



Willapa NWR Phase II Ecological Integrity Assessment Pilot Project

Prepared for
U.S. Fish and Wildlife Service
Pacific Region, Portland, OR

Prepared by
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October 31, 2013



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Prepared for:

U.S. Fish and Wildlife Service, Pacific Region, Portland Office. Agreement
F12AC00449

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1. Introduction

Recently, an effort to develop a toolkit of approaches, best practices, and protocols to support the development of vegetation and habitat maps in the U.S. Fish and Wildlife Service, National Wildlife Refuge Systems (NWRS) was initiated (Kittel et al. 2012, Christy 2013) This report documents a task related to further develop and testing of this Refuge-wide toolkit as applied in the Willapa National Wildlife Refuge (NWR). Previous pilot projects have been implemented at Camas NWR (Kittel et al. 2012), Idaho and at Malheur NWR (Christy 2013), Oregon. Willapa NWR occurs in a maritime climate and encompasses estuarine, dunal, and forested systems, which represent very different ecosystems than those previously assessed during pilot projects.

The Willapa pilot project focused on two units of the Refuge: Leadbetter Point and South Bay (Figure 1). The objectives of the Willapa pilot project were to (1) apply a classification of vegetation occurring in the Leadbetter Point and South Bay units using the new revised US National Vegetation Classification (USNVC) standard (FGDC 2008); (2) and conduct an assessment of ecological condition of vegetation types in the Leadbetter Point and South Bay units. This report documents the methods and results for two of those activities: (1) development of a vegetation classification and (2) assessment of ecological condition of vegetation types.

The vegetation classification was developed using existing data and resources while the Ecological Integrity Assessment (EIA) approach was used to assess ecological condition. This report provides a summary of the methods and results of these efforts. Data collected and synthesized results are in the accompanying Microsoft excel spreadsheet that contains Metadata, EIA, CCP, vegetation plot data, and NVCS classification for the project.

This report summarizes the lessons learned about the effort to develop a vegetation classification, a method for assessing ecological integrity, and an integration of these two efforts.

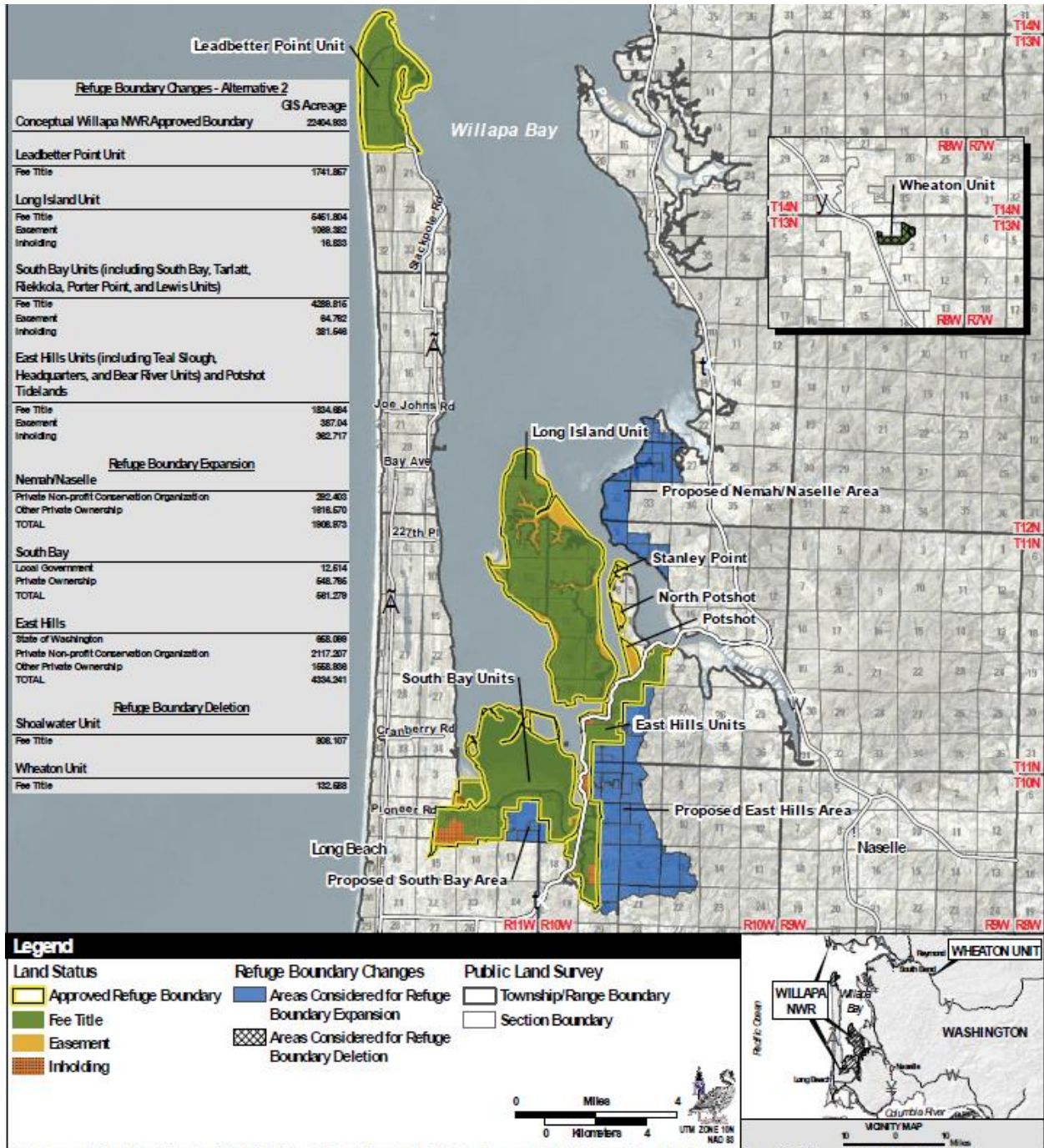


Figure 1. Location of Willapa National Wildlife Refuge and Management Units,

2. Ecological Integrity Assessment

2.1 Purpose of the Ecological Integrity Assessment

An objective of this pilot project is to assess the ecological condition of vegetation types in the Leadbetter Point and South Bay units of the Willapa NWR. One approach for assessing ecological condition is the Ecological Integrity Assessment (EIA) methods developed by NatureServe and the Natural Heritage Network (Faber-Langendoen et al. 2006, 2008, 2009). The EIA is designed to assess current ecological integrity of a site based on the natural range of variation of the ecosystem or vegetation type in question. A method for estimating overall ecological integrity for vegetation types (USNVC Group level) within the Leadbetter Point and South Bay units was developed and tested in this pilot project.

2.2 Definition of Ecological Integrity

Ecological integrity, based on the concepts of biological integrity and ecological health, is a broad and useful endpoint for ecological assessment and reporting of the condition of habitats on the refuges. Ecological integrity can be defined as “an assessment of the structure, composition, and function of an ecosystem as compared to reference ecosystems operating within the bounds of natural or historic disturbance regimes” (adapted from Lindenmayer and Franklin 2002, Young and Sanzone 2002, Parrish et al. 2003) A general conceptual model for Ecological Integrity Assessments (EIA) provides a general set of ecological factors found across ecosystem types, and then encourages the identification of individual key ecological attributes for individual system types (Noon 2003, Faber-Langendoen et al. 2008, Unnasch et al. 2009) (Figure 2).

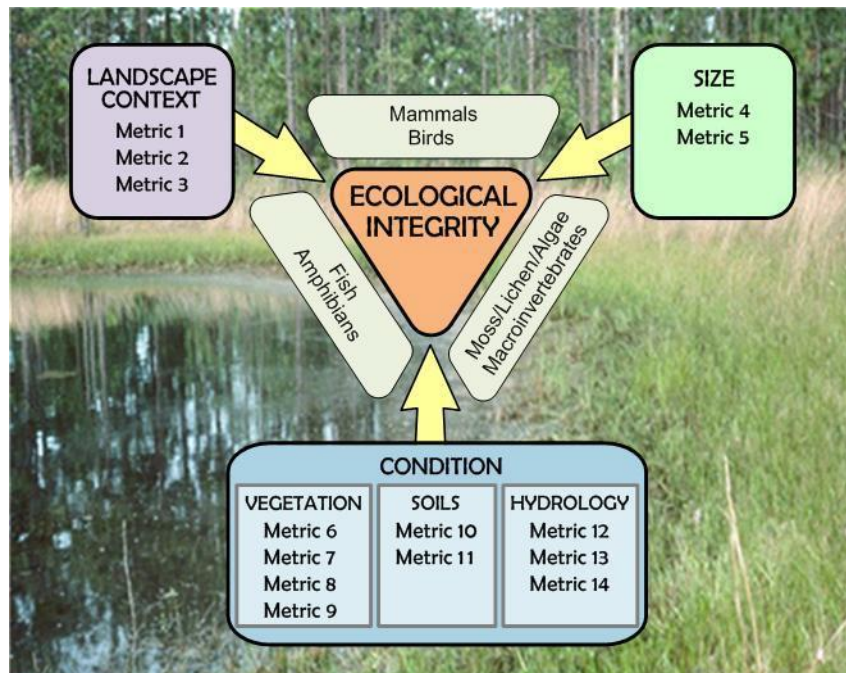


Figure 2. General conceptual model for Ecological Integrity Assessments (EIA). (Kittel et al 2012)

Ecological Integrity is a set of measures of ecosystem structure, function and composition, referenced to the range of natural variation and resistance to perturbation. Ecological integrity measures also link with management goals. The analysis of acceptable ecological conditions can help refuge planners establish and document their desired resource conditions. This makes ecological integrity a flexible tool for meeting the needs of a variety of management goals of parks, wildlife refuges and other natural areas. Along with this flexibility comes a responsibility to be transparent about exactly how current conditions are determined.

2.3 The Ecological Integrity Assessment Approach

The Ecological Integrity Assessment method (EIA) is used to measure the ecological integrity of a site through a standardized and repeatable assessment of current ecological conditions associated with the structure, composition, and ecological processes relative to what is expected within the bounds of natural variation for any give ecological system (Rocchio and Crawford 2011). The purpose of assigning an index of ecological integrity is to give a general sense of conservation value, management effects, restoration success, etc. It can be used for monitoring (Rocchio and Crawford 2009) and for conservation planning (Rocchio and Crawford 2010). An EIA is tailored to individual ecological systems by listing the major or key ecological attributes (KEA) that have an important function in the viability or integrity of each ecological system (see http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html for complete EIA lists and descriptions for Washington State). Each KEA has associated indicators and/or metrics that provide the specificity needed to assess the major ecological attributes. Indicators or metrics are scored or rated to measure its expression on a particular site relative to the natural range of variation (NRV). Each indicator or metric, through its ratings relative to NRV, provides explicit endpoints and standards for management objectives. Land units managed for specific objectives outside the NRV, such as hay production, forage, recreation activities, are not intended applications of the EIA, although specific metrics could be used to monitor site characteristics.

Metrics within each rank factor category (i.e., landscape context, size and condition) are combined to provide a single score for each category. Metrics, or indicators, are assigned one of four ranks, ranging from excellent (A) to poor (D), (see Tables 1 and 2). These category rankings can then be combined into an Overall Ecological Integrity Rank. The EIA is a practical and transparent tool to document the ecological condition of a given site. For this project, metrics within each rank factor category were simply averaged to determine the score for that category, and scores for the three categories were averaged to calculate the overall ecological integrity score for individual sites. An alternative choice would have been to weight individual metrics, or rank factor categories, with different values.

EIA methodology can be applied at three scales, or levels:

- Level 1 Remote Assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data shed (Faber- Langendoen et al. 2008).
- Level 2 Rapid Assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment (Fennessy et al. 2007).

- Level 3 Intensive Assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences within a site.

At Willapa NWR we conducted Ecological Integrity with Level-2 field based metrics appropriate for uplands (forests and dunes), freshwater wetlands and salt marshes.

Table 1. Basic Ecological Integrity Ranks

| Ecological Integrity Rank | Description |
|---------------------------|--|
| A | Excellent estimated ecological integrity |
| B | Good estimated ecological integrity |
| C | Fair estimated ecological integrity |
| D | Poor estimated ecological integrity |

Table 2. Ecological Integrity Rank Descriptions

| Rank Value | Description |
|------------|---|
| A | Occurrence is believed to be, on a global or range-wide scale, among the highest quality examples with respect to major ecological attributes functioning within the bounds of natural disturbance regimes. Characteristics include: the landscape context contains natural habitats that are essentially unfragmented (reflective of intact ecological processes) and with little to no stressors; the size is very large or much larger than the minimum dynamic area ; vegetation structure and composition, soil status, and hydrological function are well within natural ranges of variation, exotics (non-natives) are essentially absent or have negligible negative impact; and, a comprehensive set of key plant and animal indicators are present. |
| B | Occurrence is not among the highest quality examples, but nevertheless exhibits favorable characteristics with respect to major ecological attributes functioning within the bounds of natural disturbance regimes. Characteristics include: the landscape context contains largely natural habitats that are minimally fragmented with few stressors; the size is large or above the minimum dynamic area, the vegetation structure and composition, soils, and hydrology are functioning within natural ranges of variation; invasives and exotics (non-natives) are present in only minor amounts, or have or minor negative impact; and many key plant and animal indicators are present. |
| C | Occurrence has a number of unfavorable characteristics with respect to the major ecological attributes, natural disturbance regimes. Characteristics include: the landscape context contains natural habitat that is moderately fragmented, with several stressors; the size is small or below, but near the minimum dynamic area; the vegetation structure and composition, soils, and hydrology are altered somewhat outside their natural range of variation; invasives and exotics (non-natives) may be a sizeable minority of the species abundance, or have moderately negative impacts; and many key plant and animal indicators are absent. Some management is needed to maintain or restore ¹ these major ecological attributes. |
| D | Occurrence has severely altered characteristics (but still meets minimum criteria for the type), with respect to the major ecological attributes. Characteristics include: the landscape context contains little natural habitat and is very fragmented; size is very small or well below the minimum dynamic area; the vegetation structure and composition, soils, and hydrology are severely altered well beyond their natural range of variation; invasives or exotics (non-natives) exert a strong negative impact, and most, if not all, key plant and animal indicators are absent. There may be little long-term conservation value without restoration, and such restoration may be difficult or uncertain. ² |

¹ Ecological restoration is: “the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Restoration attempts to return an ecosystem to its historic trajectory” (SER 2004).

² D-ranked types present a number of challenges. First, with respect to classification, a degraded type may bear little resemblance to examples in better condition. Whether a degraded type has “crossed the line” (“transformed” in the words of SER 2004) into a semi-natural or cultural type is a matter of classification criteria. These criteria specify whether sufficient diagnostic criteria of a type remain, bases on composition, structure, and habitat.

3. Vegetation Classification

3.1 Purpose of Vegetation Classification

One of the objectives of the Willapa Pilot Project is to develop a classification of vegetation occurring in the Leadbetter Point and South Bay units using the new revised US National Vegetation Classification (USNVC) standard (FGDC 2008). This classification has many potential uses but specifically for this project will provide (1) a list of vegetation types to be mapped in the Refuge and (2) a baseline from which to develop a sampling scheme for assessing ecological condition.

3.2 Utility of Vegetation Classification for Assessing Ecological Condition

Assessment and interpretation of ecological integrity depends on understanding the structure, composition, and processes that govern the wide variety of ecosystem types. The Washington Natural Heritage Information System (WNHP) applied two classifications to characterize ecosystem types: (1) the plant association within the National Vegetation Classification (NVC) and (2) Ecological Systems (FGDC 2008; Comer et al. 2003). The Ecological Systems and NVC classifications can be used in conjunction to sort out the ecological variability that may affect ecological integrity. EIAs are prepared for ecological systems and applied to their constituent plant associations. Washington ecological systems are described in Rocchio and Crawford (2008) and are available on-line at http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems.html.

3.2.1 Ecological Systems

Ecological systems integrate vegetation with natural dynamics, soils, hydrology, landscape setting, and other ecological processes. Ecological systems types facilitate mapping at mesoscales (1:24,000 – 1:100,000; Comer and Schulz 2007). Using ecological systems as a classification meets two important needs for conservation, management and restoration, because they provide: An integrated approach that is effective at defining both biotic and abiotic variability within one classification unit. Comprehensive maps of all ecological system types exist for the State of Washington. Importantly for this project, EIAs are written to apply to Ecological Systems.

3.2.2 U.S. National Vegetation Classification

The International Vegetation Classification (IVC) (Faber-Langendoen et al. 2012) covers all vegetation around the world. In the United States, its national application is the U.S. National Vegetation Classification (NVC), supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009c), and the Ecological Society of America (Jennings et al. 2009), with other partners. The IVC and NVC were developed to classify and identify types based on vegetation composition and structure and associated ecological factors. The NVC is hierarchical. The finest-scale unit of the NVC is the plant association, which is defined by diagnostic species that reflect topo-edaphic, climate, substrate, hydrology, and/or natural disturbance regimes. The NVC levels allow for a linkage to NatureServe's Ecological Systems classification (described above) typically at the NVC Group-level. The NVC meets several important needs for conservation and resource management.

4. Comprehensive Conservation Plan (CCP)

The Comprehensive Conservation Plan (CCP) articulates goals and objectives of successful refuge management (USFWS 2010). A CCP describes management actions that help bring a refuge closer to its vision that broadly reflects the refuge purposes and goals. Goals define general targets, objectives direct effort into incremental and measurable steps, and strategies identify specific tools and actions (see section 2.4 USFWS 2010). Measurable attributes of individual CCP goal objectives provide more specific information about habitat conditions than EIA metrics and are included in the project as listed in Table 3).

Table 3. Attributes of Comprehensive Conservation Plan Goal Objectives selected for sampling (USFWS 2010).

| Goal | Objective | Attribute summary |
|---|-----------|---|
| 1 | 2.4.1.1 | Dominant trees 100 to 200+ years |
| | | Shrub layer composed of native species |
| | | Prevalence of large fallen trees and snags. |
| | | Multiaged, multilayered |
| | | Less than 80% dominant tree canopy cover. |
| | | Largest tree diameters 32 to over 39 inches. |
| | | Moss-covered branches >7 inches in diameter. |
| | | Branches at least 50 feet above the ground. |
| | | Mean nest branch height equal to 120 feet. |
| High canopy closure over nest branches. | | |
| 2 | 2.4.2.5 | Vegetation within 9 to 11 feet NGVD primarily native species |
| | | No Spartina. |
| | | Interspersion of tidal sloughs. |
| | 2.4.2.3 | Infrequent inundation except on highest high tides. |
| 3 | 2.4.3.3 | Exposed mud to sandy substrate interspersed with eelgrass beds. |
| | | Sand bars that provide roost sites. |
| | | Less than 40% cover desirable/native wetland plants/short emergent vegetation |
| | | Less than 5% cover of invasive plant species |
| | | Variable water levels (6 inches to over 4 feet). |
| 4 | 2.4.4.1 | No bullfrogs (<i>Rana catesbeiana</i>). |
| | | Desirable and native wetland plants and emergent vegetation |
| | | Presence of native beach plants |
| 4 | 2.4.4.1 | Sparsely vegetated habitat; ground layer sand dominated. |
| | | Beach or dune habitat free of introduced beachgrasses |

5. Methods

5.1 Sample Selection

USFWS staff provided sample points using a Generalized Random Tessellation Stratification (GRTS) procedure to determine sampling locations at both units. USFWS staff completed the GRTS sample draw using vegetation maps as the input for sampling targets. GRTS results in a spatially balanced sample design for specified sampling targets. Each management unit had a slightly different stratification process based on the status of the mapping project at the time of field EIA sampling.

At Leadbetter Point in 2012, the classification had not been fully developed or validated for mapping so number and distribution of sample points were based on physiognomic classes (Figure 3). In the field, if the sample location did not meet the physiognomic class, location proceeded to alternate replacement points provided for each physiognomic class.

At South Bay in 2013, NWI mapping was complete using the preliminary classification to NVC Group or NVC Alliance with limited validation. EIA sample locations were provided for NVC Groups without replacement points. If the point did not represent a homogenous area at the NVC Group-Level, the point was moved not exceeding 50 meters. At South Bay sample points were also used as part of the accuracy assessment of the vegetation map (Figure 4).

Although sample points were generated for Tidal Flats and Eelgrass Beds, they were not surveyed because EIA were not available for assessment.



Figure 3. Location of EIA Points Sampled at Leadbetter Point.



Figure 4. Location of EIA Points Sampled at South Bay

5.2 Field Protocol

Rex Crawford and Joe Rocchio sampled Leadbetter Point during the summer of 2012 and South Bay during September of 2013. Benyamin Wishnek provided EIA evaluation of seven salt marsh sites at South Bay in 2012.

5.2.1 Sample Location

Sample points were supplied by USFWS via GIS and on paper field maps. A shapefile depicting the sample points was loaded onto field GPS units (Ashtech Mobile Mapper 10) and were used to navigate to each sample point. The sample point was located to within 1-2 meters using the GPS unit. Once at the point, a separate GPS point was recorded and with the sample point code noted in the Site Name field.

5.2.2 Classification

Preliminary classification (map legend) and a key to NVC Group and Alliance with crosswalk to ecological systems were prepared prior to each field season (Appendix B). The classification and the vegetation key for Willapa NWR were adapted from vegetation mapping at Lewis and Clark Historic National Park (Kagan et al 2011) at the mouth of the Columbia River and with consultation with NatureServe (Gwen Kittel, regional ecologist). The Ecological System was first identified at the sample point to determine which EIA protocol to use at that location. The NVC Group and/or Alliance was determined at each point

along with recording environmental data such as topographic position, hydrogeomorphic class, soil drainage, soil moisture and a general site description.

In addition, a vegetation plot was established around the point and data collected in an excel spreadsheet on the Ashtech Mobile Mapper. Vegetation plot size was 10x10 m plot for herbaceous and shrub vegetation or 20x20 m for tree-dominated sites. The vegetation plot data helped fine-tune the vegetation classification and vegetation mapping efforts, assisted in the assessment of EIA metrics, and provided supplementary information for CCP evaluation.

5.2.3 Ecological Integrity Assessment

Level-2 EIA metrics that were appropriate for the Ecosystem System at the sample site were assessed and recorded using an ArcPad-based field form employed on the Ashtech MobileMapper 10 unit. Each metric measures a different physical or biological aspect of the site and the scores rank how well the site is performing relative to an undisturbed, reference condition. A definition for each metric and final EIA scoring and ranking is in Appendix A. More detailed definition, rationale, scoring criteria and literature references for these metrics are available in http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems/eia_list.html. See Faber-Langendoen (2012) for the protocols on all EIA metrics.

5.2.4 Comprehensive Conservation Plan (CCP)

Measurable attributes of CCP objectives included in the field assessments were chosen after consultation with refuge staff (Table 3). Attributes included in field surveys provide more specific information about habitat conditions than site than EIA metrics. Attributes selected were those requiring minimal training and could be judged to be either present or absent around the sample point.

5.3 Office Procedures

All EIA and vegetation plot data were entered into unique excel databases for evaluation.

5.3.1 Classification

NVC classification assigned each sample site in the field was re-evaluated and checked for consistency with the vegetation classification used in mapping. The version of the NVC presented in this report is a modified version developed prior to field application (as of March 2012) and does not reflect on-going development of NVC Group and Alliance definitions (Table 4). As such, the codes and names in the report may be non-standard, provisional project codes and names. WNHP's continued coordination with NatureServe will provide the crosswalk between classification used for this project with standard NVC concepts and nomenclature in the future.

5.3.2 Individual Site EIA Condition Scores

Ecological Integrity is scored on a 1 to 5 scale, where 5 represents reference conditions in a completely undisturbed state, that is, where the ecosystem is experiencing very little to no stressors, has full buffering capacity and is able to resist or fully recover from disturbance. EIA score of 1 is a highly altered ecosystem that has high level of stress, little buffer or resistance capacity, and may not recover at all from continued application of stressors. This 1-5 scaling rationale is also used when ranking metrics or determining roll-up scores for Rank Factors (i.e. Condition, Landscape Context, or Size). Each of the 94

field sites receive a single, EIA Condition score based on the number of metrics, depending ecological system.

To calculate overall ecological integrity scores for a given sample point, each applicable EIA metric was assigned a letter rank in the field. These ranks were converted to a numerical score (A=5, B=4, C=3, D=1). These scores were averaged to create combined Vegetation Condition Score (metrics related to vegetation structure and composition), Soils or Physiochemical Condition Score (metrics related to soils, natural disturbance regimes, physical patch types, or water quality) for all sites and for wetlands, a Hydrology Score (metrics related to water source, hydrological regime and connectivity). For uplands, Vegetation and Soils scores were then averaged into a single EIA Condition score for each assessed sample point. For wetlands, Vegetation, Soils and Hydrology scores were then averaged for a single EIA Condition score with Soils rating one-half that of Hydrology and Vegetation. EIA numeric scores are converted back to ranks as follows: A=4.5-5.0, B = 3.5-4.4, C=2.5-3.4, D=1.0-2.4. Landscape and Size Scores were not calculated because point samples were not natural patches. An Buffer and Edge metric rank was estimated from approximately 200 meter radius around the survey point on aerial imagery for each point but not used in the calculations described above (however, they are provided in the accompanying Excel spreadsheet).

The EIA scores for individual sample points were average across NVC Groups and Alliances. These values provide an estimate of ecological integrity among the habitats on Willapa NWR.

5.3.3. Comprehensive Conservation Plan

CCP assessments were edited and included an excel spreadsheet. Summary of numbers of observations per NVC Group were obtained and summaries in the results section.

6. Results and Discussion

Data collected and synthesized results are in the accompanying Microsoft excel spreadsheet that contains Metadata, EIA, CCP, Vegetation plot data, and NVCS classification for the project. The following discusses the Classification, EIA and CCP results of the pilot project.

6.1 Distribution of Sample Points in the NVC Classification

The crosswalk between the NVC and Ecological System (used for EIA application) appears in the key to vegetation in Appendix B. The NVC codes and names are those provided by NatureServe, March 2012. Eight Ecological System EIAs were applied to 10 different NVC Groups at 94 sample points.

Three of the 10 NVC Groups represent provisional ruderal vegetation types: (1) (A.NCCN-NEW1 *Pinus contorta* var. *contorta* Ruderal Coastal Dune Woodland Alliance; (2) NEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group ; (3) GNEW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group. Although EIAs are intended for natural or native types, EIAs were applied to these ruderal sample points as the EIA metrics provide information about which ecological attributes are degraded and could assist in prioritizing restoration efforts of these locations.

The final NVC classification including provisional types for this project and the number of EIA ratings per NVC Group and Alliances are in Table 3.

Table 4. NVC Classification and number of sites with EIA scores at the NVC Group level.

| Division | MacroGroup | Group | Alliance/Association | Number of EIAs |
|---|------------|--|----------------------|----------------|
| 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 | | 15 |
| | | A.NCCN-NEW1 <i>Pinus contorta</i> var. <i>contorta</i> Coastal Dune Provisional Woodland Alliance | | |
| | | <i>Pinus contorta</i> var. <i>contorta</i> - <i>Pseudotsuga menziesii</i> / <i>Morella californica</i> - <i>Vaccinium ovatum</i> Forest | | |
| | | <i>Pinus contorta</i> var. <i>contorta</i> / <i>Cytisus scoparius</i> / <i>Ammophila arenaria</i> Semi-natural Forest | | |
| | | <i>Pinus contorta</i> var. <i>contorta</i> / <i>Gaultheria shallon</i> - <i>Morella californica</i> / <i>Ammophila arenaria</i> Woodland | | |
| | | Not classified | | |
| 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 | | 0 |
| | | A.NCCN-019 <i>Acer macrophyllum</i> - (<i>Pseudotsuga menziesii</i>) Provisional Forest Alliance | | |
| | | A.NCCN-020 <i>Alnus rubra</i> - (<i>Picea sitchensis</i>, <i>Tsuga heterophylla</i>) Provisional Forest and Woodland Alliance | | |

| Division | MacroGroup | Group | Alliance/Association | Number of EIAs |
|----------|------------|---|----------------------|----------------|
| | | G238 North Pacific Maritime Western Redcedar-Western Hemlock Forest Group | | 4 |
| | | A.NCCN-new <i>Tsuga heterophylla</i> – <i>Thuja plicata</i> Provisional Forest Alliance | | |
| | | <i>Tsuga heterophylla/Polystichum munitum - Blechnum spicant Forest</i> | | |
| | | G239 North Pacific Maritime Sitka Spruce Forest Group | | 5 |
| | | A.NCCN-027 <i>Picea sitchensis</i> - (<i>Tsuga heterophylla</i>) Provisional Forest Alliance | | |
| | | <i>Picea sitchensis/Vaccinium ovatum Forest</i> | | |
| | | <i>Picea sitchensis-Tsuga heterophylla/Polystichum munitum Forest</i> | | |
| | | A.2067 North Pacific (<i>Pinus contorta</i> var. <i>contorta</i> – <i>Picea sitchensis</i>) Stabilized Dune Forest | | |
| | | <i>Picea sitchensis - Pinus contorta / Gaultheria shallon - Vaccinium ovatum</i> | | |
| | | 1.C.3.c Western North American Flooded & Swamp Forest | | |
| | | MG035 Vancouverian Flooded & Swamp Forest | | |
| | | G254 North Pacific Lowland Riparian Forest Group | | 0 |
| | | (<i>Acer macrophyllum</i>, <i>Alnus rubra</i>) Riparian Provisional Forest Alliance | | |
| | | (<i>Picea sitchensis</i>, <i>Abies grandis</i>, <i>Tsuga heterophylla</i>, <i>Thuja</i>) - (<i>Alnus</i>, <i>Acer</i>) Riparian Provisional Forest Alliance | | |
| | | G256 North Pacific Maritime Lowland Hardwood-Conifer Swamp Group | | 8 |
| | | A.NCCN-002 (<i>Alnus</i> spp., <i>Fraxinus</i> spp., <i>Populus</i> spp.) / <i>Lysichiton americanus</i> Deciduous Swamp Provisional Woodland Alliance | | |
| | | <i>Alnus rubra/Rubus spectabilis/Carex obnupta-Lysichiton americanus</i> | | |
| | | 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 Provisional Woodland Alliance | | |
| | | <i>Picea sitchensis/Rubus spectabilis/Carex obnupta-Lysichiton americanus</i> | | |
| | | <i>Pinus contorta</i> var. <i>contorta</i> / <i>Carex obnupta</i> provisional woodland | | |
| | | 2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland | | |
| | | MG050 Southern Vancouverian Lowland Grassland & Shrubland | | 0 |
| | | G488-Southern Vancouverian Shrub & Herbaceous Bald and Bluff | | |
| | | A.2064 <i>Festuca rubra</i> – <i>Calamagrostis nutkaensis</i> Coastal Herbaceous Alliance | | |
| | | A.2065 <i>Gaultheria shallon</i> Coastal Shrubland Alliance | | |
| | | MGNEW Southern Vancouverian Lowland RUDERAL Provisional Grassland & Shrubland | | |
| | | GNEW Southern Vancouverian Lowland Ruderal Provisional Grassland & Shrubland Group | | 1 |
| | | A.NEW <i>Anthoxanthum odoratum</i> – <i>Holcus lanatus</i> Ruderal Coastal Grassland Provisional Alliance | | |
| | | 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 | | 7 |
| | | A.2066 <i>Poa macrantha</i> – <i>Leymus mollis</i> – <i>Festuca rubra</i> Sand Dune | | |

| Division | MacroGroup | Group | Alliance/Association | Number of EIAs |
|----------|------------|--|--|----------------|
| | | | Herbaceous Alliance | |
| | | | A.NCCN-NEW3 (Pinus contorta var. contorta, Picea sitchensis, Gaultheria shallon) Stabilized Dune Provisional Shrubland Alliance | |
| | | GNEW North Pacific Maritime Coastal Sand Dune Vegetation Group | RUDERAL Provisional Scrub & Herb | 11 |
| | | | A.2061 <i>Ammophila arenaria</i> - Planted <i>Leymus mollis ssp. mollis</i> Coastal Dunegrass Ruderal Grassland | |
| | | | <i>Ammophila arenaria</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 | |
| | | | <i>Cytisus scoparius</i> Shrubland | |
| | | 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 | | 9 |
| | | | A.NCCN-999 <i>Salix hookeriana</i> Seasonally Flooded Provisional Shrubland Alliance | |
| | | | <i>Salix hookeriana</i> (<i>Malus fusca</i>) / <i>Carex obnupta</i> – <i>Lysichiton americanus</i> | |
| | | | A.NCCN.NEW11 <i>Salix</i> spp. – <i>Malus fusca</i> - <i>Spiraea</i> spp. Lowland Riparian & Wet Slope Provisional Shrubland Alliance | |
| | | | A.NCCN-997 <i>Spiraea douglasii</i> Seasonally Flooded Provisional Shrubland Alliance | |
| | | G517 Vancouverian Freshwater Coastal Marsh & Meadow Group | | 7 |
| | | | 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 | |
| | | | <i>Carex obnupta</i> – <i>Argentina egedii</i> Herbaceous Vegetation | |
| | | | <i>Carex obnupta</i> Herbaceous Vegetation | |
| | | | <i>Juncus falcatus</i> - <i>Juncus</i> (<i>lesueurii</i> , <i>nevadensis</i>) Herbaceous Vegetation | |
| | | | A.1375 <i>Juncus effusus</i> Semi-Natural Seasonally Flooded Alliance | |
| | | | <i>Juncus effusus</i> var. <i>brunneus</i> Pacific Coast Herbaceous Vegetation | |
| | | G518 Western North American Temperate Interior Freshwater Marsh Group | | 0 |
| | | | A.1433 <i>Schoenoplectus acutus</i> (<i>Schoenoplectus pungens</i>) Semi-Permanently Flooded Herbaceous Alliance | |
| | | | A.NCCN-NEW4 <i>Typha</i> (<i>angustifolia</i>, <i>latifolia</i>) Freshwater Provisional Marsh Alliance | |
| | | | A.2598 <i>Sparganium eurycarpum</i> Hydromorphic Rooted Herbaceous Vegetation | |
| | | G523 Western North American Maritime Lowland Wet Meadow, Marsh & Seep Herbaceous Group | | 0 |
| | | | 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 | | |
| | | G499 Temperate Pacific Tidal Salt & Brackish Marsh Group | | 21 |

| Division | MacroGroup | Group | Alliance/Association | Number of EIAs |
|-------------------|------------|-------|--|----------------|
| | | | A.2622 <i>Carex lyngbyei</i> Tidal Herbaceous Alliance | |
| | | | <i>Carex lyngbyei</i> - (<i>Distichlis spicata</i> , <i>Triglochin maritima</i>) Herbaceous Vegetation | |
| | | | <i>Carex lyngbyei</i> - <i>Argentina egedii</i> Herbaceous Vegetation | |
| | | | <i>Carex lyngbyei</i> Herbaceous Vegetation | |
| | | | A.2618 <i>Salicornia virginica</i> Tidal Herbaceous Alliance | |
| | | | <i>Salicornia virginica</i> Herbaceous Vegetation | |
| | | | <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 | |
| | | | <i>Deschampsia caespitosa</i> - <i>Argentina egedii</i> Herbaceous Vegetation | |
| | | | <i>Ammophila arenaria</i> - <i>Deschampsia caespitosa</i> provisional wetland transition | |
| | | | Unclassified Alliance | 7 |
| 5.B.1.a | | | North American Freshwater Aquatic Vegetation | |
| | | | G544 Western North American Temperate Freshwater Aquatic Bed Group | 0 |
| | | | A.NCCN-NEW5 <i>Nuphar</i> spp. - <i>Potamogeton</i> spp. - <i>Lemna</i> spp. Freshwater Provisional Aquatic Alliance | |
| 5.A.1.e | | | Temperate Seagrass Aquatic Vegetation | |
| | | | MG184 Temperate Pacific Seagrass Vegetation | |
| | | | MG109 Western North American Freshwater Aquatic Vegetation | |
| | | | G373 Temperate Pacific Seagrass Group | 0 |
| | | | A.NCCN-NEW6 <i>Zostera</i> spp. Permanently Flooded - Provisional Tidal Herbaceous Alliance | |
| 6.B.2.b | | | Western North American Temperate Cliff, Scree & Rock Vegetation | |
| | | | MG114 Vancouverian Cliff, Scree & Rock Vegetation | |
| 5.A.1.D047 | | | Temperate Intertidal Shore | |
| | | | M106 Temperate Pacific Intertidal Shore | |
| | | | G385 North American Pacific Intertidal Algal Flat Group | 0 |
| 8.1.A | | | Developed Herbaceous & Woody Vegetation | |
| | | | M491 Temperate & Tropical Lawn | |
| | | | G622 Cool-Season, Warm-Season, Dry-Season Lawn | 0 |
| | | | A. New Temperate Mowed Lawns Alliance | |
| | | | M492 Temperate & Tropical Planted Landscaping & Gardens | |
| | | | G623 Treed Landscaping | 0 |

6.2 Ecological Integrity Assessment and NVC Groups

Because EIAs were applied to sample plots instead of polygons, Landscape and Size Metrics were not evaluated. The overall EIA ranks discussed in this section are the combined condition scores of Vegetation, Hydrology and Physiochemical (soils) condition rating (Figure 5). How scores are calculated appears in 5.3.2 Individual Site EIA Condition Scores.

Overall ecological integrity of the G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group sample points (n = 15) ranged from 40% having excellent integrity, 27% with good integrity, and 33% with fair integrity (Figure 3). The distribution of averaged ranks for Vegetation and Physiochemical rank factors are shown in Table 5. Only one alliance in this Group A.NCCN-NEW1 *Pinus contorta* var. *contorta* Coastal Dune Woodland Alliance) was assessed (Table 6, 7, and 8).

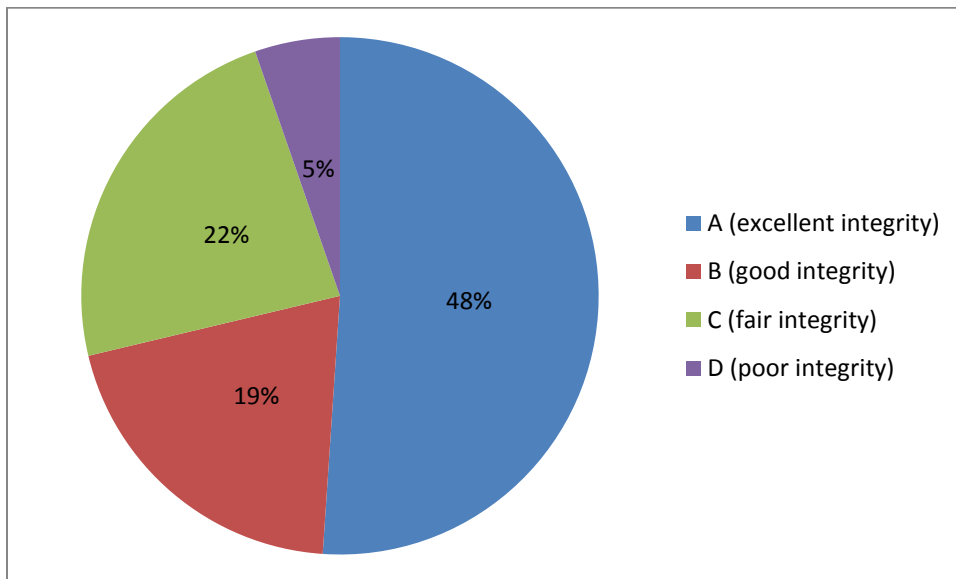


Figure 5. Overall EIA Rank of All Groups. (n= 94)

All four of the G238-North Pacific Maritime Western Redcedar-Western Hemlock Forest Group sample points had good overall ecological integrity (Figure 7). Average ranks for the Vegetation Rank Factor were mostly fair (75%) while the remaining 25% had good integrity (Table 5). Physiochemical Rank Factor ranks were distributed evenly between excellent and good (Table 5). A single alliance was sampled in this group: A.NCCN-New *Tsuga heterophylla* - *Thuja plicata* Forest Alliance assessed (Table 5, 6, and 7,).

Sixty percent of the five sample points of the G239-North Pacific Maritime Sitka Spruce Forest Group had fair integrity while the remaining 40% were split evenly between excellent and good integrity (Figure 8). Forty percent of sample points had average Vegetation ranks of fair, while the remaining 60%

were split evenly between excellent, good, and poor (Table 5). Sixty percent of sites had an average of fair integrity for Physiochemical metrics while 40% has excellent integrity (Table 5). Two Alliances were sampled in this group including the A.NCCN-027 *Picea sitchensis*-(*Tsuga heterophylla*) Forest Alliance (four sample points) and the A.2067 North Pacific (*Pinus contorta var. contorta* - *Picea sitchensis*) Stabilized Dune Forest Alliance (one sample point.) The single point of the latter Alliance had excellent integrity for average Vegetation and Physiochemical Rank Factors as well as overall Ecological Integrity (Table 6, 7, and 8).

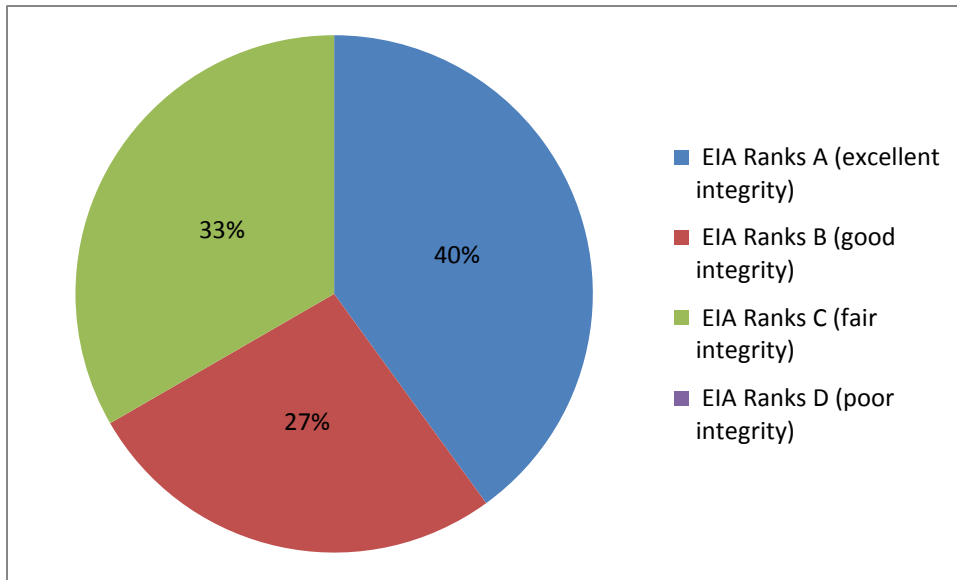


Figure 6. Overall EIA Rank of G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group. (n= 15)

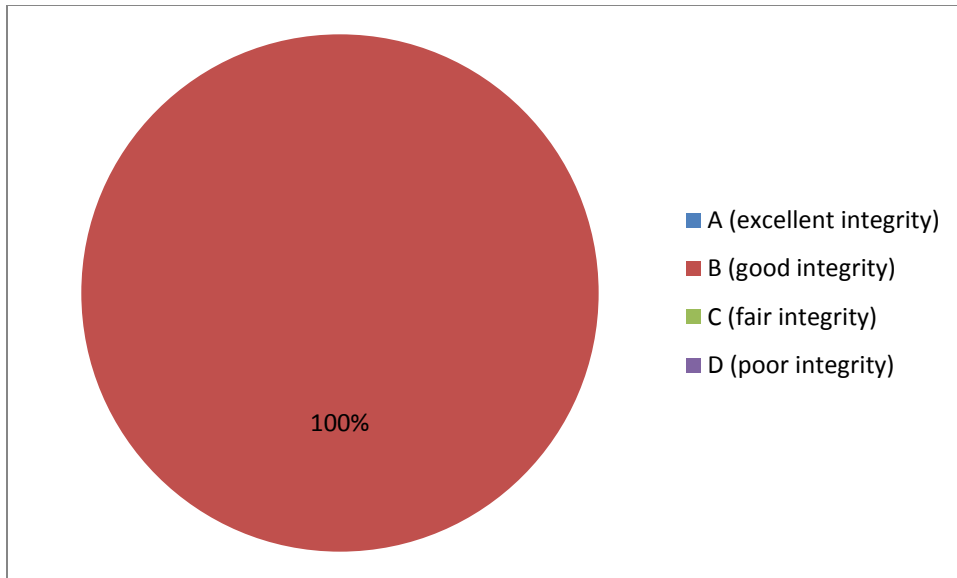


Figure 7. Overall EIA Rank of G238-North Pacific Maritime Western Redcedar-Western Hemlock Forest Group. (n=4)

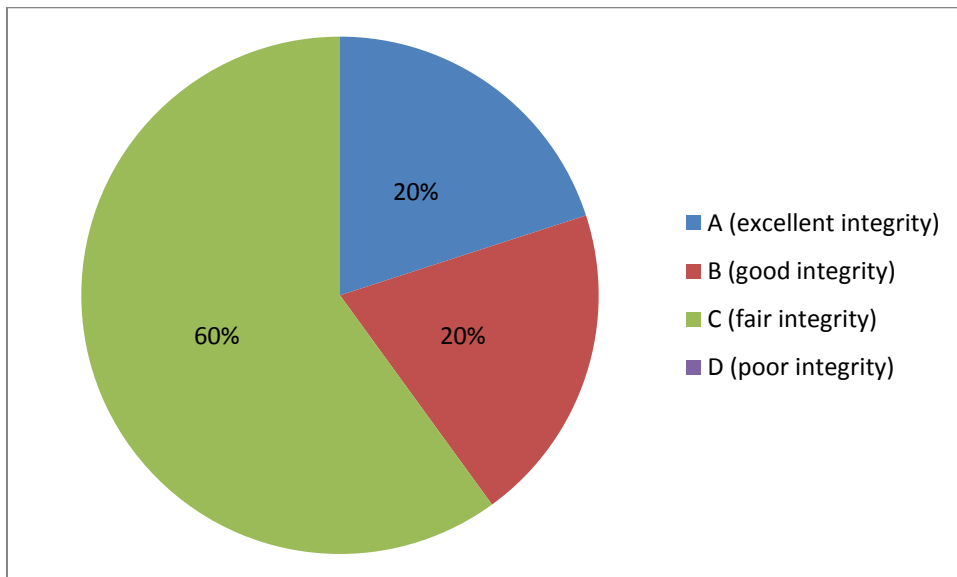


Figure 8. Overall EIA Rank of G239-North Pacific Maritime Sitka Spruce Forest Group. (n=5)

Of the eight sample points for the G256-North Pacific Lowland Hardwood-Conifer Swamp Group, 88% had excellent and 13% had good overall ecological integrity (Figure 9). Although overall ranks were high, 13% of sites had fair integrity for both Vegetation and Physiochemical Rank Factors (Table 5). Two Alliances were sampled in this Group: A.NCCN-002 (*Alnus – Fraxinus - Populus*)/*Lysichiton americanus* Deciduous Swamp Woodland Alliance (3 sample points); A.NCCN-004 (*Tsuga heterophylla - Picea sitchensis - Thuja plicata - Abies*)/*Lysichiton americanus* Alliance (4 sample points plus 1 sample recorded

as *Pinus contorta* Interdunal Swamp Alliance). All of the latter Alliance sample points had excellent overall integrity (Table 5). Sixty seven percent of the A. NCCN-002 (*Alnus – Fraxinus – Populus*)/*Lysichiton americanus* Deciduous Swamp Woodland Alliance had excellent and 33% had good ecological integrity (Table 6). The average ranks for the Vegetation and Physiochemical Rank Factors was variable across the Alliances (Table 8, 9) while all sample points across Alliances had excellent integrity for the Hydrology Rank Factor (Table 9).

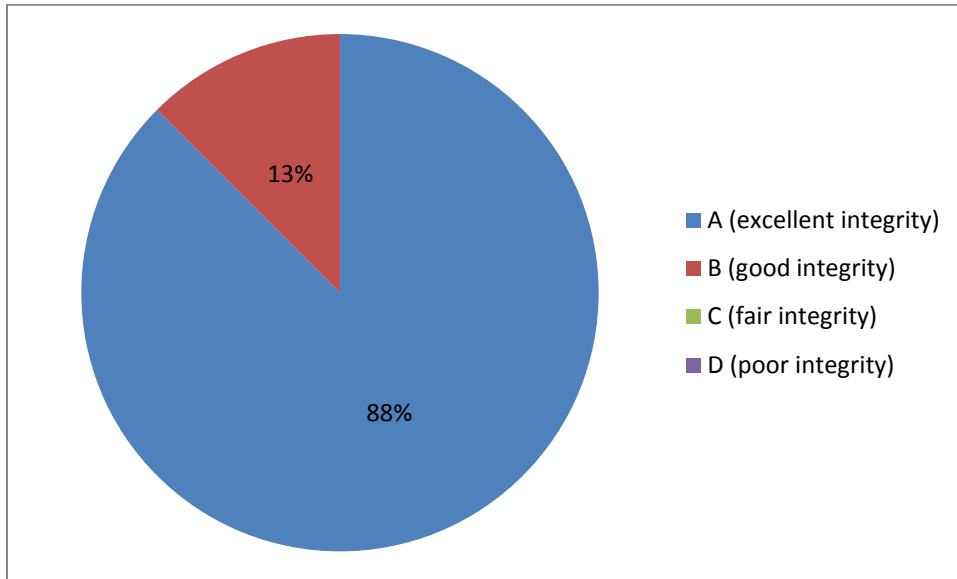


Figure 9. Overall EIA Rank of G256-North Pacific Lowland Hardwood-Conifer Swamp Group. (n=8)

All nine sample points of the G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group had excellent overall ecological integrity (Figure 10). All of the sample points had excellent integrity for the Hydrology Rank Factor and the majority of sample points had excellent integrity for the Vegetation Rank Factor (67%) while 89% had good integrity for the Physiochemical Rank Factor (Table 5). The A.NCCN-999 *Salix hookeriana* Seasonally Flooded Shrubland Alliance was the only one sampled, all at the Leadbetter Point Unit (Tables 6, 7, 8, and 9).

Fifty seven percent of the G498-North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Vegetation Group sample points had fair and 43% had good ecological integrity (Figure 11). Vegetation condition (per Vegetation Rank Factor ranks) was fair (43%) to poor (57%) while Physiochemical Rank Factors ranks were either excellent (57%) to good 43% (Table 5). Two Alliances were sampled in this Group: A.2066 *Poa macrantha – Leymus mollis – Festuca rubra* Sand Dune Herbaceous Alliance (five sample points) and A.NCCN-New3 (*Pinus contorta* var. *contorta*, *Picea sitchensis*, *Gaultheria shallon*) Stabilized Dune Shrubland Alliance (two sample points). Both samples for the latter Alliance were of fair ecological integrity while the former had 60% good and 40% fair ecological integrity. Vegetation Rank

Factor average ranks were 100% poor for the A.NCCN-New3 Alliance and 60% fair and 40% poor for the A.2066 Alliance (Table 7). Physiochemical Rank Factor ranks were all either excellent or good for both Alliances (Table 8).

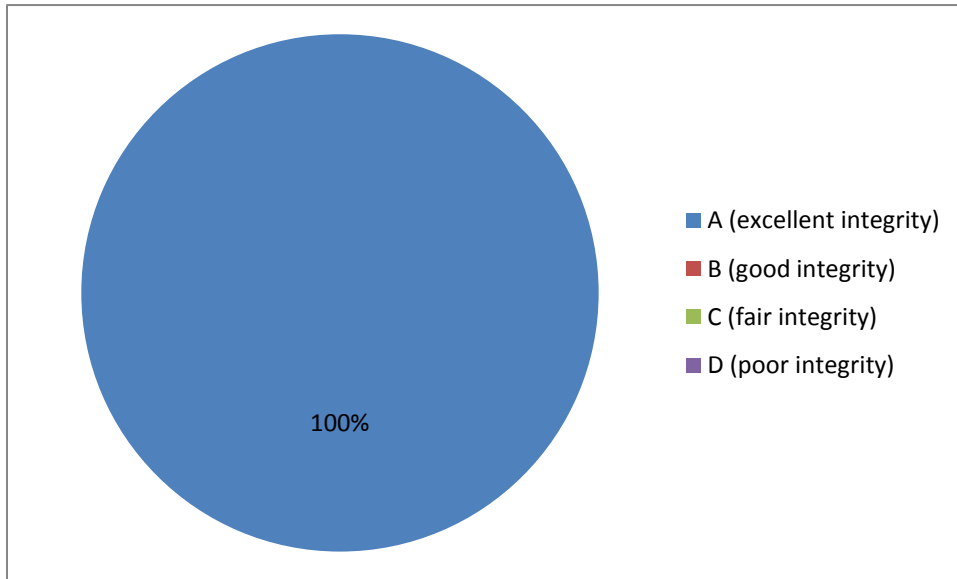


Figure 10. Overall EIA Rank of G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group. (n=9))

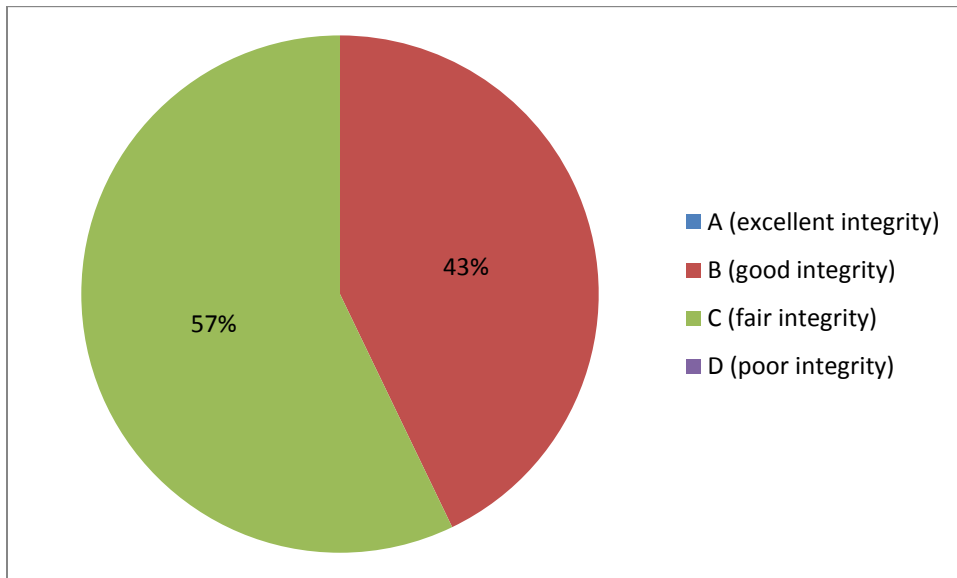


Figure 11. Overall EIA Rank of G498-North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Vegetation Group (n=7)

The most frequently sampled Group (28 sample points) was the G499-Temperate Pacific Tidal Salt & Brackish Marsh Group. An overwhelming majority of those sampled points had excellent integrity (79%) while 14% had good and 7% had fair integrity (Figure 12). The majority of ranks for the Vegetation and Physiochemical Rank Factors were also excellent or good (Table 5). Seven samples did not have any Alliances assigned to them but the remaining 21 sample points represented three Alliances in this Group: A.2618 *Salicornia virginica* Tidal Herb Alliance (eight sample points); A.2622 *Carex lyngbyei* Tidal Herb Alliance (four sample points); and A.2623 *Deschampsia caespitosa* Tidal Herb Alliance (nine sample points). The A.2623 *Deschampsia caespitosa* Tidal Herb Alliance sample points showed the most degradation relatively to the other Alliances in the Group with 44% having excellent, 44% good, and 11% fair ecological integrity (Table 6). All of the A.2618 *Salicornia virginica* Tidal Herb Alliance sample points and 75% of the A.2622 *Carex lyngbyei* Tidal Herb Alliance sample points had excellent ecological integrity (Table 5). The lower ecological integrity for the A.2623 *Deschampsia caespitosa* Tidal Herb Alliance was primarily due to lower ranks for the Vegetation Rank Factor (Tables 7, 8 and 9).

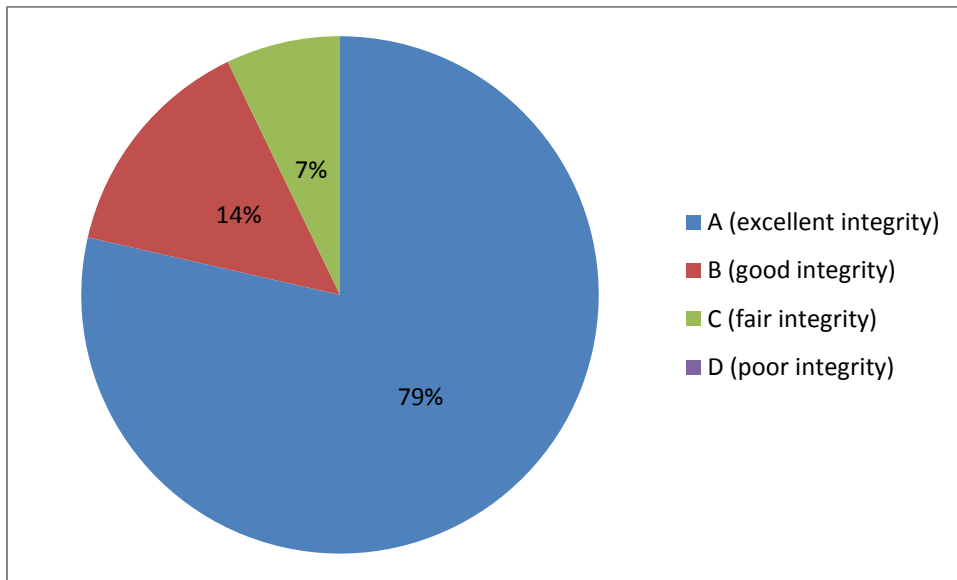


Figure 12. Overall EIA Rank of G499-Temperate Pacific Tidal Salt & Brackish Marsh Group. (n=28)

The G517-Vancouverian Freshwater Coastal Marsh & Meadow Group was sampled at seven points and 43% had excellent, 29% good, and 14% for fair and poor ecological integrity (Figure 13). There was quite a bit of variability of ranks associated with the Vegetation, Physiochemical, and Hydrology Rank Factors but the most concerning result might be the 43% of samples site which had a poor rank for Vegetation (Table 5). Two Alliances from this Group were observed during the course of this project: A.1375 *Juncus effusus* Semi-Natural Seasonally Flooded Alliance and A.2582 *Carex obnupta* Seasonally Flooded Herb

Alliance, but only the A.2582 *Carex obnupta* Seasonally Flooded Herb Alliance was sampled (seven sample points).

Eleven sample points were assessed for the GNEW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group (Figure 14). Typically, ecological integrity assessments are limited to “native” types but this ruderal group was assessed to determine which ecological attributes (i.e. metrics) were in most need to restoration. All vegetation metrics had poor integrity (Table 7) but some of the Physiochemical metrics showed some signs of remaining intact (Table 8).

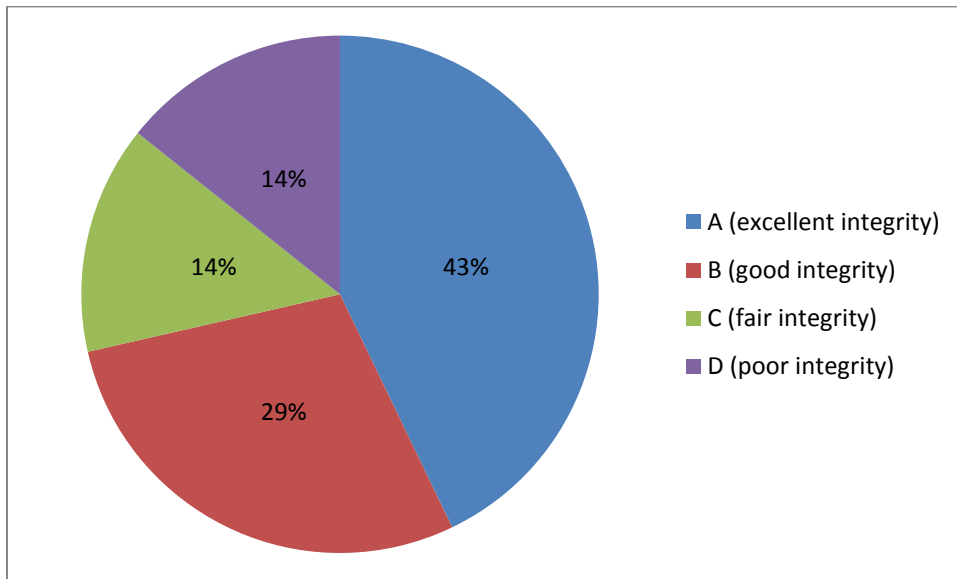


Figure 13. Overall EIA Rank of G517-Vancouverian Freshwater Coastal Marsh & Meadow Group (n=7)

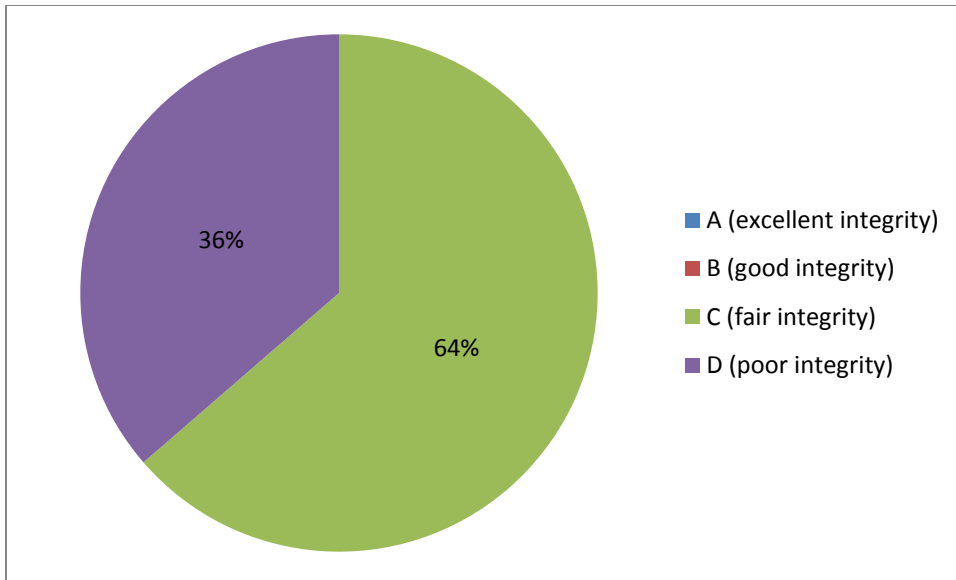


Figure 14. Overall EIA Rank of GNEW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group (n=11)

Table 5. Summary of Overall Ecological Integrity Assessment Rank and Rank Factors for Groups.

| USNVC Group | EIA Ranks | | | | Vegetation Rank | | | | Physiochemical Rank | | | | Hydrology Rank (wetland types only) | | | | N = |
|---|-----------|------|-----|-----|-----------------|-----|-----|-----|---------------------|-----|-----|-----|--|-----|-----|-----|--------|
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | |
| G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) For & Woodland Group | 40% | 27% | 33% | 0% | 53% | 7% | 33% | 7% | 40% | 27% | 33% | 0% | n/a | n/a | n/a | n/a | 15 |
| G238-North Pacific Maritime Western Redcedar-Western Hemlock For Group | 0% | 100% | 0% | 0% | 0% | 25% | 75% | 0% | 50% | 50% | 0% | 0% | n/a | n/a | n/a | n/a | 4 |
| G239- North Pacific Maritime Sitka Spruce For Group | 20% | 20% | 60% | 0% | 20% | 20% | 40% | 20% | 40% | 0% | 60% | 0% | n/a | n/a | n/a | n/a | 5 |
| G256- North Pacific Lowland Hardwood-Conifer Swamp Group | 88% | 13% | 0% | 0% | 63% | 25% | 13% | 0% | 75% | 13% | 13% | 0% | 100% | 0% | 0% | 0% | 8 |
| G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group | 100% | 0% | 0% | 0% | 67% | 33% | 0% | 0% | 11% | 89% | 0% | 0% | 100% | 0% | 0% | 0% | 9 |
| G498- North Pacific Maritime Coastal Sand Dune Scrub & Herb Veg Group | 0% | 43% | 57% | 0% | 0% | 0% | 43% | 57% | 57% | 43% | 0% | 0% | n/a | n/a | n/a | n/a | 7 |
| G499-Temperate Pacific Tidal Salt & Brackish Marsh Group | 79% | 14% | 7% | 0% | 68% | 21% | 4% | 7% | 93% | 4% | 0% | 4% | 96% | 4% | 0% | 0% | 28 |
| G517-Vancouverian Freshwater Coastal Marsh & Meadow Group | 43% | 29% | 14% | 14% | 29% | 29% | 0% | 43% | 29% | 57% | 0% | 14% | 57% | 0% | 29% | 14% | 7 |

| USNVC Group | EIA Ranks | | | | Vegetation Rank | | | | Physiochemical Rank | | | | Hydrology Rank (wetland types only) | | | | N = | |
|--|-----------|-----|-----|-----|-----------------|-----|-----|------|---------------------|-----|-----|-----|--|-----|-----|-----|--------|----|
| | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | | |
| GENW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 0 |
| GENW- North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group | 0% | 0% | 64% | 36% | 0% | 0% | 0% | 100% | 27% | 27% | 45% | 0% | n/a | n/a | n/a | n/a | n/a | 11 |

Table 6. Summary of Overall Ecological Integrity Assessment Rank for Alliances.

| Group/Alliance | Overall EIA Rank | | | | N |
|--|------------------|------|-----|---|----|
| | A | B | C | D | |
| G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) For & Woodland Group | | | | | |
| A.NCCN-NEW1 Pinus contorta var. contorta Coastal Dune Woodland Alliance | 40% | 27% | 33% | | 15 |
| G238-North Pacific Maritime Western Redcedar-Western Hemlock For Group | | | | | |
| A.NCCN-New Tsuga heterophylla - Thuja plicata Forest Alliance | | 100% | | | 4 |
| G239- North Pacific Maritime Sitka Spruce For Group | | | | | |
| A.2067 North Pacific (Pinus contorta var. contorta - Picea sitchensis) Stabilized Dune Forest Alliance | 100% | | | | 1 |
| A.NCCN-027 Picea sitchensis-(Tsuga heterophylla) Forest Alliance | | 25% | 75% | | 4 |
| G256- North Pacific Lowland Hardwood-Conifer Swamp Group | | | | | |
| A.NCCN-002 (Alnus – Fraxinus - Populus)/Lysichiton americanus Deciduous Swamp Woodland Alliance | 67% | 33% | | | 3 |
| A.NCCN-004 (Tsuga heterophylla - Picea sitchensis - Thuja plicata-Abies)/Lysichiton americanus Alliance | 100% | | | | 4 |
| Pinus contorta Interdunal Swamp Alliance | 100% | | | | 1 |
| G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group | | | | | |
| A.NCCN-999 Salix hookeriana Seasonally Flooded Shrubland Alliance | 100% | | | | 9 |
| G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Veg Group | | | | | |

| Group/Alliance | | Overall EIA Rank | | | | |
|---|---|------------------|-----|------|------|----|
| | | A | B | C | D | N |
| | A.2066 <i>Poa macrantha</i> – <i>Leymus mollis</i> – <i>Festuca rubra</i> Sand Dune Herbaceous Alliance | | 60% | 40% | | 5 |
| | A.NCCN-New3 (<i>Pinus contorta</i> var. <i>contorta</i> , <i>Picea sitchensis</i> , <i>Gaultheria shallon</i>) Stabilized Dune Shrubland Alliance | | | 100% | | 2 |
| G499-Temperate Pacific Tidal Salt & Brackish Marsh Group | | | | | | |
| | A.2618 <i>Salicornia virginica</i> Tidal Herb Alliance | 100% | | | | 8 |
| | A.2622 <i>Carex lyngbyei</i> Tidal Herb Alliance | 75% | | 25% | | 4 |
| | A.2623 <i>Deschampsia caespitosa</i> Tidal Herb Alliance | 44% | 44% | 11% | | 9 |
| | No Alliance identified | 100% | | | | 7 |
| G517-Vancouverian Freshwater Coastal Marsh & Meadow Group | | | | | | |
| | A.1375 <i>Juncus effusus</i> Semi-Natural Seasonally Flooded Alliance | | | | | 0 |
| | A.2582 <i>Carex obnupta</i> Seasonally Flooded Herb Alliance | 43% | 29% | 14% | 14% | 7 |
| GNW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group | | | | | | |
| | A.NEW <i>Anthoxanthum odoratum</i> - <i>Holcus lanatus</i> Ruderal Coastal Grassland Alliance | | | | | |
| GNW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group | | | | | | |
| | A.2061 <i>Ammophila arenaria</i> -Planted <i>Leymus mollis</i> ssp. <i>mollis</i> Coastal Dunegrass Ruderal Grassland Alliance | | | 70% | 30% | 10 |
| | A.2062 <i>Cytisus scoparius</i> - <i>Ulex europaeus</i> - <i>Lupinus arboreus</i> Coastal Dune Ruderal Shrubland & Dwarf Tree Alliance | | | | 100% | 1 |

Table 7. Summary of Overall Vegetation Condition Rank for Alliances.

| Group/Alliance | | Vegetation Condition Rank | | | | |
|--|---|---------------------------|-----|-----|-----|----|
| | | A | B | C | D | N |
| G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) For & Woodland Group | | | | | | |
| | A.NCCN-NEW1 <i>Pinus contorta</i> var. <i>contorta</i> Coastal Dune Woodland Alliance | 53% | 7% | 33% | 7% | 15 |
| G238-North Pacific Maritime Western Redcedar-Western Hemlock For Group | | | | | | |
| | A.NCCN-New <i>Tsuga heterophylla</i> - <i>Thuja plicata</i> Forest Alliance | | 25% | 75% | | 4 |
| G239- North Pacific Maritime Sitka Spruce For Group | | | | | | |
| | A.2067 North Pacific (<i>Pinus contorta</i> var. <i>contorta</i> - <i>Picea sitchensis</i>) Stabilized Dune Forest Alliance | 100% | | | | 1 |
| | A.NCCN-027 <i>Picea sitchensis</i> -(<i>Tsuga heterophylla</i>) Forest Alliance | | 25% | 50% | 25% | 4 |

| Group/Alliance | | Vegetation Condition Rank | | | | |
|--|--|---------------------------|-----|-----|------|----|
| | | A | B | C | D | N |
| G256- North Pacific Lowland Hardwood-Conifer Swamp Group | | | | | | |
| | A.NCCN-002 (Alnus – Fraxinus - Populus)/Lysichiton americanus Deciduous Swamp Woodland Alliance | 67% | | 33% | | 3 |
| | A.NCCN-004 (Tsuga heterophylla - Picea sitchensis - Thuja plicata-Abies)/Lysichiton americanus Alliance | 50% | 50% | | | 4 |
| | Pinus contorta Interdunal Swamp Alliance | 100% | | | | 1 |
| G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group | | | | | | |
| | A.NCCN-999 Salix hookeriana Seasonally Flooded Shrubland Alliance | 67% | 33% | | | 9 |
| G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Veg Group | | | | | | |
| | A.2066 Poa macrantha – Leymus mollis – Festuca rubra Sand Dune Herbaceous Alliance | | | 60% | 40% | 5 |
| | A.NCCN-New3 (Pinus contorta var. contorta, Picea sitchensis, Gaultheria shallon) Stabilized Dune Shrubland Alliance | | | | 100% | 2 |
| G499-Temperate Pacific Tidal Salt & Brackish Marsh Group | | | | | | |
| | A.2618 Salicornia virginica Tidal Herb Alliance | 100% | | | | 8 |
| | A.2622 Carex lyngbyei Tidal Herb Alliance | 50% | 25% | | 25% | 4 |
| | A.2623 Deschampsia caespitosa Tidal Herb Alliance | 22% | 56% | 11% | 11% | 9 |
| | No Alliance identified | 100% | | | | 7 |
| G517-Vancouverian Freshwater Coastal Marsh & Meadow Group | | | | | | |
| | A.1375 Juncus effusus Semi-Natural Seasonally Flooded Alliance | | | | | 0 |
| | A.2582 Carex obnupta Seasonally Flooded Herb Alliance | 29% | 29% | | 43% | 7 |
| GNEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group | | | | | | |
| | A.NEW Anthoxanthum odoratum - Holcus lanatus Ruderal Coastal Grassland Alliance | | | | | |
| GNEW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group | | | | | | |
| | A.2061 Ammophila arenaria-Planted Leymus mollis ssp. mollis Coastal Dunegrass Ruderal Grassland Alliance | | | | 100% | 10 |
| | A.2062 Cytisus scoparius-Ulex europaeus-Lupinus arboreus Coastal Dune Ruderal Shrubland & Dwarf Tree Alliance | | | | 100% | 1 |

Table 8. Summary of Overall Physiochemical Condition Rank for Alliances.

| Group/Alliance | Physio-chemical Condition Rank | | | | |
|--|--------------------------------|------|-----|-----|----|
| | A | B | C | D | N |
| G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) For & Woodland Group | | | | | |
| A.NCCN-NEW1 Pinus contorta var. contorta Coastal Dune Woodland Alliance | 40% | 27% | 33% | | 15 |
| G238-North Pacific Maritime Western Redcedar-Western Hemlock For Group | | | | | |
| A.NCCN-New Tsuga heterophylla - Thuja plicata Forest Alliance | 50% | 50% | | | 4 |
| G239- North Pacific Maritime Sitka Spruce For Group | | | | | |
| A.2067 North Pacific (Pinus contorta var. contorta - Picea sitchensis) Stabilized Dune Forest Alliance | 100% | | | | 1 |
| A.NCCN-027 Picea sitchensis-(Tsuga heterophylla) Forest Alliance | 25% | | 75% | | 4 |
| G256- North Pacific Lowland Hardwood-Conifer Swamp Group | | | | | |
| A. NCCN-002 (Alnus – Fraxinus - Populus)/Lysichiton americanus Deciduous Swamp Woodland Alliance | 67% | | 33% | | 3 |
| A. NCCN-004 (Tsuga heterophylla - Picea sitchensis - Thuja plicata-Abies)/Lysichiton americanus Alliance | 100% | | | | 4 |
| Pinus contorta Interdunal Swamp Alliance | | 100% | | | 1 |
| G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group | | | | | |
| A.NCCN-999 Salix hookeriana Seasonally Flooded Shrubland Alliance | 11% | 89% | | | 9 |
| G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Veg Group | | | | | |
| A.2066 Poa macrantha – Leymus mollis – Festuca rubra Sand Dune Herbaceous Alliance | 60% | 40% | | | 5 |
| A.NCCN-New3 (Pinus contorta var. contorta, Picea sitchensis, Gaultheria shallon) Stabilized Dune Shrubland Alliance | 50% | 50% | | | 2 |
| G499-Temperate Pacific Tidal Salt & Brackish Marsh Group | | | | | |
| A.2618 Salicornia virginica Tidal Herb Alliance | 100% | | | | 8 |
| A.2622 Carex lyngbyei Tidal Herb Alliance | 75% | | | 25% | 4 |
| A.2623 Deschampsia caespitosa Tidal Herb Alliance | 89% | 11% | | | 9 |
| No Alliance identified | 100% | | | | 7 |
| G517-Vancouverian Freshwater Coastal Marsh & Meadow Group | | | | | |
| A.1375 Juncus effusus Semi-Natural Seasonally Flooded Alliance | | | | | 0 |
| A.2582 Carex obnupta Seasonally Flooded Herb Alliance | 29% | 57% | | 14% | 7 |
| GNEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group | | | | | |
| A.NEW Anthoxanthum odoratum - Holcus lanatus Ruderal Coastal Grassland Alliance | | | | | |
| GNEW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group | | | | | |

| Group/Alliance | | Physio-chemical Condition Rank | | | | |
|----------------|--|--------------------------------|-----|------|---|----|
| | | A | B | C | D | N |
| A.2061 | Ammophila arenaria-Planted Leymus mollis ssp. mollis Coastal Dunegrass Ruderal Grassland Alliance | 30% | 30% | 40% | | 10 |
| A.2062 | Cytisus scoparius-Ulex europaeus-Lupinus arboreus Coastal Dune Ruderal Shrubland & Dwarf Tree Alliance | | | 100% | | 1 |

Table 9. Summary of Overall Hydrological Condition Rank for Alliances (wetland types only)

| Group/Alliance | | Hydrological Condition Rank | | | | |
|--|--|-----------------------------|---|---|---|----|
| | | A | B | C | D | N |
| G205-Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) For & Woodland Group | | | | | | |
| A.NCCN-NEW1 | Pinus contorta var. contorta Coastal Dune Woodland Alliance | | | | | 15 |
| G238-North Pacific Maritime Western Redcedar-Western Hemlock For Group | | | | | | |
| A.NCCN-New | Tsuga heterophylla - Thuja plicata Forest Alliance | | | | | 4 |
| G239- North Pacific Maritime Sitka Spruce For Group | | | | | | |
| A.2067 | North Pacific (Pinus contorta var. contorta - Picea sitchensis) Stabilized Dune Forest Alliance | | | | | 1 |
| A.NCCN-027 | Picea sitchensis-(Tsuga heterophylla) Forest Alliance | | | | | 4 |
| G256- North Pacific Lowland Hardwood-Conifer Swamp Group | | | | | | |
| A. NCCN-002 | (Alnus – Fraxinus - Populus)/Lysichiton americanus Deciduous Swamp Woodland Alliance | 100% | | | | 3 |
| A. NCCN-004 | (Tsuga heterophylla - Picea sitchensis - Thuja plicata-Abies)/Lysichiton americanus Alliance | 100% | | | | 4 |
| | Pinus contorta Interdunal Swamp Alliance | 100% | | | | 1 |
| G322-Vancouverian Lowland Riparian & Wet Slope Shrubland Group | | | | | | |
| A.NCCN-999 | Salix hookeriana Seasonally Flooded Shrubland Alliance | 100% | | | | 9 |
| G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Veg Group | | | | | | |
| A.2066 | Poa macrantha – Leymus mollis – Festuca rubra Sand Dune Herbaceous Alliance | | | | | 5 |
| A.NCCN-New3 | (Pinus contorta var. contorta, Picea sitchensis, Gaultheria shallon) Stabilized Dune Shrubland Alliance | | | | | 2 |
| G499-Temperate Pacific Tidal Salt & Brackish Marsh Group | | | | | | |
| A.2618 | Salicornia virginica Tidal Herb Alliance | 100% | | | | 8 |
| A.2622 | Carex lyngbyei Tidal Herb Alliance | 100% | | | | 4 |

| Group/Alliance | Hydrological Condition Rank | | | | |
|---|-----------------------------|-----|-----|-----|----|
| | A | B | C | D | N |
| A.2623 Deschampsia caespitosa Tidal Herb Alliance | 89% | 11% | | | 9 |
| No Alliance identified | 100% | | | | 7 |
| G517-Vancouverian Freshwater Coastal Marsh & Meadow Group | | | | | |
| A.1375 Juncus effusus Semi-Natural Seasonally Flooded Alliance | | | | | 0 |
| A.2582 Carex obnupta Seasonally Flooded Herb Alliance | 57% | | 29% | 14% | 7 |
| GNEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group | | | | | |
| A.NEW Anthoxanthum odoratum - Holcus lanatus Ruderal Coastal Grassland Alliance | | | | | |
| GNEW-North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herbaceous Vegetation Group | | | | | |
| A.2061 Ammophila arenaria-Planted Leymus mollis ssp. mollis Coastal Dunegrass Ruderal Grassland Alliance | | | | | 10 |
| A.2062 Cytisus scoparius-Ulex europaeus-Lupinus arboreus Coastal Dune Ruderal Shrubland & Dwarf Tree Alliance | | | | | 1 |

6.3 Comprehensive Conservation Plan Objectives (CCP)

The attributes of CCP objectives selected to be included in the field assessments are those that provide more specific site information than Level-2 EIA metrics. The numbers of each attribute assessed as neither meeting the attribute criteria or not are listed by NVC Group in Table 9. Specific ratings at the site level are in attached excel files. The results of CCP determination for each attribute are displayed in Table 10. CCP attributes receiving an affirmative determination varied from all sites (CCP11SS- No Spartina) to none (CCP09NBH-Mean nest branch height and CCP21A- free of introduced beach grasses) with an average affirmative percent of 44% (31% standard deviation) across all attributes.

Table 10. Number of Comprehensive Conservation Plan (CCP) Attribute Assessments per NVC Group. Values in table represent the number of sample points that met the characteristics of the attribute or not.

| Code | Attribute summary | Dunes | | Forests | | | Swamp | Riparian | Marsh | Salt Marsh | Tideflat |
|-----------|--|-------|--------|---------|------|------|-------|----------|-------|------------|----------|
| | | G498 | GNEW-N | G205 | G238 | G239 | G256 | G322 | G517 | G499 | none |
| CCP001DT | Dominant trees 100 to 200+ years | | | 10 | 4 | 5 | 5 | | | | |
| CCP002SL | Shrub layer composed of native species | | | 10 | 4 | 5 | 5 | | | | |
| CCP003LFT | Prevalence of large fallen trees and snags. | | | 10 | 4 | 5 | 5 | | | | |
| CCP004MC | Multiaged, multilayered | | | 10 | 4 | 5 | 5 | | | | |
| CCP005DTC | <80% dominant tree canopy cover. | | | 10 | 4 | 5 | 5 | | | | |
| CCP006LDT | largest tree diameters 32 to >39 inches. | | | 10 | 4 | 5 | 5 | | | | |
| CCP007FMB | Moss-covered branches >7 inches in diameter. | | | 10 | 4 | 5 | 5 | | | | |
| CCP008BH | Branches at least 50 feet above the ground. | | | 10 | 4 | 5 | 5 | | | | |
| CCP009NBH | Mean nest branch height equal to 120 feet. | | | 9 | 4 | 5 | 5 | | | | |
| CCP010VT | Vegetation within 9 to 11 feet NGVD primarily native species | | | | | | | | | 20 | 1 |
| CCP011SS | No Spartina. | | | | | | | | | 28 | 1 |
| CCP011SI | Interspersion of tidal sloughs. | | | | | | | | | | |
| CCP012II | Infrequent inundation except on highest high tides. | | | | | | | | | 21 | 1 |

| | | | | | | | |
|-----------|--|---|----|---|---|---|---|
| CCP013HCC | High canopy closure over nest branches. | | 4 | | 1 | | |
| CCP014NWP | >40% cover desirable/native wetland plants/short emergent vegetation | 2 | | | 1 | 7 | 7 |
| CCP015IP | <5% cover of invasive plant species | 1 | | | 3 | 9 | 9 |
| CCP016VW | Variable water levels (6 inches to >4 feet). | 1 | | | 3 | 8 | 7 |
| CCP017B | No bullfrogs (<i>Rana catesbeiana</i>). | | | | 3 | 1 | 4 |
| CCP018DWP | Desirable and native wetland plants and emergent vegetation | 5 | 1 | | 3 | 9 | 9 |
| CCP019NBP | Presence of native beach plants | 5 | 11 | 5 | | | |
| CCP020SH | Sparsely vegetated habitat; ground layer sand dominated. | 7 | 11 | 5 | | | |
| CCP021A | Beach or dune habitat free of introduced beachgrasses | 7 | 11 | 5 | | | |
| CCP022E | Exposed mud to sandy substrate interspersed with eelgrass beds. | | | | | | |
| CCP023S | Sand bars that provide roost sites. | | | | | | |

Table 11 . Results of Comprehensive Conservation Plan (CCP) Attribute Assessments. Values represent the number of determinations. See Table 9 for codes. Total = the number of determinations, unknown = determination not possible, empty field=no determinations.

| CCP Attribute | total | no | yes | unk |
|--|-------|----|-----|-----|
| No <i>Spartina</i> . | 29 | 0 | 29 | |
| Vegetation within 9 to 11 feet NGVD primarily native species | 21 | 2 | 19 | |
| Infrequent inundation except on highest high tides. | 22 | 3 | 19 | |
| <5% cover of invasive plant species | 22 | 4 | 17 | 1 |
| Variable water levels (6 inches to >4 feet). | 19 | 2 | 14 | 3 |
| Desirable and native wetland plants and emergent vegetation | 27 | 9 | 18 | |
| Shrub layer composed of native species | 24 | 8 | 15 | 1 |
| <80% dominant tree canopy cover. | 24 | 9 | 15 | |
| No bullfrogs (<i>Rana catesbeiana</i>). | 8 | 0 | 5 | 3 |
| >40% cover desirable/native wetland plants/short emergent vegetation | 17 | 9 | 8 | |
| Sparsely vegetated habitat; ground layer sand dominated. | 23 | 14 | 9 | |
| Multiaged, multilayered | 24 | 16 | 8 | |
| Dominant trees 100 to 200+ years | 24 | 19 | 5 | |
| Branches at least 50 feet above the ground. | 24 | 18 | 5 | 1 |
| High canopy closure over nest branches. | 5 | 4 | 1 | |
| Prevalence of large fallen trees and snags. | 24 | 20 | 4 | |
| largest tree diameters 32 to >39 inches. | 24 | 21 | 3 | |
| Moss-covered branches >7 inches in diameter. | 24 | 20 | 3 | 1 |
| Presence of native beach plants | 21 | 19 | 2 | |
| Mean nest branch height equal to 120 feet. | 23 | 22 | 0 | 1 |
| Beach or dune habitat free of introduced beachgrasses | 23 | 23 | 0 | |
| Interspersion of tidal sloughs. | 0 | | | |
| Exposed mud to sandy substrate interspersed with eelgrass beds. | 0 | | | |
| Sand bars that provide roost sites. | 0 | | | |

6. Conclusions

6.1 Classification

The initial classification applied to the pilot project was modified from the Lewis and Clark National Historic Park vegetation classification and mapping project report (Kagan et al 2011) after review of Washington Natural Heritage information and information and consultation from NatureServe. For the most part the final classification was applicable for natural vegetation although classification of “ruderal” vegetation was unresolved. That was particularly apparent in the Leadbetter Point sand dunes and South Bay freshwater marsh and meadows and second growth forests.

Classification was least satisfying when addressing vegetation altered by human modification, such as ditching, diking, or by exotic plant invasion and dominance that alters natural processes, such as *Ammophila* in coastal dunes. Semi-natural vegetation (ruderal) and natural vegetation are treated at the higher NVC Macrogroup level based on the “overwhelming dominance of ruderal and exotic species in the semi-natural vegetation.”

“Natural vegetation is vegetation where ecological processes primarily determine species and site characteristics; that is, vegetation comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes (Küchler 1969, Westhoff and van der Maarel 1973). Semi-natural vegetation is vegetation in which past or present human activities significantly influence composition or structure, but do not eliminate or dominate spontaneous ecological processes (Westhoff and Van der Maarel 1973). Semi-natural vegetation typically results from prior intensive human land use followed by appearance of vegetation that is dominated by spontaneously growing plants that require no human input for their maintenance and also have no apparent natural analog; e.g., “old field” vegetation assemblages that do not occur without prior, intensive human activity.” Copied from: http://esa.org/vegweb2/wp-content/uploads/2013/08/USNVC-FAQ_V1-Aug-2013.pdf.

In this context much of the dune vegetation at Leadbetter Point displays a ruderal vegetation characteristic an “overwhelming dominance of ruderal and exotic species” (*Ammophila* species) although it has not resulted from “prior human use” that resulted “in vegetation dominated by spontaneously growing plants that don’t require human input.” We concluded that where *Ammophila* dominates grasslands and shrublands, it represents a provisional GNEW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group. Where *Ammophila* has been removed along the Pacific coastal beach and was now sparsely re-colonized by native species and *Ammophila*, it represents the G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Veg Group. Six of 15 points included in the G205 Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group occur on stabilized dunes with dense shrub and tree cover with little undergrowth still mostly composed of *Ammophila*. Those sites could be considered either a semi-natural, ruderal vegetation type or an early seral or poor condition natural vegetation type. In all cases, the North Pacific Coastal Maritime Sand Dunes EIA was applied to sites classified as G498- North Pacific Maritime Coastal Sand Dune Scrub & Herbaceous Group, GNEW North Pacific Maritime Coastal Sand Dune RUDERAL

Provisional Scrub & Herb Vegetation Group or G205 Vancouverian Dry Coastal & Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group.

Twelve points were in ruderal vegetation or on sites too altered to be assessed with an EIA and were used only for the AA. The vegetation classification developed at the beginning of the project did not adequately address this condition since the key lead the user to:

- G517 Vancouverian Freshwater Coastal Marsh & Meadow Group (eight sites are tidal marsh to converted ruderal wet pasture that were mapped as “Ruderal Freshwater Alliance” without an equivalent NVC type)
- G239 North Pacific Maritime Sitka Spruce Forest Group (three sites with planted and residual trees in upland pastures mapped as G239 with an equivalent NVC type)

All of these represent needs for modification of the NVC classification and vegetation key. 6.2 Ecological Integrity Assessment

The current Ecological Integrity Assessments (EIA) of two management units of Willapa NWR habitats indicate some areas are compromised by numerous invasive species (European beachgrasses), planted non-native species (quack grass and western wheat grass) and by alteration of tidal hydrology by diking and ditching. However the EIA also indicate some areas that represent high ecological integrity that can be used as reference sites for both wetland and upland habitats.

The EIA provides a good representation of ecological condition at the sample points and of generalized condition of specific NVC units although the ability to extrapolate beyond the few sample points to stands or specific management sites is questionable because of the sampling design of the pilot project. 7. Lessons Learned for Future Work

A lesson learned is that the mappers work more closely with the Natural Heritage Program and NatureServe in developing and validating the NVC classification prior to condition assessment. Ideally, the Accuracy Assessment would be complete prior to condition assessments.

Stand or management level evaluations would be improved by performing EIA sampling after classification and mapping was complete and directed to assess map units that represent the variation across specific classification units.

Including CCP objectives as threshold yes or no determinations during the Level-2 EIA survey, provides reconnaissance level information. Because many of the EIA metrics and vegetation plot information are related to CCP attributes, there was little effect of EIA survey effort. CCP attributes that are more dependent on wildlife detection (bullfrog presence) or specific habitat requirements (possible murrelet nest locations) are less reliable or precise because of the insufficient time on site for a level-2 EIA survey and small sample area for the pilot project.

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8. Appendices

Appendix A. Ecological Systems and Metric used in Ecological Integrity Assessments

| metric code | Metric\Ecological System | North Pacific Hyper-Maritime Sitka Spruce | North Pacific Hyper-Maritime Western RedCedar Western Hemlock | North Pacific Maritime Coastal Sand Dune | North Pacific Hardwood-Conifer Swmp | Temperate Pacific Freshwater Emergent Marsh | Temperate Pacific Tidal Salt & Brackish Marsh |
|-------------|--|---|---|--|-------------------------------------|---|---|
| M004HCT | M04 Hydrological Connectivity (tidal) | | | | | | X |
| M005H | M05 Hydroperiod | | | | X | X | |
| M006H_T | M06 Hydroperiod - Tidal | | | | | | X |
| M008AOSTS | M08 Abundance of Salt Tolerant Species | | | | | | X |
| M030HCNR | M30 Hydrological Connectivity (non-riverine) | | | | X | X | |
| M035WS | M35 Water Source | | | | X | X | X |
| M007SD | M07 Sand Dynamics | | | X | | | |
| M040SSC | M40 Soil Surface Condition | | | X | | X | |
| M041SSC | M41 Soil Surface Condition (wetland) | | | | | | X |
| M042SSC | M42 Soil Surface Condition (upland) | X | X | | X | | |
| M043WQ | M43 Water Quality | | | | | X | |
| M051SC | M51 Species Composition | X | X | X | X | X | X |
| M001RCONPS | M01 Relative Cover of Native Plant Species | | | X | X | X | X |
| M010RCNUPS | M10 Relative Cover Native Understory Plant Species | X | X | | | | |
| M002ACOIS | M02 Absolute Cover of Invasive Species | | | X | X | X | X |
| M048RCONIS | M48 Relative Cover of Native Inceaser Species | X | X | | | X | X |
| M045ACOIHS | M45 Absolute Cover of Invasive Understory Species | X | X | | | | |
| M009ASA | M09 Ammophila species Abundance | | | X | | | |
| M077VSH | M77 Vegetation Structure Herbaceous | | | X | | X | X |
| M003LLT | M03 Large Live Trees | | X | | | | |
| M011CWDU | M11 Coarse Woody Debris (upland) | X | X | | | | |
| M012LS | M12 Large Snags | X | X | | | | |
| M013TSD | M13 Tree Size Diversity | X | | | | | |

| metric code | Metric\Ecological System | North Pacific Hyper-Maritime Sitka Spruce | North Pacific Hyper-Maritime Western RedCedar Western Hemlock | North Pacific Maritime Coastal Sand Dune | North Pacific Hardwood-Conifer Swmp | Temperate Pacific Freshwater Emergent Marsh | Temperate Pacific Tidal Salt & Brackish Marsh |
|-------------|--|---|---|--|-------------------------------------|---|---|
| M053LLT | M53 Large Live Trees (Wetland) | X | X | | X | | |
| M054CC | M54 Canopy Composition | | | | X | | |
| M056CWD | M56 Coarse Woody Debris | | | | X | | |
| M059NTR | M59 Natural Tree regeneration | X | X | | | | |
| M037PPD | M37 Physical Patch Diversity | | | | | | |
| M017BC | M17 Buffer Condition | | | | X | X | X |
| M018BL | M18 Buffer Length | | | | X | X | X |
| M019BW | M19 Buffer Width | | | | X | X | X |
| M020EC | M20 Edge Condition | X | X | X | | | |
| M021EL | M21 Edge Length | X | X | X | | | |
| M022EW | M22 Edge Width | X | X | X | | | |
| M023C | M23 Connectivity | X | X | X | X | X | |
| M027PDO_1K | M27 Patch Diversity Origin (within 1 km) | X | X | | | | |
| M028WC | M28 Watershed Connectivity | | | | | | X |

Appendix B. Key to Vegetation at Willapa NWR, Leadbetter Point and South Bay Units.

Aug 2012 provisional version modified from Kagan et al. 2012 with information Washington Natural Heritage and a 2012 provisional NVC version from NatureServe.

Key to NVC Groups and Alliances within Willapa NWR

- 1a.** Vegetation dominated by tall trees, either as forest or woodland-- *Alnus rubra* forests are included in this here.**Section I.**
- 1b.** Vegetation dominated by shrubs and/or herbaceous plants. Shrubs can be tall or dwarf. Dwarf or stunted trees 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. Primarily dominated by *Pinus contorta*. Sites **on sand dunes** usually with dune indicators present such as *Morrellia californica*, *Arctostaphylos uva-ursi*, *Ammophila spp*, *Leymus mollis*, *Fragaria chiloensis*, *Lathyrus japonicus*, *Lathyrus littoralis*, *Glehnia littoralis* although more typical forest species, such as *Gaultheria shallon*, and *Vaccinium ovatum* and other typical forests maybe common. Amounts of *Picea sitchensis*, *Tsuga heterophylla* or *Thuja plicata* may be present as regeneration. **G205-Vancouverian Dry Coastal and Lowland (Douglas-Fir, Shore Pine, Madrone) Forest & Woodland Group** **A.NCCN-NEW1 *Pinus contorta* var. *contorta* Coastal Dune Woodland Alliance (apply North Pacific Maritime Coastal Dune and Strand ecological system EIA)**

3b. More closed forests dominated or co-dominated by deciduous trees, *Thuja plicata*, *Tsuga heterophylla*, and/or *Picea sitchensis* not like above in all respects; *Pinus contorta* can co-dominate on old stabilized dunes..... **4**

4a. *Alnus rubra*, *Acer macrophyllum* are dominant or co-dominant. 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 can be codominant, including *Pseudotsuga menziesii*, *Thuja plicata*, *Abies grandis*, *Tsuga heterophylla*, and/or *Picea sitchensis*. However if associated with spring, stands should fall in a wetland group. [MG024Vancouverian Lowland and Montane Rainforest]
G237- North Pacific Red Alder-Bigleaf Maple-Douglas-fir Forest Group (apply North Pacific Hypermaritime Western Redcedar-Western Hemlock Forest ecological system EIA; if on landslide or unstable slope, apply North Pacific Broadleaf Landslide Forest and Shrubland ecological system EIA)

4a1. Stands dominated by *Acer macrophyllum*. Often on some disturbed ground, landslide or burn. May have some conifers present. ***Acer macrophyllum* - (*Pseudotsuga menziesii*) Forest Alliance**

4a2. Stands dominated by *Alnus rubra*, Often on some disturbed ground, landslide or burn, conifers present may be present
**Alnus rubra - (Picea sitchensis, Tsuga heterophylla) Forest and Woodland Alliance**

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

5a. Stands are typically dominated or codominated by *Picea sitchensis* (minimally 10% canopy) but often have a mixture of other conifers present, such as *Tsuga heterophylla* or *Thuja plicata*. [MG024Vancouverian Lowland and Montane Rainforest]

G239-North Pacific Hypermaritime Sitka Spruce Forest Group
(apply North Pacific Hypermaritime Sitka Spruce Forest ecological system EIA)

5a1. Stands not on old stabilized dunes
 **Picea sitchensis - (Tsuga heterophylla) Forest Alliance**

5a2. Stands on stabilized dunes
**A.2067 North Pacific (Pinus contorta var. contorta – Picea sitchensis) Stabilized Dune Forest**

5b. Stands without or less than 10% *Picea sitchensis*, *Thuja plicata* always present usually with *Tsuga heterophylla* as dominant or co-dominant. *Pseudotsuga menziesii* presence is naturally rare although it appears in planted stands where it may be codominant or dominant younger stands. *Acer macrophyllum* and *Alnus rubra* may be found as canopy or subcanopy codominants. *Gaultheria shallon*, *Vaccinium ovalifolium*, and *Menziesia ferruginea* is usually well-developed. The fern *Blechnum spicant* occurs which is typical of hypermaritime conditions. *Oxalis oregana* is important in the understory of moist sites. [MG024Vancouverian Lowland and Montane Rainforest]

G238-North Pacific Maritime Western Redcedar-Western Hemlock Forest Group
(apply North Pacific Hypermaritime Western Redcedar-Western Hemlock Forest ecological system EIA)
A.NCCN-new Tsuga heterophylla – Thuja plicata Forest Alliance

1c. FORESTED WETLANDS

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

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

7a. Riparian forest canopy dominated by deciduous trees other than cottonwoods, such as *Acer* or *Alnus*
G254 North Pacific Lowland Riparian Forest Group
(Acer macrophyllum, Alnus rubra) Riparian Forest Alliance
(apply North Pacific Lowland Riparian Forest and Shrubland ecological system EIA)

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

G254 North Pacific Lowland Riparian Forest Group

(Picea sitchensis, Abies grandis, Tsuga heterophylla, Thuja) - (Alnus, Acer) Riparian Forest Alliance

(apply North Pacific Lowland Riparian Forest and Shrubland ecological system EIA)

8a. Open forest canopy dominated by *Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata* or *Abies*, 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. *Pseudotsuga menziesii* and *Abies grandis* may also share the upper tree canopy. *Lysichiton americanus* is always present and very few to no shrubs are present.....

G256 North Pacific Lowland Hardwood-Conifer Swamp Group

(Tsuga heterophylla –Picea sitchensis – Thuja plicata - Abies) / Lysichiton americanus Alliance

(apply North Pacific Hardwood-Conifer Swamp ecological system EIA)

8b. Depression swamp wetland forest with the indicator herbaceous species *Lysichiton americanus* nearly always present. Overstory canopy dominated by *Alnus rubra*, *Fraxinus latifolia* or *Populus balsamifera ssp. trichocarpa* [MG035 Vancouverian Flooded & Swamp Forest]

G256 North Pacific Lowland Hardwood-Conifer Swamp Group

.....(Alnus – Fraxinus – Populus) / Lysichiton americanus Deciduous Swamp Woodland Alliance

(apply North Pacific Hardwood-Conifer swamp ecological System EIA)

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, aquatic plants; includes salt and freshwater marshes, , tall shrub swamps, marshes, sloping wetlands, riparian zones, floating & rooted aquatic plants **8**

Uplands

2a. Vegetation on sand dunes (may be very open, active dunes, or well vegetated back dunes)..... **3**

2b. Herbaceous or shrubland generally not associated with sand dunes (includes slopes, mowed road verges, sparsely vegetated cliffs, 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 (apply North Pacific Maritime Coastal Dune and Strand ecological system EIA) | |
| 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] GNEW North Pacific Maritime Coastal Sand Dune RUDERAL Scrub & Herb Vegetation Group (apply North Pacific Maritime Coastal Dune and Strand ecological system EIA) | |
| 3b1. Herbaceous | |
| 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 (apply North Pacific Coastal Cliff and Bluff ecological system EIA) No alliances defined | |
| Sand or cobble beach | |
| GXXX Undefined Group | |
| 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 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) (apply North Pacific Herbaceous Bald and Bluff ecological system EIA) | |
| 6a1. Herbaceous | 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]
GENEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland Group
(apply North Pacific Herbaceous Bald and Bluff ecological system EIA)
 **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 and/or garden beds
[M492 Temperate & Tropical Planted Landscaping & Gardens]
G623 Treed Landscaping
 **A.New Temperate Planted Trees/Gardens Alliance**

Wetlands

- 8a. Freshwater wetlands and marshes, woody swamps and riparian shrublands, floating aquatic plants in freshwater (includes slightly brackish areas)..... **9**
- 8b. Saltwater wetlands and Marshes, including seagrass areas in shallow ocean waters near the seashore **11**
- 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**
(if within coastal dunes apply North Pacific Coastal Interdunal Wetland ecological system EIA; in other settings apply North Pacific Shrub Swamp ecological system EIA)
 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
(if within coastal dunes apply North Pacific Coastal Interdunal Wetland ecological system EIA; in other settings apply Temperate Pacific Freshwater Emergent Marsh ecological system EIA)
 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
(very cosmopolitan alliance, occurs 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 (may be flooded with shallow) standing water.....

G517 Vancouverian Freshwater Coastal Marsh & Meadow Group

(if within coastal dunes apply North Pacific Coastal Interdunal Wetland ecological system EIA; in other settings apply Temperate Pacific Freshwater Emergent Marsh ecological system EIA)

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

(if within coastal dunes apply North Pacific Coastal Interdunal Wetland ecological system EIA; in other settings apply Temperate Pacific Freshwater Emergent Marsh ecological system EIA) (this alliance is in a different Group as it is very wide spread 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

(apply Temperate Pacific Tidal Salt and Brackish Marsh ecological system EIA)

11a1. Tidal areas dominated by Lyngby's sedge.....

A.2622 *Carex lyngbyei* Tidal Herbaceous Alliance

11a2 Tidal areas dominated by pickleweed or glasswort.....

A.2618 *Salicornia virginica* Tidal Herbaceous Alliance

11a3. 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

(apply North Pacific Eelgrass Bed ecological system EIA)

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

11c. Near-shore intertidal water on exposed silty substrates with little to no vascular plants dominated by algal or invertebrate species..... **apply Temperate Pacific Intertidal Flat ecological system EIA**

Appendix C. Group and Alliance Descriptions

from KAGAN, J. S., G. KITTEL, AND L. K. WISE. 2011. LEWIS AND CLARK NATIONAL HISTORIC PARK ALLIANCE DESCRIPTIONS: FORESTED AND NON-FORESTED ALLIANCES. Unless otherwise noted.

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* Woodland Alliance

Shorepine Coastal Dune Woodland Alliance

These dune woodlands occur primarily at Leadbetter Point and south along the Long Beach Peninsula.

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. These are short, 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. More open areas with *Arctostaphylos uva-ursi* in the understory, usually *Ammophila* species cover on much of the sand, and barely stabilized dunes. More closed shorepine woodlands include areas with dense and tall ericaceous shrublands where *Gaultheria shallon*, *Morella californica*, and *Vaccinium ovatum* is abundant along with the exotic shrubs *Cytisus scoparius* or *Ulex europaeus* with *Ammophila* species.

References: Kagan 2011.

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

MG NEW Californian-Vancouverian Foothill & Valley Ruderal Forest & Woodland

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

A.NCCN-NEW1 *Pinus contorta* var. *contorta* Coastal Provisional Ruderal Woodland Alliance

Shorepine Coastal Dune Ruderal Woodland Alliance

This is a provisional alliance. These dune woodlands occur primarily at Leadbetter Point and south along the Long Beach Peninsula.

Summary: This shorepine dominated conifer woodland alliance occurs on stabilized to semi-stabilized dunes. These are short, 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 canopy *Pinus contorta* var. *contorta* dominated forests.

References: none.

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

This alliance is widespread in the Oregon and Washington Coast Ranges but not encountered during mapping but likely less where on the NWR.

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*. 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

This alliance is widespread in the Oregon and Washington Coast Ranges but not encountered during mapping but likely less where on the NWR. 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.

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.

References: Kagan 2011.

G238-North Pacific Maritime Western Redcedar-Western Hemlock Forest Group

A.NCCN-new *Tsuga heterophylla* – *Thuja plicata* Forest Alliance

G239 North Pacific Maritime Sitka Spruce Forest Group

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

Sitka Spruce - (Western Hemlock) Forest Alliance

This is a common forest alliance found at Willapa NWR. These forests 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).

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** 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.

Reference. Kagan 2011

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

This forest alliance was not encountered at Leadbetter Point or South Bay but is likely elsewhere on the NWR.

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. 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.

Reference. Kagan 2011

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

MG404 Western North American Ruderal Forest and Plantation Macrogroup

GNEW Vancouverian Ruderal Forest and Plantation Provisional Group

A.NCCN-NEW2 North Pacific (*Pinus contorta* var. *contorta* – *Picea sitchensis*) Stabilized Dune Forest

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

This is a provisional alliance. This type is found primarily on the areas of dunes at Leadbetter Point 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.

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, the provisional Ruderal Shore pine Woodland and the red alder forest or Sitka spruce forest depending on the species present and hydrography.

References: Christy et al. 1998.

A.NCCN-NEW2 North Pacific– *Picea sitchensis* Provisional Ruderal Alliance

This is a provisional alliance. This type is found primarily on the areas at South Bay where Sitka spruce is planted or invaded upland soils along with other native trees . It can be difficult to classify due to the variety of species present, but is characterized by the presence of pasture grasses, blackberry and other exotic plants indicative of past cultivations.

Summary: This is an early successional provisional type that occurs on past cultivated land. 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 other trees may also be present. If present the shrub layer may include *Rubus* species exotic and native along with *Symphoricarpos albus*. Graminoids such as *Anthoxanthum odoratum*, *Holcus lanatus*, *Agrostis* species, *Dactylis glomerata*, *Poa* species, *Juncus arcticus* or *Juncus effusus*, are common to dominant.

References: none

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

These are hardwood riparian forests dominated by *Alnus rubra* at the park, but mixed hardwoods without cottonwood elsewhere in the Coast Ranges. They are very common at low elevations throughout western Oregon and Washington. These are riparian forests in the NWR.

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. 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.

Reference. Kagan 2011

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

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 conifer or deciduous forest types.

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. 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).

Reference. Kagan 2011

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

These are lowland deciduous forested swamps dominated by red alder with slough sedge, salmonberry, and skunk cabbage often present. Soils are seasonally flooded and saturated year-round.

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.

References: Christy 2004.

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

Suggested Alternate Name: Conifer / *Lysichiton americanus* Coniferous Swamp Woodland (Western Hemlock, Sitka Spruce, Western Red-cedar, Fir species) / Yellow Skunk-cabbage Coniferous Swamp Woodland Alliance

These are coastal conifer forested swamps, dominated by Sitka spruce. Soils are seasonally flooded and saturated year-round. Slough sedge and skunk cabbage are often present.

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*.

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.

Reference. Kagan 2011

A.NEW *Pinus contorta* var. *contorta* Coniferous Swamp Provisional Woodland Alliance

This is a provisional Alliance found on Leadbetter Point. These are coastal conifer forested swamps, dominated by shore pine. Soils are sandy and seasonally flooded and saturated year-round. Slough sedge and rarely skunk cabbage are often present. Maybe an environmental extreme of the A.NCCN-004 (*Tsuga heterophylla*, *Picea sitchensis*, *Thuja plicata*, *Abies* spp.) / *Lysichiton americanus* Coniferous Swamp Woodland Alliance.

Reference. none

2.C.1.a Vancouverian & Rocky Mountain Grassland & Shrubland

MG050 Southern Vancouverian Lowland Grassland & Shrubland

G488 Southern Vancouverian Shrub & Herbaceous Bald & Bluff Group

A.1OBC *Festuca rubra* – *Calamagrostis nutkaensis* Coastal Herbaceous Alliance

Red Fescue – Nootka bentgrass Herbaceous Alliance (PROVISIONAL)

These are vegetated rocky headlands found along or near the coast that are dominated by grasses, most often red fescue or Pacific reedgrass not encountered at Willapa NWR.

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

Reference. Kagan 2011

MGNEW Southern Vancouverian Lowland Ruderal Grassland & Shrubland

GNEW Southern Vancouverian Shrub & Herbaceous Ruderal Group

A.NEW *Anthoxanthum odoratum* – *Holcus lanatus* Ruderal Coastal Grassland Alliance

This is a provisional alliance that occurs on past cultivated land. 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. The shrub layer may include *Rubus* species exotic and native along with *Symphoricarpos albus*. Graminoids such as *Anthoxanthum odoratum*, *Elymus repens*, *Holcus lanatus*, *Agrostis* species, *Dactylis glomerata*, *Poa* species, *Juncus arcticus* or *Juncus effusus*, are common to dominant.

References: none

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

MG058 Cool Pacific Coastal Beach, Dune & Bluff Vegetation

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

CES200.881 *Poa macrantha* – *Leymus mollis* – *Festuca rubra* Sand Dune Alliance

Seashore bluegrass – American dunegrass – Red fescue Herbaceous Alliance

These are upland coastal dune communities dominated by native grasses. Examples of this type are uncommon, or occur in very small patch. Most of the dunes present 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 alliance or a ruderal type. 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.

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

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

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

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

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. Scots broom may form dense thickets, or be mixed with pine and spruce. Beachgrass, dunegrass, or slough sedge also may be abundant. This type is found at Leadbetter Point.

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*. *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. These are low-stature shrublands or stunted woodlands below three meters tall found within 1 km of the ocean on sandy soils.

Reference. Kagan 20111

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

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

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.

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

Reference. Christy 1998

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

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 Willapa NWR. 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.

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.

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.

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

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.

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

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

G517 Vancouverian Freshwater Coastal Marsh & Meadow Group

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

Broad or Narrow Cattail Freshwater Marsh Alliance

This is a provisional alliance.

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.

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

A.2582 *Carex obnupta* Seasonally Flooded Herbaceous Alliance

Slough sedge Seasonally Flooded Herbaceous Alliance

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.

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

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

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.

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 these plots. Present on lowland, seasonally flooded marshes.

References: Christy 2004, Zika 2003.

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

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

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 ponds. 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*. Lowland freshwater lakes, ponds, and sloughs dominated by narrowleaf or European bur-reed.

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

G518 Western North American Temperate Interior Freshwater Marsh Group

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

Bulrush Semi-Permanently Flooded Herbaceous Alliance

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. Marshes with an influx of both tidal saltwater and freshwater dominated by bulrush.

G523 Western North American Temperate Wet Meadow & Seep Herbaceous Group

A.1342 *Eleocharis palustris* Seasonally Flooded Herbaceous Alliance

Common Spikerush Seasonally Flooded Herbaceous Alliance

Alliances in this group are under review. These spikerush marshes are found in small patches throughout Willapa NWR along freshwater streams, ponds, and wet depressions.

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*. Lowland wet meadows, streambeds, or ponds dominated by common spikerush. Below minimal mapping unit.

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

M301. Western North American Ruderal Wet Meadow & Marsh

G524 Western North American Ruderal Wet Shrubland, Meadow & Marsh

Type Concept: This group contains disturbed wet meadows found in lowland, montane and subalpine elevations, occasionally reaching into the lower edges of the alpine elevations (sea level to 3600 m) throughout the western U.S. and Canada. These are wet meadows that occur in open wet depressions, basins and flats with low-velocity surface and subsurface flows. They can be large meadows in montane or subalpine valleys, or occur as narrow strips bordering ponds, lakes, and streams, and along toeslope seeps. They are typically found on flat areas or gentle slopes, but may also occur on subirrigated sites with slopes up to 10%. Sites are usually seasonally wet, often drying by late summer, and many occur in a tension zone between perennial wetlands and uplands, where water tables fluctuate in response to long-term climatic cycles. They may have surface water for part of the year, but depths rarely exceed a few centimeters. Soils are mostly mineral and show typical hydric soil characteristics such as low chroma and redoximorphic features; some areas may have high organic content as inclusions or pockets. Due to disturbance, soils may be compacted. Vegetation of this group is dominated by non-native species such as *Agrostis gigantea*, *Agrostis stolonifera*, *Conyza canadensis*, *Phalaris arundinacea*, *Phragmites australis*, *Poa palustris*, and *Poa pratensis*. Native species may be present but are so low in abundance that the original native plant association is impossible to determine. These can be wet meadows, wet emergent marshes, coastal backwater dunes, and sloughs. This group may be difficult to tease apart from its native counterpart. The test is that the non-native species far outweigh native species in abundance and richness, such that a well-trained observer cannot tell what the native counterpart may have been or to do so is only speculation. .

References: 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

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. Salt marshes are present on the east side of Leadbetter Point, South bay and elsewhere on Willapa Bay.

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

References: Faber-Langendoen et al. 2011

A.2618 *Salicornia virginica* Tidal Herbaceous Alliance

Virginia Glasswort Tidal Herbaceous Alliance

Tidal salt marshes dominated by Virginia glasswort. This constitutes a rare type in the Pacific Northwest. Associations within this alliance are under review and may be combined in the future. *Distichlis spicata* and *Jaumea carnosa* are both present with *Jaumea* being a common codominant in areas less frequently submerged by the tide.

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 *Salicornia* / *Distichlis* association and was characterized by strong dominance of *Salicornia* with *Distichlis* ranging from 4-20% cover

References: Keeler-Wolf et al. 2000.

A.2623 *Deschampsia caespitosa* Tidal Herbaceous Alliance

Tufted hairgrass Tidal Herbaceous Alliance

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.

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

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

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.

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

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.

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.

References: Christy 2004. A-38

8.1.A Developed Herbaceous & Woody Vegetation

CDNEW1 Lawn & Other Developed Urban or Built Up Vegetation

Types not characterized: Lawns, Campgrounds, Offices and Visitor Centers, Parking Lots

This provisional type includes all landscaped and developed areas, including lawns, pastures, campgrounds, roads, parking lots and buildings. These types are present in all the park units, with the largest concentrations being at Fort Stevens (historical buildings, campgrounds, parking areas, and former pastures).

Summary: Lands typified by development or modification, with minimal natural features. Two types are present, one characterized by buildings, roads, and other impervious features, and the second characterized by non-native vegetation present in lawns, pastures, and ruderal areas.

References: Faber-Langendoen et al. 2011. A-40

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