
Brassicaceae	<i>Rorippa palustris</i>	bog yellowcress	Y	Unc
Brassicaceae	<i>Sisymbrium officinale</i>	hedge mustard	N	Unc
Brassicaceae	<i>Teesdalia nudicaulis</i>	barestem teesdalia	N	Unc
Buxaceae	<i>Buxus</i> sp.	boxwood	N	Rare
Buxaceae	<i>Pachysandra terminalis</i>	Japanese pachysandra	N	Unc
Cabombaceae	<i>Cabomba caroliniana</i>	Carolina fanwort	N	Com
Callitrichaceae	<i>Callitriche hermaphroditica</i>	northern water-starwort	Y	Rare
Callitrichaceae	<i>Callitriche stagnalis</i>	pond water-starwort	N	Com
Campanulaceae	<i>Lobelia cardinalis</i>	cardinalflower	Y	NA
Caprifoliaceae	<i>Lonicera involucrata</i> var. <i>involucrata</i>	twinberry honeysuckle	Y	Com
Caprifoliaceae	<i>Lonicera periclymenum</i>	European honeysuckle	N	Unc
Caprifoliaceae	<i>Sambucus racemosa</i> var. <i>racemosa</i>	scarlet elderberry	Y	Com
Caprifoliaceae	<i>Symphoricarpos albus</i> var. <i>laevigatus</i>	common snowberry	Y	Unc
Caprifoliaceae	<i>Weigela</i> sp.	weigela	N	Rare
Caryophyllaceae	<i>Cardionema ramosissimum</i>	sandcarpet	Y	Rare
Caryophyllaceae	<i>Cerastium arvense</i>	field chickweed	Y	Unc
Caryophyllaceae	<i>Cerastium fontanum</i> ssp. <i>vulgare</i>	big chickweed	N	Com
Caryophyllaceae	<i>Cerastium glomeratum</i>	sticky chickweed	N	Com
Caryophyllaceae	<i>Cerastium semidecandrum</i>	five-stamen chickweed	N	Rare
Caryophyllaceae	<i>Dianthus armeria</i>	Deptford pink	N	Unc
Caryophyllaceae	<i>Honckenya peploides</i>	seaside sandplant	Y	Unc
Caryophyllaceae	<i>Honckenya peploides</i> ssp. <i>major</i>	seaside sandplant	Y	Unc
Caryophyllaceae	<i>Moenchia erecta</i>	upright chickweed	N	Rare
Caryophyllaceae	<i>Sagina apetala</i>	annual pearlwort	N	Unc
Caryophyllaceae	<i>Sagina maxima</i> ssp. <i>crassicaulis</i>	stickystem pearlwort	Y	Unc
Caryophyllaceae	<i>Sagina procumbens</i>	procumbent pearlwort	N	Rare

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Caryophyllaceae	<i>Scleranthus annuus</i>	German knotgrass	N	Unc
Caryophyllaceae	<i>Silene gallica</i>	common catchfly	N	Unc
Caryophyllaceae	<i>Spargula arvensis</i>	pickpurse	N	Unc
Caryophyllaceae	<i>Spargularia rubra</i>	red sandspurry	N	Unc
Caryophyllaceae	<i>Stellaria calycantha</i>	northern starwort	Y	Unc
Caryophyllaceae	<i>Stellaria crispa</i>	crisp starwort	Y	Unc
Caryophyllaceae	<i>Stellaria humifusa</i>	saltmarsh starwort	Y	Unc
Caryophyllaceae	<i>Stellaria longipes</i> var. <i>longipes</i>	longstalk starwort	Y	Unc
Caryophyllaceae	<i>Stellaria media</i>	chickweed	N	Com
Ceratophyllaceae	<i>Ceratophyllum demersum</i>	coon's tail	Y	Com
Chenopodiaceae	<i>Atriplex prostrata</i>	hastate orache	Y	Unc
Chenopodiaceae	<i>Chenopodium album</i>	lambsquarters goosefoot	N	Unc
Chenopodiaceae	<i>Salicornia virginica</i>	Virginia glasswort	Y	Unc
Clusiaceae	<i>Hypericum anagalloides</i>	creeping St. Johnswort	Y	Rare
Clusiaceae	<i>Hypericum androsaemum</i>	sweet-amber	N	Rare
Clusiaceae	<i>Hypericum perforatum</i>	St. Johnswort	N	Rare
Clusiaceae	<i>Hypericum scouleri</i> ssp. <i>scouleri</i>	Scouler St. Johnswort	Y	Unc
Convolvulaceae	<i>Calystegia sepium</i> ssp. <i>sepium</i>	hedge false bindweed	N	Unc
Convolvulaceae	<i>Calystegia soldanella</i>	seashore morning-glory	Y	Unc
Cornaceae	<i>Cornus sericea</i>	redosier dogwood	Y	Unc
Crassulaceae	<i>Crassula tillaea</i>	moss pygmyweed	N	Rare
Crassulaceae	<i>Sedum oreganum</i>	Oregon stonecrop	Y	Com
Cucurbitaceae	<i>Marah oreganus</i>	coastal manroot	Y	Unc
Cupressaceae	<i>Chamaecyparis lawsoniana</i>	Oregon cedar	N	Unc
Cupressaceae	<i>Thuja plicata</i>	western red cedar	Y	Com
Cyperaceae	<i>Carex brevicaulis</i>	shortstem sedge	Y	Rare
Cyperaceae	<i>Carex deweyana</i>	Dewey sedge	Y	Unc
Cyperaceae	<i>Carex kobomugi</i>	Japanese sedge	N	Unc
Cyperaceae	<i>Carex leptopoda</i>	shortscale sedge	Y	Unc
Cyperaceae	<i>Carex lyngbyei</i>	Lyngbye's sedge	Y	Com
Cyperaceae	<i>Carex macrocephala</i>	largehead sedge	Y	Unc
Cyperaceae	<i>Carex obnupta</i>	slough sedge	Y	Abun
Cyperaceae	<i>Carex pansa</i>	sanddune sedge	Y	Unc
Cyperaceae	<i>Carex stipata</i>	owlfruit sedge	Y	Unc
Cyperaceae	<i>Carex stipata</i> var. <i>stipata</i>	owlfruit sedge	Y	Unc
Cyperaceae	<i>Eleocharis ovata</i>	ovate spikerush	Y	Unc
Cyperaceae	<i>Eleocharis palustris</i>	spikesedge	Y	Com
Cyperaceae	<i>Eleocharis parvula</i>	dwarf spikesedge	Y	Unc
Cyperaceae	<i>Isolepis cernua</i>	low bulrush	Y	Com
Cyperaceae	<i>Schoenoplectus acutus</i> var. <i>occidentalis</i>	tule	Y	Unc
Cyperaceae	<i>Schoenoplectus americanus</i>	American bulrush	Y	Unc
Cyperaceae	<i>Schoenoplectus tabernaemontani</i>	soft-stem bulrush	Y	Com
Cyperaceae	<i>Scirpus microcarpus</i>	panicled bulrush	Y	Com
Dennstaedtiaceae	<i>Pteridium aquilinum</i>	northern bracken fern	Y	Com
Dipsacaceae	<i>Dipsacus fullonum</i> ssp. <i>sylvestris</i>	common teasel	N	Com

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Dryopteridaceae	<i>Athyrium filix-femina</i>	common ladyfern	Y	Com
Dryopteridaceae	<i>Dryopteris expansa</i>	spreading woodfern	Y	Unc
Dryopteridaceae	<i>Polystichum munitum</i>	western swordfern	Y	Abun
Equisetaceae	<i>Equisetum arvense</i>	western horsetail	Y	Com
Equisetaceae	<i>Equisetum hyemale</i>	western scouringrush	Y	Unc
Equisetaceae	<i>Equisetum telmateia ssp. braunii</i>	giant horsetail	Y	Com
Ericaceae	<i>Arctostaphylos uva-ursi</i>	bearberry	Y	Com
Ericaceae	<i>Gaultheria shallon</i>	salal	Y	Abun
Ericaceae	<i>Menziesia ferruginea</i>	rusty menziesia	Y	Unc
Ericaceae	<i>Rhododendron macrophyllum</i>	Pacific rhododendron	Y	Unc
Ericaceae	<i>Rhododendron occidentale</i>	western azalea	Y	Rare
Ericaceae	<i>Vaccinium ovalifolium</i>	oval-leaf huckleberry	Y	Unc
Ericaceae	<i>Vaccinium ovatum</i>	California huckleberry	Y	Com
Ericaceae	<i>Vaccinium parvifolium</i>	red huckleberry	Y	Com
Euphorbiaceae	<i>Chamaesyce maculata</i>	spotted sandmat	N	Com
Fabaceae	<i>Cytisus scoparius</i>	English broom	N	Unc
Fabaceae	<i>Lathyrus japonicus</i>	beach pea	Y	Abun
Fabaceae	<i>Lathyrus latifolius</i>	everlasting peavine	N	Unc
Fabaceae	<i>Lathyrus littoralis</i>	silky beach pea	Y	Unc
Fabaceae	<i>Lathyrus palustris</i>	marsh pea	Y	Unc
Fabaceae	<i>Lotus corniculatus</i>	bird's-foot-trefoil	N	Com
Fabaceae	<i>Lotus denticulatus</i>	riverbar bird's-foot trefoil	Y	Rare
Fabaceae	<i>Lotus pedunculatus</i>	big trefoil	N	Com
Fabaceae	<i>Lotus unifoliolatus var. unifoliolatus</i>	American bird's-foot-trefoil	Y	Unc
Fabaceae	<i>Lupinus arboreus</i>	yellow bush lupine	N	Rare
Fabaceae	<i>Lupinus latifolius var. latifolius</i>	broad-leaved lupine	Y	Rare
Fabaceae	<i>Lupinus littoralis</i>	seashore lupine	Y	Com
Fabaceae	<i>Medicago lupulina</i>	black medic	N	Com
Fabaceae	<i>Melilotus alba</i>	white sweetclover	N	Unc
Fabaceae	<i>Robinia pseudoacacia</i>	black locust	N	Unc
Fabaceae	<i>Trifolium arvense</i>	rabbitfoot clover	N	Unc
Fabaceae	<i>Trifolium dubium</i>	hop clover	N	Com
Fabaceae	<i>Trifolium hybridum</i>	alsike clover	N	Unc
Fabaceae	<i>Trifolium pratense</i>	red clover	N	Rare
Fabaceae	<i>Trifolium repens</i>	Dutch clover	N	Com
Fabaceae	<i>Trifolium subterraneum</i>	subterranean clover	N	Unc
Fabaceae	<i>Trifolium wormskjoldii</i>	cow clover	Y	Unc
Fabaceae	<i>Ulex europaeus</i>	gorse	N	NA
Fabaceae	<i>Vicia americana ssp. americana</i>	American vetch	Y	Unc
Fabaceae	<i>Vicia hirsuta</i>	tiny vetch	N	Com
Fabaceae	<i>Vicia nigricans ssp. gigantea</i>	giant vetch	Y	Unc
Fabaceae	<i>Vicia sativa ssp. nigra</i>	common vetch	N	Com
Fabaceae	<i>Vicia tetrasperma</i>	lentil vetch	N	Com
Fumariaceae	<i>Corydalis scouleri</i>	Scouler's fumewort	Y	Unc
Fumariaceae	<i>Dicentra formosa</i>	Pacific bleeding heart	Y	Rare
Gentianaceae	<i>Centaurium erythraea</i>	European centaury	N	Unc
Geraniaceae	<i>Erodium cicutarium</i>	redstem stork's bill	N	Unc

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Geraniaceae	<i>Geranium dissectum</i>	cutleaf geranium	N	Unc
Geraniaceae	<i>Geranium molle</i>	dovefoot geranium	N	Unc
Geraniaceae	<i>Geranium robertianum</i>	herb robert	N	Rare
Grossulariaceae	<i>Escallonia rubra</i>	redclaws	N	Rare
Grossulariaceae	<i>Ribes bracteosum</i>	stink currant	Y	Com
Grossulariaceae	<i>Ribes divaricatum</i> var. <i>divaricatum</i>	spreading gooseberry	Y	Unc
Grossulariaceae	<i>Ribes lacustre</i>	prickly currant	Y	Unc
Grossulariaceae	<i>Ribes laxiflorum</i>	trailing black currant	Y	Unc
Grossulariaceae	<i>Ribes sanguineum</i>	redflower currant	Y	Unc
Haloragaceae	<i>Myriophyllum aquaticum</i>	parrot's-feather	N	Com
Haloragaceae	<i>Myriophyllum hippuroides</i>	western watermilfoil	Y	Unc
Hippuridaceae	<i>Hippuris vulgaris</i>	marestail	Y	Unc
Hydrangeaceae	<i>Deutzia scabra</i>	fuzzy pride-of-Rochester	N	Rare
Hydrocharitaceae	<i>Egeria densa</i>	Brazilian waterweed	N	Rare
Hydrocharitaceae	<i>Elodea canadensis</i>	broad waterweed	Y	Com
Hydrocharitaceae	<i>Vallisneria americana</i>	American eelgrass	N	Com
Hydrophyllaceae	<i>Hydrophyllum tenuipes</i>	Pacific waterleaf	Y	Unc
Hydrophyllaceae	<i>Phacelia nemoralis</i>	shade phacelia	Y	Unc
Hydrophyllaceae	<i>Romanzoffia tracyi</i>	Tracy's mist maiden	Y	Rare
Iridaceae	<i>Crococsmia X crocosmiiflora</i>	montbretia	N	Rare
Iridaceae	<i>Iris pseudacorus</i>	paleyellow iris	N	Unc
Iridaceae	<i>Sisyrinchium californicum</i>	golden blue-eyed grass	Y	Rare
Iridaceae	<i>Sisyrinchium idahoense</i> var. <i>occidentale</i>	Idaho blue-eyed grass	Y	Rare
Juncaceae	<i>Juncus acuminatus</i>	sharp-fruit rush	Y	Com
Juncaceae	<i>Juncus articulatus</i>	jointed rush	Y	Unc
Juncaceae	<i>Juncus balticus</i> var. <i>balticus</i>	Baltic rush	Y	Rare
Juncaceae	<i>Juncus breweri</i>	Brewer's rush	Y	Rare
Juncaceae	<i>Juncus bufonius</i>	toad rush	N	Com
Juncaceae	<i>Juncus effusus</i> var. <i>effusus</i>	common rush	N	Com
Juncaceae	<i>Juncus effusus</i> var. <i>pacificus</i>	Pacific rush	Y	Com
Juncaceae	<i>Juncus ensifolius</i>	three-stamened rush	Y	Unc
Juncaceae	<i>Juncus hesperius</i>	three-stamened rush	Y	Unc
Juncaceae	<i>Juncus lesueurii</i>	salt rush	Y	Unc
Juncaceae	<i>Juncus nevadensis</i> var. <i>inventus</i>	Sierra rush	Y	Rare
Juncaceae	<i>Juncus oxymiris</i>	pointed rush	Y	Unc
Juncaceae	<i>Juncus supiniformis</i>	hairyleaf rush	Y	Unc
Juncaceae	<i>Juncus tenuis</i>	path rush	Y	Unc
Juncaceae	<i>Luzula comosa</i>	Pacific woodrush	Y	Unc
Juncaceae	<i>Luzula parviflora</i>	smallflower woodrush	Y	Unc
Juncaginaceae	<i>Lilaea scilloides</i>	awl-leaf lilaea	Y	Rare
Juncaginaceae	<i>Triglochin maritima</i>	seaside arrowgrass	Y	Com
Juncaginaceae	<i>Triglochin striata</i>	three-rib arrowgrass	Y	Unc
Lamiaceae	<i>Glechoma hederacea</i>	creeping charlie	N	Unc
Lamiaceae	<i>Lamium purpureum</i>	purple deadnettle	N	Unc
Lamiaceae	<i>Lycopus americanus</i>	water horehound	Y	Unc
Lamiaceae	<i>Mentha aquatica</i>	water mint	N	Rare

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Lamiaceae	<i>Mentha arvensis</i>	field mint	Y	Unc
Lamiaceae	<i>Mentha pulegium</i>	pennyroyal	N	Unc
Lamiaceae	<i>Mentha X piperita</i>	peppermint	N	Unc
Lamiaceae	<i>Prunella vulgaris ssp. lanceolata</i>	lance selfheal	Y	Unc
Lamiaceae	<i>Prunella vulgaris ssp. vulgaris</i>	common selfheal	N	Unc
Lamiaceae	<i>Stachys mexicana</i>	Mexican hedgenettle	Y	Unc
Lemnaceae	<i>Lemna minor</i>	common duckweed	Y	Unc
Lemnaceae	<i>Spirodela polyrhiza</i>	giant duckweed	Y	Unc
Liliaceae	<i>Hyacinthoides nonscripta</i>	English bluebell	N	Unc
Liliaceae	<i>Maianthemum dilatatum</i>	false lily of the vally	Y	Abun
Liliaceae	<i>Maianthemum racemosum</i>	feathery false lily of the vally	Y	Unc
Liliaceae	<i>Narcissus sp.</i>	daffodil	N	Unc
Liliaceae	<i>Prosartes smithii</i>	largeflower fairybells	Y	Unc
Liliaceae	<i>Streptopus amplexifolius</i>	clasping twistedstalk	Y	Rare
Liliaceae	<i>Trillium ovatum</i>	Pacific trillium	Y	Unc
Lycopodiaceae	<i>Lycopodium clavatum</i>	common club moss	Y	Rare
Lythraceae	<i>Lythrum hyssopifolia</i>	hyssop loosestrife	N	Rare
Lythraceae	<i>Lythrum portula</i>	spatulaleaf loosestrife	N	Unc
Lythraceae	<i>Lythrum salicaria</i>	purple loosestrife	N	Unc
Malvaceae	<i>Sidalcea hendersonii</i>	Henderson's checkerbloom	Y	Rare
Monotropaceae	<i>Monotropa uniflora</i>	Indian pipe	Y	Rare
Myricaceae	<i>Morella californica</i>	California wax myrtle	Y	Unc
Najadaceae	<i>Najas flexilis</i>	nodding waternymph	Y	Unc
Nyctaginaceae	<i>Abronia latifolia</i>	coastal sand verbena	Y	Rare
Nymphaeaceae	<i>Nuphar lutea ssp. polysepala</i>	Rocky Mountain cowlily	Y	Com
Nymphaeaceae	<i>Nymphaea odorata</i>	white waterlily	N	Unc
Onagraceae	<i>Chamerion angustifolium</i>	fireweed	Y	Unc
Onagraceae	<i>Epilobium ciliatum ssp. glandulosum</i>	fringed willowherb	Y	Unc
Onagraceae	<i>Epilobium minutum</i>	chaparral willowherb	Y	Rare
Onagraceae	<i>Fuchsia magellanica</i>	hardy fuchsia	N	Rare
Onagraceae	<i>Ludwigia palustris</i>	marsh seedbox	Y	Com
Onagraceae	<i>Oenothera glazioviana</i>	redsepal evening-primrose	N	Unc
Ophioglossaceae	<i>Botrychium multifidum</i>	leathery grapefern	Y	Unc
Orchidaceae	<i>Goodyera oblongifolia</i>	rattlesnake plantain	Y	Unc
Orchidaceae	<i>Spiranthes romanzoffiana</i>	hooded lady's tresses	Y	Rare
Oxalidaceae	<i>Oxalis oregana</i>	redwood-sorrel	Y	Com
Oxalidaceae	<i>Oxalis trilliifolia</i>	threeleaf woodsorrel	Y	Unc
Papaveraceae	<i>Eschscholzia californica</i>	California goldenpoppy	Y	Unc
Pinaceae	<i>Abies grandis</i>	silver fir	Y	Unc
Pinaceae	<i>Abies procera</i>	noble fir	Y	Rare
Pinaceae	<i>Cedrus libani</i>	cedar of Lebanon	N	Rare
Pinaceae	<i>Picea sitchensis</i>	coast spruce	Y	Com
Pinaceae	<i>Pinus contorta var. contorta</i>	beach pine	Y	Unc
Pinaceae	<i>Pinus nigra</i>	australian pine	N	Unc

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Pinaceae	<i>Pinus pinaster</i>	cluster pine	N	Unc
Pinaceae	<i>Pinus sylvestris</i>	Scots pine	N	Unc
Pinaceae	<i>Pseudotsuga menziesii</i>	Douglas-fir	Y	Unc
Pinaceae	<i>Tsuga heterophylla</i>	pacific hemlock	Y	Abun
Plantaginaceae	<i>Plantago coronopus</i>	buckhorn plantain	N	Com
Plantaginaceae	<i>Plantago elongata</i>	prairie plantain	Y	Rare
Plantaginaceae	<i>Plantago lanceolata</i>	ribwort	N	Com
Plantaginaceae	<i>Plantago major</i>	rippleseed plantain	N	Com
Plantaginaceae	<i>Plantago psyllium</i>	sand plantain	N	Rare
Plantaginaceae	<i>Plantago subnuda</i>	tall coastal plantain	Y	Unc
Plumbaginaceae	<i>Armeria maritima ssp. californica</i>	California seapink	Y	Unc
Poaceae	<i>Agrostis capillaris</i>	colonial bentgrass	N	Unc
Poaceae	<i>Agrostis exarata</i>	spike bentgrass	Y	Com
Poaceae	<i>Agrostis pallens</i>	seashore bentgrass	Y	Unc
Poaceae	<i>Agrostis scabra</i>	rough bent	Y	Unc
Poaceae	<i>Agrostis stolonifera</i>	spreading bent	N	Com
Poaceae	<i>Aira praecox</i>	yellow hairgrass	N	Com
Poaceae	<i>Alopecurus geniculatus</i>	marsh meadow-foxtail	Y	Com
Poaceae	<i>Alopecurus pratensis</i>	field meadow-foxtail	N	Com
Poaceae	<i>Ammophila arenaria</i>	European beachgrass	N	Abun
Poaceae	<i>Ammophila breviligulata</i>	American beachgrass	N	Abun
Poaceae	<i>Anthoxanthum odoratum</i>	sweet vernalgrass	N	Unc
Poaceae	<i>Bromus carinatus</i>	California brome	Y	Unc
Poaceae	<i>Bromus diandrus</i>	rippgut brome	N	Unc
Poaceae	<i>Bromus hordeaceus ssp. hordeaceus</i>	downy brome	N	Com
Poaceae	<i>Bromus sitchensis var. sitchensis</i>	Sitka brome	Y	Com
Poaceae	<i>Bromus sterilis</i>	poverty brome	N	Unc
Poaceae	<i>Cynosurus echinatus</i>	bristly dogstail grass	N	Unc
Poaceae	<i>Dactylis glomerata</i>	cocksfoot	N	Com
Poaceae	<i>Danthonia californica</i>	California oatgrass	Y	Unc
Poaceae	<i>Deschampsia caespitosa</i>	tufted hairgrass	Y	Com
Poaceae	<i>Deschampsia elongata</i>	slender hairgrass	Y	Unc
Poaceae	<i>Digitaria sanguinalis</i>	hairy crab grass	N	Com
Poaceae	<i>Echinochloa crus-galli</i>	Japanese millet	N	Unc
Poaceae	<i>Elymus repens</i>	quackgrass	N	Unc
Poaceae	<i>Festuca rubra</i>	red fescue	Y	Unc
Poaceae	<i>Glyceria grandis</i>	American mannagrass	Y	Rare
Poaceae	<i>Glyceria leptostachya</i>	davy mannagrass	Y	Unc
Poaceae	<i>Holcus lanatus</i>	common velvetgrass	N	Com
Poaceae	<i>Leymus mollis ssp. mollis</i>	American dunegrass	Y	Abun
Poaceae	<i>Lolium perenne</i>	perennial	N	Com
Poaceae	<i>Lolium perenne ssp. multiflorum</i>	Italian ryegrass	N	Com
Poaceae	<i>Phalaris arundinacea</i>	reed canary grass	N	Com
Poaceae	<i>Poa annua</i>	walkgrass	N	Com
Poaceae	<i>Poa bulbosa</i>	bulbous bluegrass	N	Unc
Poaceae	<i>Poa compressa</i>	Canada bluegrass	N	Unc

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Poaceae	<i>Poa howellii</i>	Howell's bluegrass	N	Unc
Poaceae	<i>Poa macrantha</i>	seashore bluegrass	Y	Rare
Poaceae	<i>Poa pratensis</i>	Kentucky bluegrass	Y	Com
Poaceae	<i>Poa trivialis</i>	rough bluegrass	N	Rare
Poaceae	<i>Poa unilateralis</i>	ocean-bluff bluegrass	Y	Rare
Poaceae	<i>Polypogon monspeliensis</i>	annual rabbitsfoot grass	N	Unc
Poaceae	<i>Schedonorus arundinaceus</i>	tall fescue	N	Com
Poaceae	<i>Torreyochloa pallida</i> var. <i>pauciflora</i>	pale false mannagrass	Y	Unc
Poaceae	<i>Trisetum canescens</i>	tall trisetum	Y	Unc
Poaceae	<i>Triticum aestivum</i>	common wheat	N	Unc
Poaceae	<i>Vulpia bromoides</i>	brome fescue	N	Unc
Polemoniaceae	<i>Navarretia squarrosa</i>	skunkbush	Y	Unc
Polygonaceae	<i>Polygonum amphibium</i> var. <i>emersum</i>	colored smartweed	Y	Unc
Polygonaceae	<i>Polygonum aviculare</i>	prostrate knotweed	N	Unc
Polygonaceae	<i>Polygonum cuspidatum</i>	Japanese knotweed	N	Rare
Polygonaceae	<i>Polygonum hydropiper</i>	annual smartweed	N	Unc
Polygonaceae	<i>Polygonum hydropiperoides</i>	swamp smartweed	Y	Unc
Polygonaceae	<i>Polygonum hydropiperoides</i> <i>hydropiperoides</i>	waterpepper	Y	Unc
Polygonaceae	<i>Polygonum paronychia</i>	beach knotweed	Y	Unc
Polygonaceae	<i>Polygonum persicaria</i>	ladysthumb smartweed	N	Unc
Polygonaceae	<i>Rumex acetosella</i>	sheep sorrel	N	Com
Polygonaceae	<i>Rumex aquaticus</i> var. <i>fenestratus</i>	western dock	Y	Unc
Polygonaceae	<i>Rumex conglomeratus</i>	clustered dock	N	Unc
Polygonaceae	<i>Rumex crispus</i>	Curley dock	N	Unc
Polygonaceae	<i>Rumex maritimus</i>	golden dock	Y	Rare
Polygonaceae	<i>Rumex obtusifolius</i>	bitter dock	N	Com
Polypodiaceae	<i>Polypodium glycyrrhiza</i>	licorice fern	Y	Com
Polypodiaceae	<i>Polypodium scolieri</i>	leathery polypody	Y	Com
Portulacaceae	<i>Claytonia perfoliata</i>	miner's lettuce	Y	Unc
Portulacaceae	<i>Claytonia sibirica</i>	Siberian springbeauty	Y	Com
Portulacaceae	<i>Montia fontana</i>	annual water miner's lettuce	Y	Rare
Portulacaceae	<i>Montia parvifolia</i> ssp. <i>flagellaris</i>	littleleaf minerslettuce	Y	Rare
Potamogetonaceae	<i>Potamogeton crispus</i>	curly pondweed	N	Unc
Potamogetonaceae	<i>Potamogeton foliosus</i>	leafy pondweed	Y	Unc
Potamogetonaceae	<i>Potamogeton gramineus</i>	grassy pondweed	Y	Unc
Potamogetonaceae	<i>Potamogeton zosteriformis</i>	flat-stem pondweed	Y	Unc
Primulaceae	<i>Lysimachia terrestris</i>	earth loosestrife	N	Unc
Primulaceae	<i>Samolus valerandi</i> ssp. <i>parviflorus</i>	water brookweed	Y	Rare
Pteridaceae	<i>Adiantum aleuticum</i>	maidenfern	Y	Rare
Pyrolaceae	<i>Moneses uniflora</i>	single delight	Y	Rare
Ranunculaceae	<i>Ranunculus acris</i>	meadow buttercup	N	Rare
Ranunculaceae	<i>Ranunculus ficaria</i>	fig buttercup	N	Rare

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Ranunculaceae	<i>Ranunculus flammula</i>	greater creeping spearwort	Y	Unc
Ranunculaceae	<i>Ranunculus repens</i>	creeping buttercup	N	Com
Ranunculaceae	<i>Ranunculus sceleratus</i>	celeryleaf buttercup	Y	Rare
Ranunculaceae	<i>Ranunculus uncinatus</i>	hooked buttercup	Y	Unc
Rhamnaceae	<i>Frangula purshiana</i>	cascara buckthorn	Y	Unc
Rosaceae	<i>Amelanchier alnifolia</i>	Saskatoon serviceberry	Y	Rare
Rosaceae	<i>Aphanes microcarpa</i>	slender parsley piert	N	Rare
Rosaceae	<i>Argentina egedii</i> ssp. <i>egedii</i>	Pacific silverweed	Y	Com
Rosaceae	<i>Aruncus dioicus</i> var. <i>vulgaris</i>	bride's feathers	Y	Unc
Rosaceae	<i>Cotoneaster franchetii</i>	orange cotoneaster	N	Rare
Rosaceae	<i>Cotoneaster horizontalis</i>	rockspray cotoneaster	N	Unc
Rosaceae	<i>Crataegus douglasii</i>	black hawthorn	Y	Unc
Rosaceae	<i>Crataegus monogyna</i>	oneseed hawthorn	N	Rare
Rosaceae	<i>Fragaria chiloensis</i>	beach strawberry	Y	Com
Rosaceae	<i>Geum macrophyllum</i> var. <i>macrophyllum</i>	large-leaf avens	Y	Com
Rosaceae	<i>Malus fusca</i>	Oregon crabapple	Y	Com
Rosaceae	<i>Malus pumila</i>	paradise apple	N	Unc
Rosaceae	<i>Oemleria cerasiformis</i>	Indian plum	Y	Unc
Rosaceae	<i>Physocarpus capitatus</i>	Pacific ninebark	Y	Unc
Rosaceae	<i>Prunus avium</i>	sweet cherry	N	Unc
Rosaceae	<i>Prunus cerasus</i>	sour cherry	N	Rare
Rosaceae	<i>Prunus domestica</i>	European plum	N	Unc
Rosaceae	<i>Rosa nutkana</i>	Nootka rose	Y	Com
Rosaceae	<i>Rubus armeniacus</i>	Himalaya blackberry	N	Com
Rosaceae	<i>Rubus laciniatus</i>	cut-leaved blackberry	N	Com
Rosaceae	<i>Rubus parviflorus</i>	thimbleberry	Y	Unc
Rosaceae	<i>Rubus spectabilis</i>	salmonberry	Y	Com
Rosaceae	<i>Rubus ursinus</i>	California blackberry	Y	Com
Rosaceae	<i>Sorbaria arborea</i>	giant false spiraea	N	Rare
Rosaceae	<i>Sorbus aucuparia</i>	European mountainash	N	Unc
Rosaceae	<i>Spiraea douglasii</i>	rose spirea	Y	Unc
Rubiaceae	<i>Galium aparine</i>	sticky-willy	Y	Com
Rubiaceae	<i>Galium trifidum</i>	small bedstraw	Y	Unc
Rubiaceae	<i>Galium trifidum</i> ssp. <i>columbianum</i>	threepetal bedstraw	Y	Com
Rubiaceae	<i>Galium triflorum</i>	fragrant bedstraw	Y	Unc
Salicaceae	<i>Populus balsamifera</i> ssp. <i>trichocarpa</i>	balsam poplar	Y	Unc
Salicaceae	<i>Salix alba</i>	golden willow	N	Unc
Salicaceae	<i>Salix hookeriana</i>	dune willow	Y	Com
Salicaceae	<i>Salix lucida</i> ssp. <i>lasiandra</i>	Pacific willow	Y	Unc
Salicaceae	<i>Salix scouleriana</i>	Scouler's willow	Y	Unc
Salicaceae	<i>Salix sitchensis</i>	Sitka willow	Y	Unc
Saxifragaceae	<i>Boykinia occidentalis</i>	coastal brookfoam	Y	Unc
Saxifragaceae	<i>Chrysosplenium glechomifolium</i>	Pacific golden saxifrage	Y	Rare

Table D-1. Vascular plant list for the legislative units of LEWI, ordered by family and scientific name (continued).

Family	Scientific name	Common name	Native	Abundance
Saxifragaceae	<i>Heuchera micrantha</i> var. <i>diversifolia</i>	crevice alumroot	Y	Unc
Saxifragaceae	<i>Tellima grandiflora</i>	bigflower tellima	Y	Rare
Saxifragaceae	<i>Tiarella trifoliata</i>	threeleaf foamflower	Y	Unc
Saxifragaceae	<i>Tiarella trifoliata</i> var. <i>trifoliata</i>	threeleaf foamflower	Y	Unc
Saxifragaceae	<i>Tolmiea menziesii</i>	youth on age	Y	Unc
Scrophulariaceae	<i>Castilleja affinis</i> ssp. <i>litoralis</i>	Pacific paintbrush	Y	Unc
Scrophulariaceae	<i>Castilleja ambigua</i> ssp. <i>ambigua</i>	johnny-nip	Y	Unc
Scrophulariaceae	<i>Cymbalaria muralis</i>	Kenilworth ivy	N	Rare
Scrophulariaceae	<i>Digitalis purpurea</i>	purple foxglove	N	Com
Scrophulariaceae	<i>Mimulus dentatus</i>	coastal monkeyflower	Y	Unc
Scrophulariaceae	<i>Mimulus guttatus</i>	yellow monkeyflower	Y	Unc
Scrophulariaceae	<i>Parentucellia viscosa</i>	yellow glandweed	N	Unc
Scrophulariaceae	<i>Scrophularia californica</i>	California figwort	Y	Unc
Scrophulariaceae	<i>Scrophularia californica</i> ssp. <i>californica</i>	California figwort	Y	Unc
Scrophulariaceae	<i>Triphysaria pusilla</i>	dwarf owl's-clover	Y	Unc
Scrophulariaceae	<i>Veronica americana</i>	American speedwell	Y	Unc
Scrophulariaceae	<i>Veronica arvensis</i>	rock speedwell	N	Unc
Scrophulariaceae	<i>Veronica scutellata</i>	grass-leaf speedwell	Y	Unc
Scrophulariaceae	<i>Veronica serpyllifolia</i> ssp. <i>serpyllifolia</i>	thymeleaf speedwell	N	Unc
Selaginellaceae	<i>Selaginella oregana</i>	Oregon spikemoss	Y	Unc
Solanaceae	<i>Solanum dulcamara</i>	woody nightshade	N	Unc
Sparganiaceae	<i>Sparganium angustifolium</i>	narrow leaf bur reed	Y	Com
Sparganiaceae	<i>Sparganium eurycarpum</i>	broad fruit bur reed	Y	Unc
Taxaceae	<i>Taxus brevifolia</i>	Pacific yew	Y	NA
Thymelaeaceae	<i>Daphne laureola</i>	spurge laurel	N	Unc
Typhaceae	<i>Typha angustifolia</i>	narrow-leaf cat-tail	N	Com
Typhaceae	<i>Typha latifolia</i>	cattail	Y	Com
Urticaceae	<i>Urtica dioica</i> ssp. <i>gracilis</i>	California nettle	Y	Unc
Valerianaceae	<i>Plectritis congesta</i> ssp. <i>brachystemon</i>	shortspur seablush	Y	Unc
Valerianaceae	<i>Valerianella locusta</i>	Lewiston cornsalad	N	Rare
Violaceae	<i>Viola adunca</i>	early blue violet	Y	Rare
Violaceae	<i>Viola glabella</i>	pioneer violet	Y	Unc
Violaceae	<i>Viola sempervirens</i>	evergreen violet	Y	Rare
Zannichelliaceae	<i>Zannichellia palustris</i>	horned-pondweed	Y	Unc

Appendix E: Simplified Field Key for Natural Map Classes

Upland Non-Forest Groups

Non-forested, headlands, coastal islands and upland grasslands **Herbaceous Headland**
Grass dominated sand dune communities:.....**Grass Dune**
Shrub dominated sand dune communities:.....**Shrub Dune**

Wetland Non-Forested Groups

1. TIDAL -By OCEAN or Columbia River

Salt marshes **Salt-Brackish Marsh**
Wetlands with tidal influence from the rivers, but with not salt-brackish marsh.....**Tidal Freshwater Marsh**

2. IN OR BY RIVERS, LAKES or STREAMS

Riparian Shrubland and Meadows, with Willow **Willow Riparian Wetland**
Floating or floating/rooted vegetation in lakes or ponds **Aquatic Bed**
Other freshwater marsh**Nontidal Freshwater Marsh**

Forested Upland Alliances

1. Hardwood or Hardwood-Conifer mixed Upland Types

Red alder dominant or important, > 40% cover**Alder Upland**
Big-leaf maple dominant or important, > 25% cover..... **Big-leaf Maple Upland**

2. Conifer Upland Types

Sitka spruce dominant or important > 10% PISI cover **Sitka Spruce Upland**
Tree (shorepine and spruce) dominated sand dune communities..... **Sitka Spruce or Pine Dune**
Western hemlock and Douglas-fir dominant, wet sites with salmonberry **Hemlock Wet Upland**
Western hemlock and Douglas-fir dominant, mesic sites without salmonberry.....**Hemlock Mesic Upland**

Forested Wetland and Riparian Alliances

1. Conifer Dominated Types

Swamp or wetland or riparian with conifers (80% of canopy). Skunk cabbage and salmonberry present and very few shrubs are present..... **Conifer Swamp and Riparian**

2. Mixed Conifer -Deciduous or Deciduous types

Riparian forest canopy dominated by Alder, > 50% cover..... **Alder Swamp and Riparian**

Appendix F: Map Class Descriptions

This appendix provides descriptions of the map classes used in creation of the LEWI vegetation map. Each description includes a list of plant association components, a summary of the distribution and floristic composition of the class, total hectares and acres of the class found within the LEWI park boundary as derived from the GIS, and representative photographs of the class. In addition, relationships between classes (e.g., successional roles and transitions) are discussed. Detailed descriptions of the vegetation types found at LEWI are found in the classification document included as Appendix A.

The map class descriptions are presented in the following order, starting with land cover types followed by wetland, upland forest, dune, and graminoid types:

1	Impervious Surface.....	F-1
2	Cliff.....	F-2
3	Beach.....	F-2
4	Water.....	F-3
5	Tidal Fresh-Brackish Marsh.....	F-4
6	Salt Marsh.....	F-5
7	Nontidal Freshwater Marsh.....	F-7
8	Willow Swamp.....	F-8
9	Alder Swamp and Riparian.....	F-9
10	Conifer Swamp and Riparian.....	F-11
11	Alder Upland Forest.....	F-13
12	Bigleaf Maple Upland Forest.....	F-14
13	Mesic Hemlock Upland Forest.....	F-15
14	Wet Hemlock Upland Forest.....	F-17
15	Sitka Spruce Upland Forest.....	F-19
16	Sitka Spruce Upland Forest- Young...	F-21
17	Disturbed Forest.....	F-22
18	Sitka Spruce Dune.....	F-23
19	Pine Dune.....	F-24
20	Shrub Dune.....	F-26
21	Herbaceous Headland.....	F-27
22	Grass Dune.....	F-29
23	Non-Native Herbaceous.....	F-30
24	Lawn and Pasture.....	F-31

1. Impervious Surface

Description: This map class was used to depict impervious man-made structures such as roads, buildings, and parking lots. These lands are typified by development or modification, with minimal natural features.

Associations: N/A

Distribution: Found in all park units.

Total Mapped Cover:

Hectares	Acres	% Cover
84	207	2.2

2. Cliff

Description: These are generally small, open, rocky areas <2 acres along the shoreline that may or may not be sparsely vegetated. Adjacent map classes include Alder Upland and Sitka Spruce Forest along the tops of the cliffs. This type was manually mapped where it was found in fairly large patches at both Ecola and Cape Disappointment State Parks. The few small patches from Dismal Nitch and Middle Village/Station Camp were too small to be mapped. While being quite noticeable from the ground, because these are so vertical, none of the areas come close to the minimum mapping unit. Along the coast, these can be barren, forb-dominated, or have occasional shrubs or trees. Determining cover for these areas can be difficult.

Group: Vancouverian Lowland and Coastal Cliffs, Bluffs and Rock Vegetation Group

Alliance/Associations: None defined

Distribution: Cape Disappointment, Ecola.

Total Mapped Cover:

Hectares	Acres	% Cover
25.9	64.0	0.7



3. Beach

Description: The beach map class applies to areas of open sand adjacent to the Pacific Ocean or Columbia River that are without vegetation, or where vegetation is very sparse (<5% cover).

Alliance/Associations: None Defined

Distribution: Present at Cape Disappointment, Ecola, Fort Stevens, Middle Village/Station Camp/Fort Columbia, and Sunset Beach/Yeon.

Total Mapped Cover:

Hectares	Acres	% Cover
85.9	212.2	2.3



4. Water

Description: This map class was used to depict standing water such as lakes and ponds. Seasonally flooded and vegetated wetland areas were classified as the appropriate wetland type (e.g., Willow Swamp, Non-Tidal Freshwater Marsh).

Alliance/Associations: None defined

Distribution: Cape Disappointment, Dismal Nitch, Middle Village/Station Camp/Fort Columbia, Fort Clatsop, Fort Stevens, Sunset Beach/Yeon.

Total Mapped Cover:

Hectares	Acres	% Cover
50.8	125.4	1.4



5. Tidal Fresh-Brackish Marsh

Description: These marshes are often adjacent to salt marshes, but are slightly higher in elevation, found further inland or otherwise separated from regular inundation by salt water. They receive a mix of salt and fresh water. Although similar to the Temperate Pacific Tidal Salt and Brackish Marsh Group, these marshes experience less saltwater influence due to slightly higher elevation zones that flood infrequently. These marshes form when there is a freshwater source that mixes with coastal ocean saltwater. Occurrences can be small or large patch, and individual associations are confined to specific environments defined by ranges of salinity, tidal inundation regime, and soil texture. Several small patches of these marshes are found in the park, identified by the dominant graminoid present.

Alliances:

- A.1433 *Schoenoplectus acutus* (*Schoenoplectus pungens*) Semi-Permanently Flooded Herbaceous Alliance
- Bulrush Semi-Permanently Flooded Herbaceous Alliance

Associations:

CEGL001840	<i>Schoenoplectus acutus</i> Herbaceous Vegetation
CWWA000146	<i>Schoenoplectus pungens</i> Herbaceous Vegetation (Pacific estuarine, provisional)

Distribution: Cape Disappointment, Fort Clatsop, Fort Stevens, Middle Village/Station Camp/Fort Columbia.

Total Mapped Cover:

Hectares	Acres	% Cover
63.5	157.0	1.7



6. Salt Marsh

Description: Several types of salt marsh are present at LEWI but many are in patches smaller than the minimal mapping unit. Distinguishing species through the imagery can be difficult, thus they are merged into a single salt marsh map class. This group consists of the intertidal salt marshes and brackish marshes found throughout the North American Pacific Coast, from Kodiak Island and south-central Alaska, south along the coast throughout British Columbia, Washington, Oregon, California, Baja California and the Sonoran coast along the Gulf of California, including coastal marshes along the Colorado River Delta and other river deltas such as the Rio Yaqui. Primarily associated with estuaries or coastal lagoons, salt marshes are limited to bays, behind sand spits or other locations protected from wave action. Vegetation ranges from very dense thickets to open and sparse. Dominant plant species change from north to south, but communities have many species in common which include *Batis maritima*, *Carex lyngbyei*, *Carex ramenskii*, *Cochlearia groenlandica* (= *Cochlearia officinalis*), *Distichlis spicata*, *Eleocharis palustris*, *Glaux maritima*, *Jaumea carnosa*, *Limonium californicum*, *Monanthochloe littoralis*, *Hippuris tetraphylla*, *Honckenya peploides*, *Plantago maritima*, *Puccinellia* spp., *Salicornia virginica*, *Salicornia* spp., *Spergularia canadensis*, *Suaeda* spp., *Triglochin maritima*, and/or *Triglochin* spp. Additionally, there is a *Salicornia virginica* salt marsh at Fort Stevens.

Alliances:

A.2622 *Carex lyngbyei* Tidal Herbaceous Alliance
Lyngbye's Sedge Herbaceous Vegetation

A.2618 *Salicornia virginica* Tidal Herbaceous Alliance
Virginia Glasswort Tidal Herbaceous Alliance

A.2623 *Deschampsia caespitosa* Tidal Herbaceous Alliance
Tufted hairgrass Tidal Herbaceous Alliance

Associations:

ELCODE	Scientific Name
CEGL003285	<i>Carex lyngbyei</i> - (<i>Distichlis spicata</i> , <i>Triglochin maritima</i>) Herbaceous Vegetation
CEGL003289	<i>Carex lyngbyei</i> - <i>Argentina egedii</i> Herbaceous Vegetation
CEGL003369	<i>Carex lyngbyei</i> Herbaceous Vegetation
CEGL003466	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Jaumea carnosa</i> Tidal Herbaceous Vegetation
CEGL003380	<i>Salicornia virginica</i> Herbaceous Vegetation
CEGL003383	<i>Deschampsia caespitosa</i> - <i>Argentina egedii</i> Herbaceous Vegetation
CEGL003366	<i>Salicornia virginica</i> - <i>Distichlis spicata</i> - <i>Triglochin maritima</i> - (<i>Jaumea carnosa</i>) Herbaceous Vegetation

Distribution: Cape Disappointment, Fort Stevens.

Total Mapped Cover:

Hectares	Acres	% Cover
104.2	257.4	2.8



7. Non-tidal Freshwater Marsh

Description: This map class includes a variety of freshwater marsh or aquatic bed alliances and associations. These include freshwater marshes or swamps characterized by Sitka sedge, slough sedge, bur-reed, cattail, or spikerush. Semi-aquatic or floating vegetation is also included in this map class. Many of these associations are below the minimum mapping unit. The vegetation types in this map class are characterized by standing freshwater or permanently saturated soils without the influence of tides or salt water. Detailed descriptions of these types are found in the classification document included in Appendix A.

Alliances:

A.1412 *Carex aquatilis* var. *dives* Semi-permanently Flooded Herbaceous Alliance
Sitka sedge Semi-permanently Flooded Herbaceous Alliance

A.NCCN-NEW4 *Typha (angustifolia, latifolia)* Freshwater Marsh Alliance
Broad or Narrow Cattail Freshwater Marsh Alliance

A.2582 *Carex obnupta* Seasonally Flooded Herbaceous Alliance
Slough sedge Seasonally Flooded Herbaceous Alliance

A.2598 *Sparganium eurycarpum* Hydromorphic Rooted Herbaceous Vegetation
Giant Bur-reed Hydromorphic Rooted Herbaceous Vegetation

A.1342 *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance
Common Spikerush Seasonally Flooded Herbaceous Alliance

A.NCCN-NEW5. *Nuphar* spp. - *Potamogeton* spp. - *Lemna* spp. Freshwater Aquatic Group
Spatterdock -Pondweed -Duckweed Freshwater Aquatic Alliance

Associations:

ELCODE	Scientific Name
CEGL001826	<i>Carex aquatilis</i> var. <i>dives</i> Herbaceous Vegetation
CEGL001820	<i>Carex obnupta</i> - <i>Argentina egedii</i> Herbaceous Vegetation
CEGL003313	<i>Carex obnupta</i> Herbaceous Vegetation
CEGL001990	<i>Sparganium angustifolium</i> Herbaceous Vegetation
CEGL001833	<i>Eleocharis palustris</i> Herbaceous Vegetation
CEGL002010	<i>Typha (latifolia, angustifolia)</i> Western Herbaceous Vegetation
CEGL003017	<i>Azolla (filiculoides, mexicana)</i> Herbaceous Vegetation
CEGL004017	<i>Ceratophyllum demersum</i> Western Herbaceous Vegetation [Provisional]
CEGL003305	<i>Lemna minor</i> Herbaceous Vegetation

CEGL002001	<i>Nuphar polysepala</i> Herbaceous Vegetation
CEGL002925	<i>Potamogeton natans</i> Herbaceous Vegetation
NEW	<i>Hydrocotyle ranunculoides</i> Herbaceous Vegetation

Distribution: Present in all park units.

Total Mapped Cover:

Hectares	Acres	% Cover
128.1	316.6	3.4



8. Willow Swamp

Description: This is a seasonally flooded shrubland alliance found in deflation plains and wetter areas within 3 km of saltwater that are seasonally flooded and saturated with freshwater. They can be small areas on small wet depressions in deflation plains or large surrounding ponds and lakes. Hooker's willow is the dominant shrub and the indicator for this type; we have also included rose spiraea flooded shrublands in this map class. Small amounts of red alder, Oregon crab apple, and California wax myrtle are often present. This type is found in all the LEWI units. Communities within this cold-deciduous, seasonally flooded shrubland alliance seldom occur more than 3 km from saltwater, often in stabilized dunes just behind the open beach. They are limited to the wetter areas where water stands to some extent during the year on deflation (wind erosion) plains and swales. These associations are found in habitats that are seasonally flooded and saturated with freshwater. Information on soils was not available. They are dominated by *Salix hookeriana*. Other codominant shrubs can include *Populus balsamifera*, *Populus fremontii*, and *Alnus rubra*. The understory is sparse but can include *Rubus ursinus*, *Baccharis pilularis*, and *Morella californica* (= *Myrica californica*). Adjacent upslope communities typically are *Picea sitchensis* with *Cornus sericea*. This alliance is limited to the western coast from southern British Columbia, Canada, to northern California.

Alliances:

A.NCCN-999 *Salix hookeriana* Seasonally Flooded Shrubland Alliance
 Hooker's Willow Seasonally Flooded Shrubland Alliance

A.NCCN-997 *Spiraea douglasii* Seasonally Flooded Shrubland Alliance
 Douglas' Meadowsweet Seasonally Flooded Shrubland Alliance

A.2068 *Salix* spp. -*Malus fusca* - *Spiraea* spp. Lowland Riparian & Wet Slope Shrubland Alliance

Associations:

ELCODE	Scientific Name
CEGL003432	<i>Salix hookeriana</i> (<i>Malus fusca</i>) / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> shrubland
CEGL001129	<i>Spiraea douglasii</i> Seasonally Flooded Shrubland
CEGL003294	<i>Malus fusca</i> - (<i>Salix hookeriana</i>) / <i>Carex obnupta</i> Shrubland

Distribution: All units.

Total Mapped Cover:

Hectares	Acres	% Cover
274.4	678.1	7.4



9. Alder Swamp and Riparian

Description: These are lowland deciduous forested swamps dominated by red alder at LEWI, with slough sedge, salmonberry, and skunk cabbage often present. This alliance occurs throughout the northern Puget Trough lowlands and in low-lying valleys near the Oregon and northern California coasts. It typically occurs along low-elevation (0-1000 m) streams or valley bottoms, along the upland margins of wetlands, or on the floodplains of streams and rivers. At LEWI, forests are dominated by *Alnus rubra*; other locations may be dominated by

Fraxinus latifolia or *Populus balsamifera* ssp. *trichocarpa*. Soils are seasonally flooded and saturated year-round. The forest undergrowth is usually dominated by a deciduous shrub layer in which *Rubus spectabilis* can be the only species. The herbaceous layer may be well-developed, with species such as *Carex obnupta*, *Athyrium filix-femina*, *Equisetum hyemale*, *Galium trifidum*, *Lonicera involucrata*, *Lysichiton americanus*, *Rubus ursinus*, *Tiarella trifoliata*, and *Tolmiea menziesii*. Also included in this map class are hardwood riparian forests dominated by *Alnus rubra* at the park, but mixed hardwoods without cottonwood elsewhere in the Coast Ranges. Conifer species, if present, are not more than 10-20% of the total cover. Shrub species can include *Rubus spectabilis* or *Rubus parviflorus*; forbs can include *Maianthemum stellatum*, *Oxalis oregana*, or *Polystichum munitum* among others. They are very common at low elevations throughout western Oregon and Washington along low-elevation streams and riparian areas, large and small rivers, but more often on steeper gradient streams. These are the only riparian forests mapped in the park, found in most of the units. The NCCN associations mostly come from a new classification of riparian forests from Northwestern Oregon by Cindy McCain of the Siuslaw National Forest (McCain and Diaz 2002), and some have not been fully integrated into the National Vegetation Classification.

Alliances:

A.NCCN-001 (*Acer macrophyllum*, *Alnus rubra*) Riparian Forest Alliance
(Bigleaf Maple, Red Alder) Riparian Forest Alliance

A.NCCN-002 (*Alnus* spp., *Fraxinus* spp., *Populus* spp.) / *Lysichiton americanus* Deciduous Swamp Woodland Alliance
(Alder species, Ash species, Cottonwood species) / Yellow Skunk-cabbage Deciduous Swamp Woodland Alliance

Associations:

ELCODE	Scientific Name
CEGL003298	<i>Alnus rubra/Acer circinatum/Claytonia sibirica</i> Forest
CEGL003401	<i>Alnus rubra/Petasites frigidus</i> Forest
CEGL003402	<i>Alnus rubra/Rubus parviflorus</i> Forest
CEGL000639	<i>Alnus rubra/Rubus spectabilis</i> Forest
CEGL003403	<i>Alnus rubra/Stachys chamissonis</i> var. <i>cooleyae</i> - <i>Tolmiea menziesii</i> Forest
CEGL003398	<i>Alnus rubra/Elymus glaucus</i> Forest
CEGL003388	<i>Alnus rubra/Athyrium filix-femina-Lysichiton americanus</i> Forest
NEW	<i>Alnus rubra/Glyceria striata</i> Forest
NEW	<i>Alnus rubra/Rubus spectabilis/Chrysosplenium glechomifolium</i> Forest
CEGL003389	<i>Alnus rubra/Rubus spectabilis/Carex obnupta-Lysichiton americanus</i> Woodland

Distribution: Cape Disappointment, Dismal Nitch, Ecola, Fort Clatsop, Fort Stevens, Middle Village/Station Camp/Fort Columbia.

Total Mapped Cover:

Hectares	Acres	% Cover
223.4	552.1	6.0



10. Conifer Swamp and Riparian

Description: These are coastal conifer forested swamps, dominated by Sitka spruce at LEWI.

Soils are seasonally flooded and saturated year-round. Slough sedge and skunk cabbage are often present. Forests are dominated by conifer species (typically *Picea sitchensis* at LEWI but including *Tsuga heterophylla*, *Thuja plicata*, and *Abies amabilis* throughout the region) which are well-adapted to wet soil conditions and highly shade-intolerant. The forest undergrowth is usually dominated by herbaceous species only, with little shrub layer. The herbaceous layer may be well-developed, with species such as *Carex obnupta*, *Athyrium filix-femina*, *Equisetum hyemale*, *Galium trifidum*, *Lonicera involucrata*, *Lysichiton americanus*, *Rubus ursinus*, *Tiarella trifoliata*, and *Tolmiea menziesii*. These are small-patch (<2 acres) coniferous wetlands and will be difficult to see/differentiate from surrounding upland forests. They may have a more open canopy, and infrared imagery may show much more biomass in the understory visible between the trees. If occurring on flat wide floodplains, they may appear as isolated tree islands surrounding open water.

Alliances:

A.NCCN-004 (*Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata*, *Abies* spp.) / *Lysichiton americanus* Coniferous Swamp Woodland Alliance
(Western Hemlock, Sitka Spruce, Western Red-cedar, Fir species) / Yellow Skunk-cabbage Coniferous Swamp Woodland Alliance

Suggested Alternate Name: Conifer / *Lysichiton americanus* Coniferous Swamp Woodland

Associations:

ELCODE	Scientific Name
CEGL000400	<i>Picea sitchensis</i> / <i>Rubus spectabilis</i> / <i>Carex obnupta</i> - <i>Lysichiton americanus</i> Forest
CEGL002670	<i>Tsuga heterophylla</i> -(<i>Thuja plicata</i> - <i>Alnus rubra</i>)/ <i>Lysichiton americanus</i> - <i>Athyrium filix-femina</i> Forest

Distribution: Fort Clatsop, Fort Stevens, and Cape Disappointment.

Total Mapped Cover:

Hectares	Acres	% Cover
9.2	22.8	0.2



Photo reproduced from Crawford et al. 2009

11. Alder Upland Forest

Description: These red alder woodlands have been mapped at most of the units at the park. These are early seral vegetation types. These mostly represent areas with frequent landslides, although can also include recent blowdowns or areas that were clearcut and not well planted with conifers. Communities within this alliance are usually strongly dominated by mixed stands of *Alnus rubra*, *Picea sitchensis*, and/or *Tsuga heterophylla*. Unlike many of the other types, at the coast it is difficult to distinguish between the completely upland types and the wetland types from the Vancouverian Flooded & Swamp Forest Macrogroup. The forest undergrowth is usually species-rich and well-developed compared to adjacent conifer forests. Common shrub species in stands of this alliance include *Alnus viridis* ssp. *sinuata*, *Rubus spectabilis*, *Sambucus racemosa* var. *melanocarpa*, *Acer circinatum*, and *Menziesia ferruginea*. The herbaceous layer is often well-developed, with *Oxalis oregana*, *Polystichum munitum*, and *Stachys mexicana* particularly common. These are large-patch (2-100 acres), distinct deciduous forests, often surrounded by coniferous forests, or in a matrix of rural and urban infrastructure. They are generally found at lower elevations (<1000 m) and may be difficult to distinguish from other deciduous forests.

Alliances:

- A. NCCN-20 *Alnus rubra*- (*Picea sitchensis*, *Tsuga heterophylla*) Forest & Woodland Alliance
- Red Alder - (Sitka Spruce, Western Hemlock) Forest & Woodland Alliance

Associations:

ELCODE	Scientific Name
CEGL000638	<i>Alnus rubra</i> / <i>Polystichum munitum</i> Forest

Distribution: Cape Disappointment, Dismal Nitch, Ecola, Fort Clatsop, Fort Columbia, Middle Village/Station Camp.

Total Mapped Cover:

Hectares	Acres	% Cover
419.4	1,036.3	11.3



12. Big-Leaf Maple Upland Forest

Description: This alliance is widespread in the Oregon and Washington Coast Ranges, but occurs in patches that are mostly too small to be mapped at LEWI. This maritime-influenced region receives annual precipitation ranging from 75-400 cm, mostly as winter rain. Vegetation within this alliance usually occurs along low-elevation (0-1000 m) valley slopes and lower mountain slopes, often forming a seral community in moist coniferous forests. This alliance is usually found within *Tsuga heterophylla* - *Thuja plicata* forests, but also grows within *Pseudotsuga menziesii* forests. This mix of deciduous and evergreen trees, dominated by *Acer macrophyllum* and *Pseudotsuga menziesii*, occurs on sites that were burned or on old hillslope landslides or inactive debris aprons. Soils can be rocky. This alliance is also common in cleared forests near human development and on the edges of farm fields and pastures. Communities within this alliance may represent early seral communities within the major coniferous forests of the region, which have been favored by past logging or other disturbances. Communities are usually strongly dominated by *Acer macrophyllum*, which forms a diffuse canopy. Some conifers, such as *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Thuja plicata*, *Picea sitchensis*, or *Abies grandis*, may be present and can usually be found growing in the understory or as occasional canopy trees. Deciduous trees, such as *Alnus rubra*, *Cornus nuttallii*, and *Betula papyrifera* (which is sometimes codominant in northwestern Washington), may also be present in the tree stratum. The forest understory is usually species-rich and well-developed compared to adjacent conifer forests in the same area. Common shrub species in stands of this alliance include *Acer circinatum* (which is always present), *Sambucus racemosa* var. *melanocarpa*, *Rubus spectabilis*, *Rubus parviflorus*, *Gaultheria shallon*, *Vaccinium membranaceum*, and *Mahonia nervosa*. The herbaceous layer is often well-developed, with ferns being the most important component. Species include *Polystichum munitum*, *Athyrium filix-femina*, and *Pteridium aquilinum*.

Alliances:

A.NCCN-019 *Acer macrophyllum* - (*Pseudotsuga menziesii*) Forest Alliance
Bigleaf Maple - (Douglas-fir) Forest Alliance

Associations:

ELCODE	Scientific Name
NEW	<i>Acer macrophyllum</i> -(<i>Pseudotsuga menziesii</i>)/ <i>Polystichum munitum</i> Forest

Distribution: Fort Clatsop, Fort Columbia.

Total Mapped Cover:

Hectares	Acres	% Cover
5.6	13.9	0.2



Photo reproduced from Crawford et al. 2009.

13. Mesic Hemlock Upland Forest

Description: Small patches of these dry forests characterized by western hemlock and Douglas-fir are found scattered through the park. Stands of the alliance generally occur on all slopes and aspects, on drained mesic sites that do not become very dry by summer's end. The overstory canopy is dominated by *Pseudotsuga menziesii* and *Tsuga heterophylla*. Understory species such as *Mahonia nervosa*, *Vaccinium membranaceum*, and *Gaultheria shallon* are intolerant of drought. Other common tree associates include *Thuja plicata*, *Abies amabilis*, and *Abies grandis*. Rarely, *Picea sitchensis* may appear, and *Chamaecyparis nootkatensis* has been documented with up to 28% cover, but neither is typically present. Shrub species are variable and include *Acer circinatum*, *Chimaphila umbellata*, *Gaultheria shallon*, *Linnaea borealis*, *Mahonia nervosa*, *Menziesia ferruginea*, *Vaccinium alaskaense*, and *Vaccinium*

parvifolium. The herbaceous layer is highly variable. The following species each occur in about one-third of documented stands: *Goodyera oblongifolia*, *Polystichum munitum*, *Achlys triphylla*, *Cornus unalaschkensis*, *Tiarella trifoliata*, *Trillium ovatum*, *Clintonia uniflora*, and *Blechnum spicant*. The diagnostic characteristic of this alliance is an overstory of both *Pseudotsuga menziesii* and *Tsuga heterophylla*, with an understory that is neither wet nor dry

Alliances:

A.NCCN-042 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Cornus unalaschkensis* Mesic Forest Alliance

Associations:

ELCODE	Scientific Name
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> / <i>Polystichum munitum</i> Forest
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> - <i>Vaccinium parvifolium</i> Forest

Distribution: Dismal Nitch, Ecola, Cape Disappointment, and Middle Village/Station Camp.

Total Mapped Cover:

Hectares	Acres	% Cover
6.9	17.0	0.2



14. Wet Hemlock Upland Forest

Description: This forest alliance occurs in relatively small patches at the Ecola State Park, Fort Columbia State Park, Dismal Nitch, and Middle Village/Station Camp. The areas at Fort Clatsop that lack mature spruce all show spruce regeneration, and clearly belong in the Sitka spruce forest group. These forests occur at low to moderate (0-460 m [0-1500 feet]) elevations, usually north-facing or otherwise protected sites that are on water-receiving topography, subirrigated or otherwise quite moist yet well-drained. They are not found on saturated soils and do not manifest as riparian or wetland in shape or species composition. These forests are characterized by a mixed canopy of *Tsuga heterophylla* and *Pseudotsuga menziesii* and can have a complex, multi-tiered structure of multiple age classes. *Thuja plicata* may codominate on valley bottom sites with poorly drained soils, and *Tsuga heterophylla* is generally the dominant regenerating tree species. Other common tree associates include *Abies grandis*, *Picea sitchensis*, *Taxus brevifolia*, *Alnus rubra*, and *Abies amabilis*. Understory species are generally intolerant of drought. Neither *Abies grandis* nor *Abies amabilis* are found at LEWI. The shrub layer is commonly composed of *Acer circinatum*, *Cornus sericea*, *Mahonia nervosa*, *Menziesia ferruginea*, *Rubus spectabilis*, or *Gaultheria shallon*. The herbaceous layer is dominated by ferns, including *Pteridium aquilinum*, *Polystichum munitum*, *Gymnocarpium dryopteris*, *Athyrium filix-femina*, and *Blechnum spicant*. Moisture-loving forbs include *Oxalis oregana*, *Achlys triphylla*, and *Tiarella trifoliata*. Diagnostic of this alliance is an upper tree canopy dominated by *Tsuga heterophylla* and *Pseudotsuga menziesii* and moist, well-drained sites.

Alliances:

A.NCCN-044 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Rubus spectabilis* Wet Forest Alliance

Western Hemlock - Douglas-fir / Salmonberry Wet Forest Alliance

Associations:

ELCODE	Scientific Name
PNWCOAST_158	<i>Pseudotsuga menziesii</i> -(<i>Alnus rubra</i> - <i>Tsuga heterophylla</i>)/ <i>Rubus spectabilis</i> Forest
PNWCOAST_195	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> /(<i>Acer circinatum</i>)/ <i>Polystichum munitum</i> Forest
PNWCOAST_191	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Mahonia nervosa</i> - <i>Polystichum munitum</i> Forest

Distribution: Fort Clatsop, Dismal Nitch.

Total Mapped Cover:

Hectares	Acres	% Cover
15.6	38.6	0.4



15. Sitka Spruce Upland Forest

Description: This is the dominant forest alliance found at the Lewis and Clark National Historic Park. It occurs throughout Ecola and Fort Clatsop, and is the dominant conifer type at Fort Columbia State Park, Cape Disappointment, Middle Village/Station Camp, and Dismal Nitch. Much of the area has been heavily impacted by a series of windstorms in which many to occasionally all of the trees have blown over. As a result, these forests at LEWI range from young, relatively short forests, to giant, mature old growth forests. Riparian forests with at least 10% spruce cover are also included in this map class. This conifer forest alliance is found within the maritime climate-influenced region of the Pacific Northwest, from northern California to southern Alaska, usually within 50 km of tidewater and below 1000 m in elevation. Stands typically occur on coastal terraces, but extend up river valleys and seaward slopes of coastal mountains. Stands occur on moderate to steep slopes with shallow to moderately deep soils and on stabilized coastal dunes with sandy soils. Forests of this alliance are dominated by *Picea sitchensis*, but *Tsuga heterophylla* and *Pseudotsuga menziesii* may codominate the canopy, especially at sites farther inland. Other common trees include *Thuja plicata* and *Abies grandis*. *Chamaecyparis nootkatensis* can be found in northern stands, while *Chamaecyparis lawsoniana* or *Sequoia sempervirens* occur in southern stands. The alliance includes more open forests or woodlands that occur on steep, ocean-facing slopes. Broad-leaved trees include the shade-tolerant *Acer macrophyllum*, which may form a sparse subcanopy in older stands. An ericaceous tall-shrub layer is common, with *Vaccinium parvifolium* or *Menziesia ferruginea* abundant at moist sites, and *Rhododendron macrophyllum*, *Vaccinium ovatum*, or *Gaultheria shallon* more important at drier sites. *Rubus spectabilis* is common and persistent following disturbance, and *Oplopanax horridus* is common at very wet sites. The herbaceous layer is dominated by mesic, shade-tolerant ferns and forbs such as *Polystichum munitum*, *Oxalis oregana*, *Maianthemum dilatatum*, *Blechnum spicant*, and *Athyrium filix-femina*. More open stands can have high cover of *Calamagrostis nutkaensis*. Mosses and lichens are abundant on logs, snags, trees, or the ground surface. The presence of an upper tree canopy that is dominated by *Picea sitchensis* is diagnostic of this forest alliance.

Alliances:

A.NCCN-005 (*Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*)-(*Alnus spp.*, *Acer spp.*) Riparian Forest Alliance
(Sitka Spruce, Grand Fir, Western Hemlock, Western Red Cedar)- (*Alder spp.*, *Maple spp.*)
Riparian Forest Alliance

A.NCCN-027 *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance
Sitka Spruce - (Western Hemlock) Forest Alliance

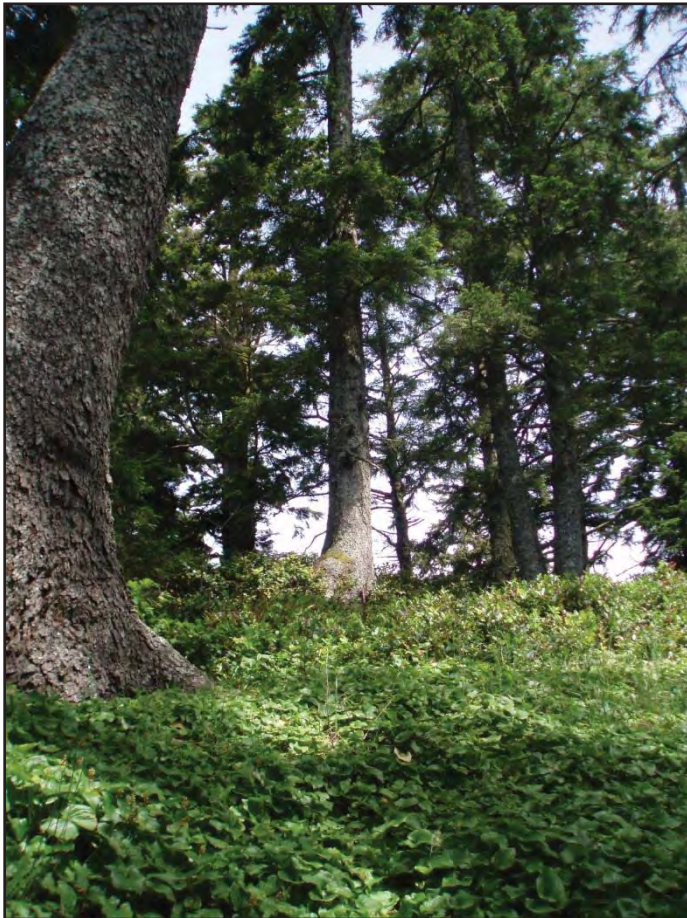
Associations:

ELCODE	Scientific Name
CEGL000060	<i>Picea sitchensis</i> -(<i>Alnus rubra</i>)/ <i>Rubus spectabilis</i> / <i>Polystichum munitum</i> Forest
CEGL003266	<i>Picea sitchensis</i> / <i>Calamagrostis nutkaensis</i> Woodland
CEGL000401	<i>Picea sitchensis</i> / <i>Gaultheria shallon</i> Forest
CEGL00XXXX	<i>Picea sitchensis</i> / <i>Maianthemum dilatatum</i> Forest
CEGL000056	<i>Picea sitchensis</i> / <i>Menziesia ferruginea</i> - <i>Vaccinium parvifolium</i> Forest
PNWCOAST_060	<i>Picea sitchensis</i> / <i>Vaccinium ovatum</i> Forest
CEGL003787	<i>Picea sitchensis</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i> Forest
Unclassified	<i>Picea sitchensis</i> / <i>Scirpus microcarpus</i> Woodland

Distribution: All units except Sunset Beach/Yeon.

Total Mapped Cover:

Hectares	Acres	% Cover
1,189.3	2,938.9	32.0



16. Sitka Spruce Upland Forest - Young

Description: These are the same coniferous forests described in the Sitka Spruce Forest map class, but these have been disturbed within the last 30-40 years and so are structurally different from undisturbed forests. Generally they are less dense and of lower height than older spruce forests. Western hemlock may dominate the canopy, but the long-term trend will be for spruce to become more important in these forests. See the Sitka Spruce Forest class description for floristic detail.

Alliances:

A.NCCN-005 (*Picea sitchensis*, *Abies grandis*, *Tsuga heterophylla*, *Thuja plicata*)-(*Alnus* spp., *Acer* spp.) Riparian Forest Alliance
 (Sitka Spruce, Grand Fir, Western Hemlock, Western Red Cedar)- (Alder spp., Maple spp.) Riparian Forest Alliance

A.NCCN-027 *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance
 Sitka Spruce - (Western Hemlock) Forest Alliance

Associations:

ELCODE	Scientific Name
CEGL000060	<i>Picea sitchensis</i> -(<i>Alnus rubra</i>)/ <i>Rubus spectabilis</i> / <i>Polystichum munitum</i> Forest
CEGL003266	<i>Picea sitchensis</i> / <i>Calamagrostis nutkaensis</i> Woodland
CEGL000401	<i>Picea sitchensis</i> / <i>Gaultheria shallon</i> Forest
CEGL00XXXX	<i>Picea sitchensis</i> / <i>Maianthemum dilatatum</i> Forest
CEGL000056	<i>Picea sitchensis</i> / <i>Menziesia ferruginea</i> - <i>Vaccinium parvifolium</i> Forest
PNWCOAST_060	<i>Picea sitchensis</i> / <i>Vaccinium ovatum</i> Forest
CEGL003787	<i>Picea sitchensis</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i> Forest
Unclassified	<i>Picea sitchensis</i> / <i>Scirpus microcarpus</i> Woodland

Distribution: Fort Clatsop.

Total Mapped Cover:

Hectares	Acres	% Cover
51.4	127.1	1.4



17. Disturbed Forest

Description: The Disturbed Forest class applies to forested areas that have been recently disturbed by storms, resulting in a significant decrease of canopy cover and many downed trees or woody debris. The recently clear-cut area at Dismal Nitch is also classified as Disturbed Forest. While the floristic composition of these forests has not been changed, the structural change is extensive. Due to the extent of the disturbance these forests will be stalled in their natural successional progression and the amount of downed wood increases the fuel load of these areas. The majority of these are disturbed Sitka spruce forests, though some western hemlock and Douglas-fir forests are also affected.

Alliances:

A.NCCN-027 *Picea sitchensis* - (*Tsuga heterophylla*) Forest Alliance
 Sitka Spruce - (Western Hemlock) Forest Alliance

A.NCCN-042 *Tsuga heterophylla* - *Pseudotsuga menziesii* / *Cornus unalaschkensis* Mesic Forest Alliance
 Western Hemlock - Douglas-fir / Western Cordilleran Bunchberry Mesic Forest Alliance

Associations:

ELCODE	Scientific Name
CEGL000401	<i>Picea sitchensis</i> / <i>Gaultheria shallon</i> Forest
CEGL00XXXX	<i>Picea sitchensis</i> / <i>Maianthemum dilatatum</i> Forest
CEGL000056	<i>Picea sitchensis</i> / <i>Menziesia ferruginea</i> - <i>Vaccinium parvifolium</i> Forest
PNWCOAST_060	<i>Picea sitchensis</i> / <i>Vaccinium ovatum</i> Forest
CEGL003787	<i>Picea sitchensis</i> - <i>Tsuga heterophylla</i> / <i>Polystichum munitum</i> Forest
NEW	<i>Pseudotsuga menziesii</i> - <i>Tsuga heterophylla</i> / <i>Gaultheria shallon</i> / <i>Polystichum munitum</i> Forest

Distribution: Dismal Nitch, Fort Stevens, Fort Clatsop, Sunset Beach.

Total Mapped Cover:

Hectares	Acres	% Cover
109.9	271.6	3.0



18. Sitka Spruce Dune

Description: This is a provisional alliance. This type is found primarily on the areas of dunes formed by the creation of the North and South Jetties at Cape Disappointment and Fort Stevens where Sitka spruce is a significant component. It can be difficult to classify due to the variety of species present, but is characterized by the presence of mid- or early-seral Sitka spruce on sandy soils. This is an early successional provisional type that occurs on sandy soils recently deposited by hydrology changes such as the building of jetties. This type occurs as native and non-native species colonize the new land area, creating a type with a diverse mix of trees and shrubs. *Picea sitchensis* is always present but *Alnus rubra* or *Pinus contorta* may also be present. The shrub layer is diverse and well developed and includes *Morella californica*, *Vaccinium ovatum*, *Gaultheria shallon*, *Salix hookeriana*, and *Malus fusca*. *Carex obnupta* or *Ammophila* spp. may also be present. This type may represent transitions between the Shrub Dune map class, and other map classes, including Alder Upland, Sitka Spruce Upland Forest depending on the species present and hydrography.

Alliances:

A.2067 North Pacific (*Pinus contorta* var. *contorta*- *Picea sitchensis*) Stabilized Dune Forest
North Pacific (Shore Pine, Sitka Spruce) Stabilized Dune Forest

Associations:

ELCODE	Scientific Name
CEGL000403	<i>Picea sitchensis</i> - <i>Pinus contorta</i> / <i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> Forest
NEW	(<i>Picea sitchensis</i> - <i>Alnus rubra</i>)/ <i>Carex obnupta</i> Stabilized Dune Forest
NEW	<i>Picea sitchensis</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i> Semi-natural Shrubland

Distribution: Cape Disappointment, Fort Stevens.

Total Mapped Cover:

Hectares	Acres	% Cover
42.0	103.9	1.1



19. Pine Dune

Description: These dune woodlands occur primarily in Fort Stevens State Park and Sunset Beach State Park with the Yeon addition, although small patches can be found in sandy areas at Cape Disappointment. They are usually found in a matrix of open dune and closed canopy *Picea sitchensis*, *Tsuga heterophylla*, and *Pseudotsuga menziesii* dominated forests. Historically they occurred in small patches in the open sandy areas between Ecola and Cape Disappointment, but as the dunes were stabilized, and the area received more and more human use, they have become dominated by non-native species. This conifer woodland alliance occurs on stabilized to semi-stabilized dunes along the coast of Oregon and northern

California. *Pinus contorta* occurs on semi-stabilized dunes along the coast of Oregon and northern California. It is best represented in natural conditions in the Oregon Dunes National Recreation Area (NRA), where small but numerous extensive stands of open shorepine occur. At the NRA, shorepine woodlands include areas with dense and tall ericaceous shrublands where *Rhododendron occidentale*, *Gaultheria shallon*, *Morella californica*, and *Vaccinium ovatum* dominate, more open areas with *Arctostaphylos columbiana* or *A. uva-ursi* in the understory, usually with dense lichen cover on much of the sand, and barely stabilized dunes with *Fragaria chiloensis*, *Lupinus littoralis*, *Pteridium aquilinum* and some *Poa macrantha* present.

Alliances:

A.NCCN-NEW1 *Pinus contorta* var. *contorta* Woodland Alliance
 Shorepine Coastal Dune Woodland Alliance (provisional)

Associations:

ELCODE	Scientific Name
CEGL002605	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Arctostaphylos uva-ursi</i> Woodland
CEGL000150	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Gaultheria shallon</i> Woodland
CEGL000151	<i>Pinus contorta</i> var. <i>contorta</i> - <i>Pseudotsuga menziesii</i> / <i>Morella californica</i> - <i>Vaccinium ovatum</i> Forest
NEW	<i>Pinus contorta</i> var. <i>contorta</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i> Semi-natural Forest

Distribution: Cape Disappointment, Fort Stevens, Sunset Beach/Yeon.

Total Mapped Cover:

Hectares	Acres	% Cover
496.9	1,227.8	13.4



20. Shrub Dune

Description: This type is characterized by small-stature shrubs and trees on dunes. Shorepine or Sitka spruce in this system remains stunted due to poor soils and coastal winds. Scots broom may form dense thickets. Beachgrass, dunegrass, or slough sedge may be abundant. This is a catch-all type to characterize the variety of shrub and tree species that colonize accretion zones along the Pacific Coast. These areas are often created behind jetties from deposited sand. These are early successional vegetation communities due to the new land surface, and are composed of a mix of surrounding vegetation types and species. Cover can be sparse to fairly dense. Tree species may or may not be present and are often short of stature (less than 3 m) due to sandy soils and exposure to strong coastal winds. In the Pacific Northwest common tree and shrub species include *Pinus contorta* var. *contorta*, *Picea sitchensis*, *Salix hookeriana*, *Vaccinium ovatum*, and *Malus fusca*. *Cytisus scoparius* can form monocultures in some areas if it becomes established before native vegetation. *Carex obnupta* is a common component; *Ammophila* spp. may be abundant at sites closer to the ocean. This alliance is very similar to the North Pacific (*Pinus contorta* var. *contorta* -*Picea sitchensis*) Stabilized Dune Forest, but differs in having fewer trees of shorter height, fewer shrub species present, and a higher cover of graminoids.

Alliances:

A.NCCN-NEW3 North Pacific (*Pinus contorta* var. *contorta* - *Picea sitchensis* - *Gaultheria shallon* - *Vaccinium ovatum* - *Cytisus scoparius*) Stabilized Dune Shrubland
North Pacific (Shore pine -Sitka Spruce -Salal -Evergreen Huckleberry -Scots Broom)
Stabilized Dune Shrubland

A.2062 *Cytisus scoparius-Ulex europaeus-Lupinus arboreus* Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance

Scots Broom- Gorse-Yellow Bush Lupine Coastal Dune Ruderal Shrubland and Dwarf Tree Alliance

Associations:

ELCODE	Scientific Name
NEW	(<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i> - <i>Salix hookeriana</i> - <i>Malus fusca</i>) Stabilized Dune Shrubland
NEW	<i>Cytisus scoparius</i> Shrubland
NEW	<i>Lupinus arboreus</i> Ruderal Shrubland
NEW	<i>Ulex europaeus</i> Ruderal Shrubland

Distribution: Cape Disappointment, Fort Stevens, Sunset Beach/Yeon.

Total Mapped Cover:

Hectares	Acres	% Cover
120.0	296.6	3.2



21. Herbaceous Headlands

Description: These are vegetated rocky headlands found along the coastline, or former coastline, that are dominated by graminoids, often red fescue or Pacific reedgrass. This type may host ocean-bluff bluegrass (*Poa unilateralis*), a species noted as rare by LEWI. These systems are threatened by non-native species encroachment, trampling by visitors, and loss of headlands to accretion. They may be loam, gravelly or sandy. Sites are often on very steep slopes. Grass-

dominated headlands feature *Festuca rubra* or *Calamagrostis nutkaensis*. *Pteridium aquilinum* is common in some associations.

Shrub-dominated headlands feature *Gaultheria shallon* or *Empetrum nigrum*. This community occurs as a thin band, maintained by heavy offshore winds, or by shallow soils. *Empetrum nigrum* is the primary dominant, making up 50-80% of the vegetation cover. *Gaultheria shallon* is always present, although the cover is variable and ranges from very low to almost 50%. *Vaccinium ovatum* and *Baccharis pilularis* also can be codominant. Forbs (*Maianthemum dilatatum*, *Erigeron glaucus*, *Angelica* spp., *Lathyrus* spp.) and *Calamagrostis nutkaensis*) are often found popping up through the fairly dense shrub cover. Inland, the *Empetrum nigrum* community is replaced by taller shrublands dominated by *Vaccinium ovatum* or *Baccharis pilularis*, or by forests of *Picea sitchensis* or *Pinus contorta* var. *contorta*. On the steep coastal bluffs, the community is replaced by *Festuca rubra* or forb-dominated headland communities.

Alliances:

A.2064 *Festuca rubra* -*Calamagrostis nutkaensis* Coastal Herbaceous Alliance
 Red Fescue -Nootka bentgrass Coastal Herbaceous Alliance

A.2065 *Gaultheria shallon* Coastal Shrubland Alliance
 Salal Coastal Shrubland Alliance

Associations:

ELCODE	Scientific Name
CEGL001567	<i>Festuca rubra</i> Coastal Headland Herbaceous Vegetation
CEGL003349	<i>Calamagrostis nutkaensis</i> - <i>Elymus glaucus</i> Herbaceous Vegetation
NEW	<i>Lomatium martindalei</i> Sparse Vegetation
NEW	<i>Baccharis pilularis</i> - <i>Vaccinium ovatum</i> Coastal Headland Herbaceous Vegetation
CEGL000971	<i>Empetrum nigrum</i> - <i>Gaultheria shallon</i> Dwarf-Shrubland
Provisional	<i>Artemisia suksdorfii</i> coastal headland Shrubland
CEGL000972	<i>Gaultheria shallon</i> - <i>Vaccinium ovatum</i> / <i>Pteridium aquilinum</i> Shrubland

Distribution: Cape Disappointment, Ecola.

Total Mapped Cover:

Hectares	Acres	% Cover
38.4	95.0	1.0



22. Grass Dune

Description: This type typically represents the near-monoculture of *Ammophila arenaria* present at many areas in the park. Both *A. arenaria* and *A. breviligulata* have been introduced to the Pacific coast for dune stabilization, significantly altering dune dynamics and vegetation types. The native dunegrass *Leymus mollis* has also been intentionally planted for dune stabilization, creating a second modified high cover, near-monoculture dune type often located just inland from the beachgrass dune types. Some native species are still present within these dune systems, such as *Lathyrus japonicus*, *Lathyrus littoralis*, *Heracleum maximum* (= *Heracleum lanatum*), *Vicia americana*, *Vicia nigricans* ssp. *gigantea*, and *Achillea millefolium*. Other non-native species include *Holcus lanatus*, *Senecio jacobaea*, *Daucus carota*, and *Sonchus asper*. Additionally, sections of native dune vegetation are also included in the Grass Dune map class, though these remnant native dune communities are below the minimum mapping unit. The herbaceous areas are often open and only slightly stabilized, although the *Festuca rubra* communities can be partially stabilized. These stabilized meadows rarely persist, as they are rapidly invaded by *Arctostaphylos uva-ursi*, *Gaultheria shallon*, *Vaccinium ovatum* and other typical dune shrubs, followed by *Pinus contorta* var. *contorta*. *Fragaria chiloensis*, *Lathyrus japonicus*, *Lathyrus littoralis*, *Glehnia littoralis*, *Polygonum paronychia* and *Argentina egedii* are commonly found in this alliance. A combination of non-native sand binding plant introductions, and a significant reduction of sand input due to extensive dams on major rivers, has altered natural conditions and threatened most examples of this alliance.

Alliances:

A.2061 *Ammophila arenaria* -Planted *Leymus mollis* ssp. *mollis* Coastal Dunegrass Ruderal Grassland Alliance

A.2066 *Poa macrantha* -*Leymus mollis* -*Festuca rubra* Sand Dune Alliance
Seashore bluegrass -American dunegrass -Red fescue Sand Dune Alliance

Associations:

ELCODE	Scientific Name
CEGL003373	<i>Ammophila arenaria</i> - <i>Cardionema ramosissimum</i> Herbaceous Vegetation
CEGL003006	<i>Ammophila arenaria</i> Semi-natural Herbaceous Vegetation
NEW	<i>Leymus mollis</i> ssp. <i>mollis</i> Semi-natural Herbaceous Vegetation
CEGL001796	<i>Leymus mollis</i> Herbaceous Vegetation
CEGL003349	<i>Festuca rubra</i> Herbaceous Vegetation
NEW	<i>Festuca rubra</i> - <i>Pteridium aquilinum</i> Sparse Herbaceous Vegetation
NEW	<i>Poa macrantha</i> Sparse Herbaceous Vegetation
NEW	<i>Lupinus littoralis</i> Sparse Vegetation

Distribution: Cape Disappointment, Fort Stevens, Ecola, and Sunset Beach/Yeon

Total Mapped Cover:

Hectares	Acres	% Cover
116.4	287.6	3.1



23. Non-native Herbaceous

Description: The non-native herbaceous class is used to describe disturbed areas that have been recolonized by non-native species such as sweet vernal grass (*Anthoxanthum odoratum*), velvet grass (*Holcus lanatus*), orchard grass (*Dactylis glomerata*), and Scots broom (*Cytisus scoparius*).

Alliances:

A.2063 *Anthoxanthum odoratum* -*Holcus lanatus* Ruderal Coastal Grassland Alliance

Associations: None defined

Distribution: This map class is present in all units along roadsides and parking lots and in disturbed areas that have been recolonized with non-native species. Units with more visitor facilities and campgrounds or old pastures have greater areas of non-native cover.

Total Mapped Cover:

Hectares	Acres	% Cover
11.5	28.4	0.3



24. Lawn and Pasture

Description: This map class was used to depict lawns, landscaped areas, farmlands, and pastures. In addition to these cultural types, one semi-natural plant association is included in this type, Lamp Rush Pacific Coast Herbaceous Vegetation. Large tufts of lamp rush characterize these marshes. Two subspecies are present in the park: the native *J. effusus* ssp. *pacificus* and the non-native *J. effusus* ssp. *effusus*. In areas that were exposed to grazing pressure, as in the South Slough area of Fort Clatsop, the non-native subspecies is dominant. Habitat is meadows, fens, and old pastures. This association is generally thought of as a disturbance type resulting from grazing, but some occurrences suggest that it is native in some places because the sites are unlikely to have ever been heavily grazed. Lamp Rush Pacific Coast Herbaceous Vegetation is widespread at a variety of elevations but is especially abundant at low elevations in western Oregon. Known plots are from the Coast Range and Cascade Range. Trees are nearly absent but may include *Alnus rubra*, *Fraxinus latifolia*, *Quercus garryana*, or conifers peripheral to the wetland. Eight shrub species are recorded, with *Salix sitchensis* being most abundant, but their cover is negligible. The herb layer includes about 60 different species, with *Juncus effusus* being most abundant with an average cover of 52% and ranging from 20 to 85%. *Juncus ensifolius* (= *Juncus xiphioides* var. *triandrus*) is a consistent associate but has very low cover, while *Hypericum anagalloides* is much more abundant but present with slightly lower constancy. Other species occurring in significant patches include *Scirpus microcarpus*, *Equisetum arvense*, *Oenanthe sarmentosa*, and *Athyrium filix-femina*, and five species are non-natives. Old pastures at low elevations may also have large amounts of *Ranunculus repens*.

Alliances:

A. New Temperate Mowed Lawns Alliance

A. New Temperate Planted Trees/Gardens Alliance

A.1375 *Juncus effusus* Semi-Natural Seasonally Flooded Alliance

Associations:

ELCODE	Scientific Name
None	Lawns, landscaped areas, pasture, farmland.
CEGL003317	<i>Juncus effusus</i> var. <i>brunneus</i> ¹ Pacific Coast Herbaceous Vegetation

Distribution: Found in all park units.

Total Mapped Cover:

Hectares	Acres	% Cover
76.8	189.8	2.1



¹ This is the only *Juncus effusus* association in the NVC, although at LEWI we believe the dominant *Juncus* is *J. effusus* var. *pacificus*. *J. effusus* ssp. *effusus* is common in semi-natural or impacted areas. The association should be renamed as *Juncus effusus* Pacific Coast Herbaceous Vegetation.

Appendix G: Detailed Vegetation Maps of LEWI Units.

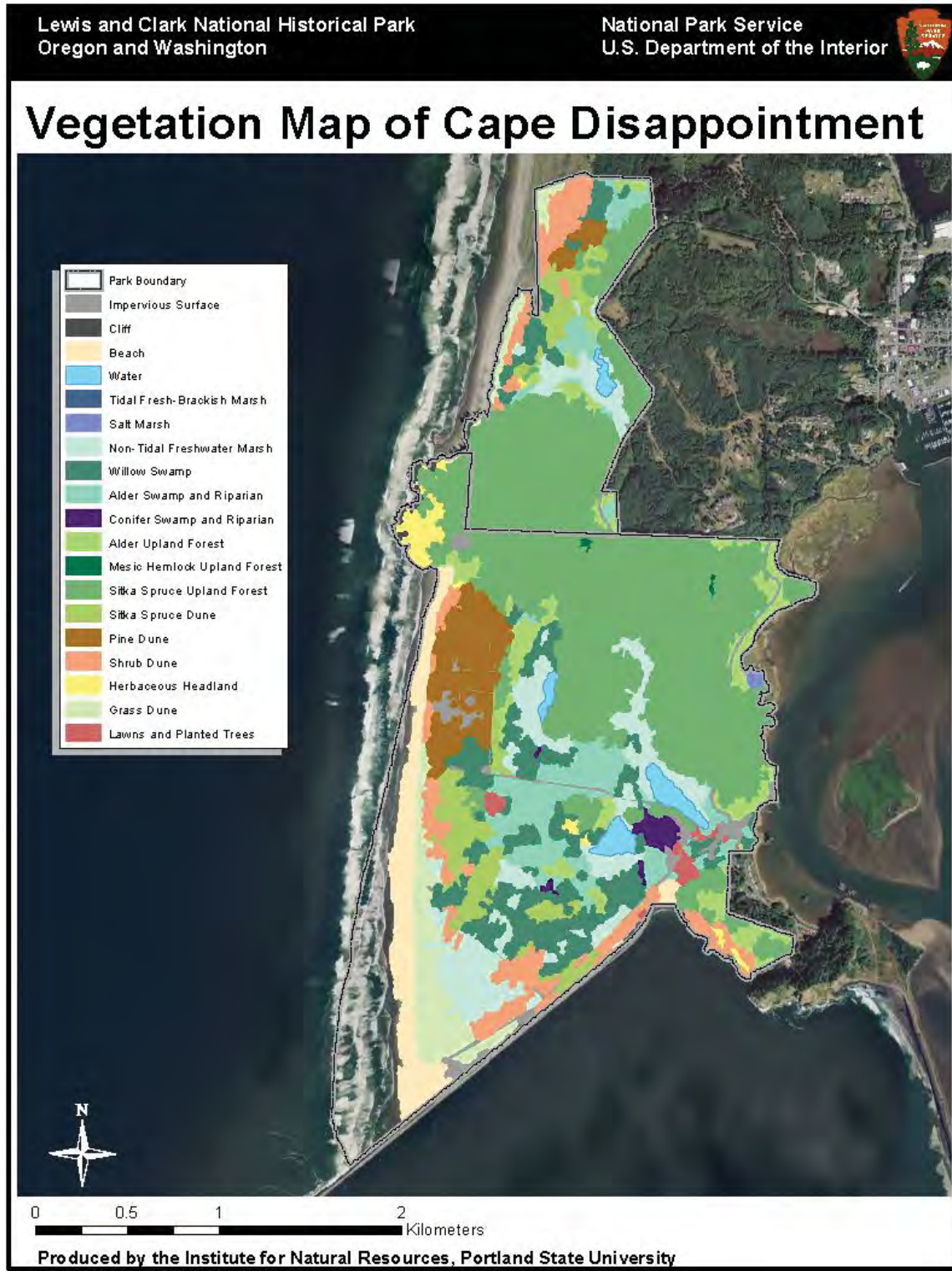
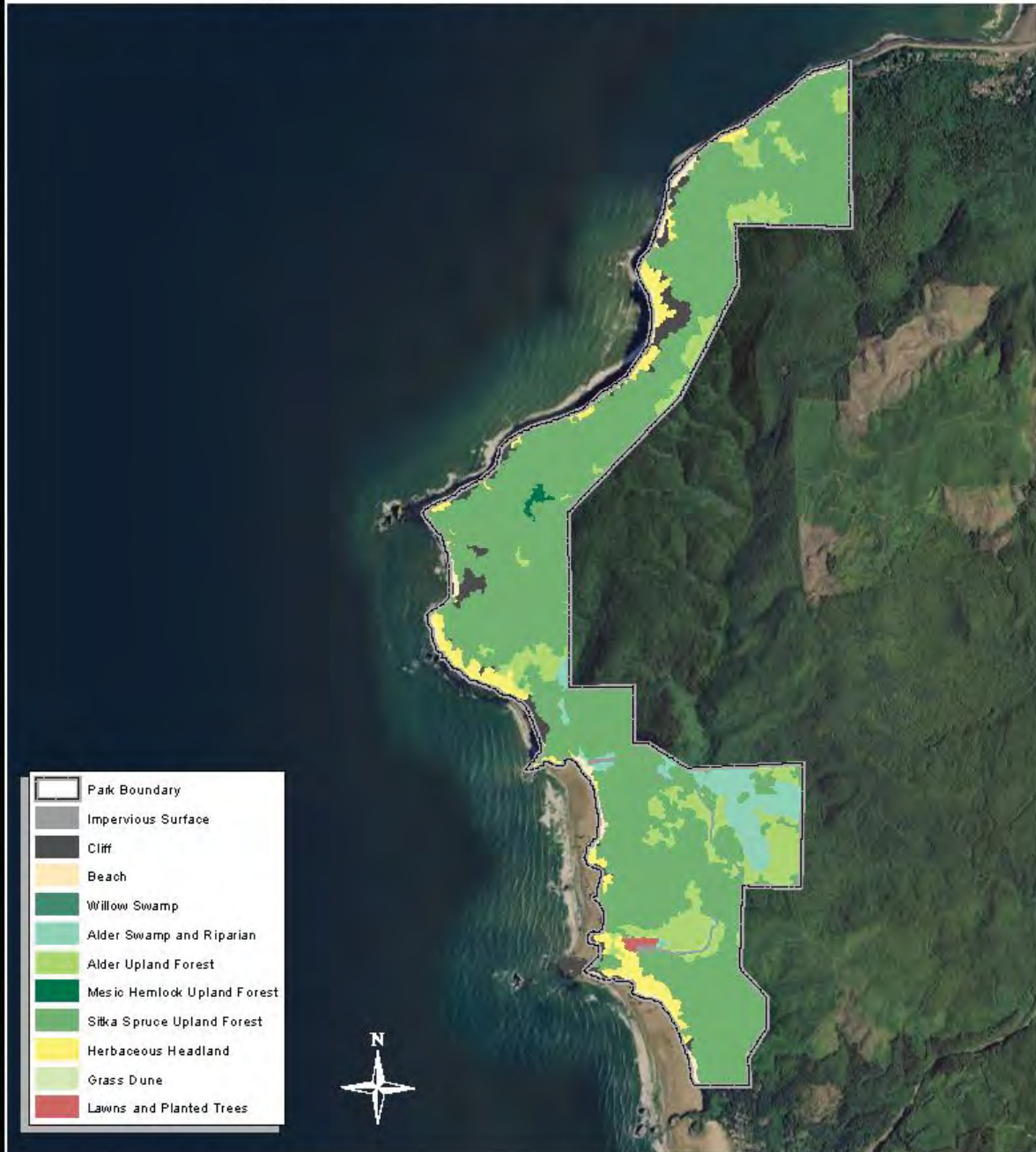


Figure G-1. Vegetation map of Cape Disappointment.



Vegetation Map of Ecola



Produced by the Institute for Natural Resources, Portland State University

FILE: LEWI_Ecola.mxd November 2012

Figure G-2. Vegetation map of Ecola.



Vegetation Map of Fort Stevens



Figure G-3. Vegetation map of Fort Stevens.



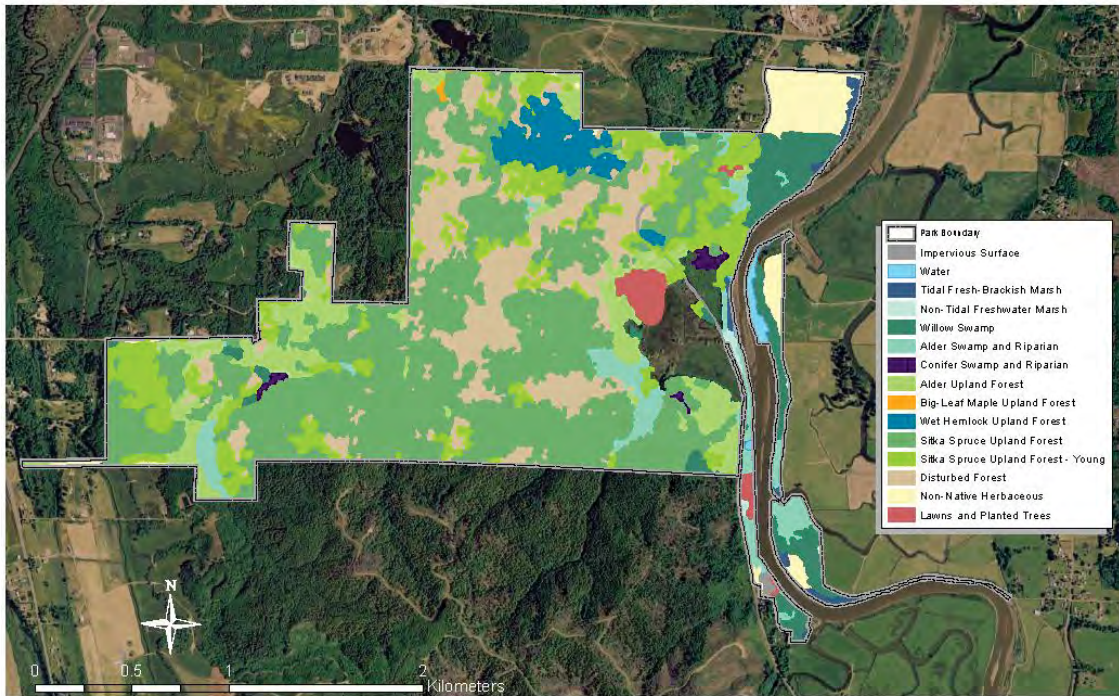
Vegetation Map of Sunset Beach/Yeon



Figure G-4. Vegetation map of Sunset Beach/Yeon.



Vegetation Map of Fort Clatsop



Produced by the Institute for Natural Resources, Portland State University

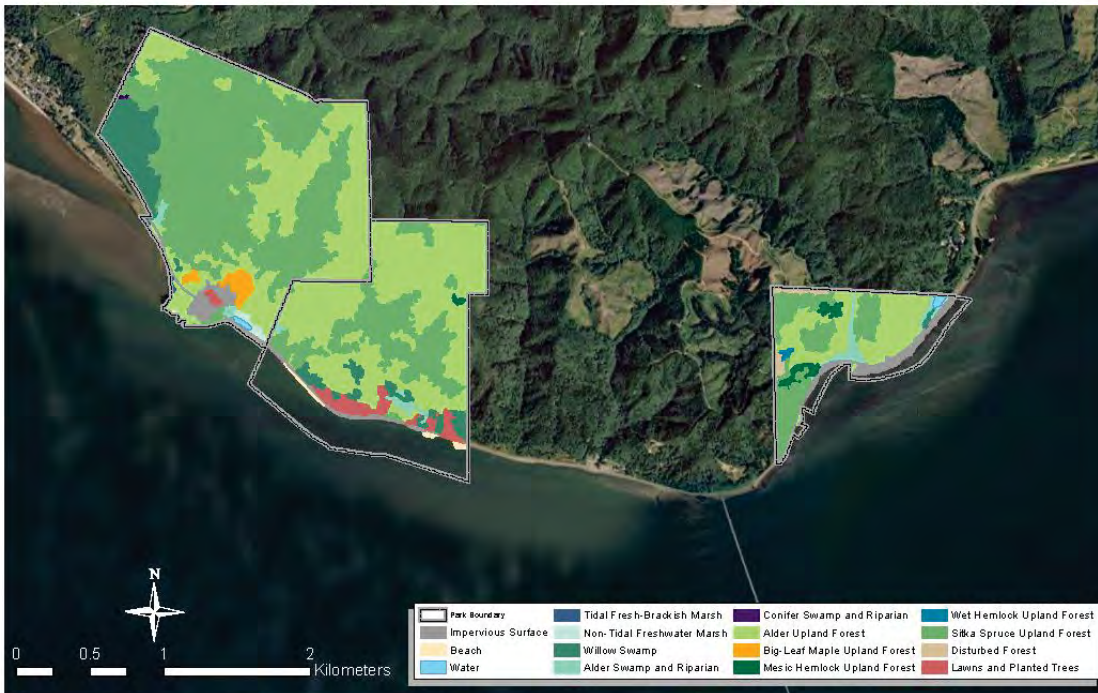
FILE: LEW1_F0CL.mxd November 2012

G-5

Figure G-5. Vegetation map of Fort Clatsop.



Vegetation Map of Fort Columbia, Middle Village/Station Camp, and Dismal Nitch



Produced by the Institute for Natural Resources, Portland State University

FILE: LEWL_RCol_MdSta_Dismal.mxd November 2012

G-6

Figure G-6. Vegetation map of Fort Columbia, Middle Village/Station Camp, and Dismal Nitch.

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NPS 405/117805, December 2012

National Park Service
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