WASHINGTON NATURAL HERITAGE PROGRAM

Wetland Conservation Priorities for Western Washington.

A Focus on Rare & High-quality Wetland & Riparian Plant Associations

Prepared for

U.S. Environmental Protection Agency, Region 10

Prepared by

F. Joseph Rocchio, Rex C. Crawford, and Rebecca Niggemann

September 30, 2014

Natural Heritage Report 2014-08

WASHINGTON STATE DEPARTMENT OF Natural Resources

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ON THE COVER: (clockwise from top left) South Nolan Creek (North Pacific Lowland Confined Riparian Forest); Marsh Creek (North Pacific Lowland Moderately Rich Sloping Fen, North Pacific Forested Seepage Swamp, Vancouverian Lowland Riverine-Impounded Shrub Swamp); Elk Lake (North Pacific Lowland Poor Water Track & Floating Bog Mat); and Loomis Lake (Western North American Temperate Freshwater Lowland Floating-leaved Rooted Aquatic Bed).

Photograph by: Joe Rocchio

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Introduction

Land managers, planners, and the public need tools to better understand the resource value of individual wetlands in order to make informed decisions to minimize loss or to protect wetland integrity and ecosystem services (Hruby 2004b). An important wetland value is their contribution to biodiversity. Wetlands provide habitat for numerous plant and animal species and are floristically diverse ecosystems. Wetlands only represent approximately 2% of Washington's landscape but over 66% of terrestrial vertebrates utilize wetlands (Sheldon et al. 2005). Approximately 30% of the native flora of western WA has a FACW or OBL wetland indicator status (614 of 2022 native species) and is undoubtedly a conservative estimate of the percentage of plant species supported by wetlands. Of the plant species considered Endangered, Threatened, or Sensitive by the Washington Natural Heritage Program (WNHP), 45% (147 of 328) are limited to or often found within wetlands or riparian areas. Certain wetland types support a higher proportion of rare plants than other types. For example, peatlands and wet meadows/seasonal wetlands support the highest proportion of wetland rare plant species compared to other wetland types. Variable climatic conditions, geologic diversity, landscape contexts, and phytogeography result in wide diversity of wetland plant associations on the landscape. The total number of plant associations (based on the U.S. National Vegetation Classification) currently documented as occurring within, or with a high likelihood of occurring, in Washington is approximately 800. Of those, approximately 48% (~386 plant associations) are associated with Washington's wetlands and riparian areas. These plant associations represent unique ecological conditions and can be viewed as coarse filters for the full suite of biodiversity (from large ungulates to soil microbes) found in wetlands. In summary, although they only represent approximately 2% of the landscape, wetlands and riparian areas support and contribute to a significant percentage of Washington's biodiversity.

Information about wetland biodiversity values is critical for conservation planning, wetland restoration and management, and application of various regulatory programs. The Washington Wetland Rating System (Rating System) is a tool to provide a basis for developing standards for protecting and managing wetlands. The Rating System provides a systematic process for categorizing wetlands based on their sensitivity to disturbance, their significance, their rarity, the ability to replace them with restoration/mitigation, and the functions they provide (Hruby 2004b). The Rating System places wetlands into four categories from Category I (irreplaceable wetlands, which are relatively undisturbed, rare or provide a high level of, or unique functions) to Category IV (wetlands that are heavily disturbed or provide the lowest level of functions). These rating categories are intended to be used to develop criteria for protecting and managing wetlands and prevent loss of their associated values (Hruby 2004b). Determining buffer widths, mitigation ratios, biodiversity values, and permitted uses are examples of the types of decisions the Rating System can assist with (Hruby 2004b). Knowing the location of Category I wetlands is integral to protecting the most irreplaceable and significant wetland resources in Washington State.

One criterion for designating Category I Wetlands is whether they are considered to be Wetlands of High Conservation Value (formerly called Natural Heritage Wetlands). Wetlands of High Conservation Value is a label applied to those places on the ground that the Washington Natural

Heritage Program (WNHP) has identified as a conservation priority. These wetlands either support a rare and/or high-quality wetland plant association or a State listed sensitive, threatened, or endangered plant species. WNHP's database contains the locations of known WHCV and is an integral resource to identify WHCV. However, much of the information about Wetlands of High Conservation Value in this database is dated (> 20 years old) and limited to western Washington lowlands (Kunze 1984, 1986, 1987, 1988, 1989, 1990, 1991). Although Kunze's surveys represent a significant effort, many ecological changes have occurred in the intervening 20-30 years, including increased development and spread of non-native species (Puget Sound Partnership 2009). WNHP has records of Wetlands of High Conservation Value in other parts of the State, although these sites were not a product of a statewide, focused effort to identify the most significant wetlands for conservation. Thus, many areas of Washington have not been systematically surveyed for significant wetlands for conservation, including montane and subalpine elevations and the entirety of eastern Washington. Such data gaps restrict the State's ability to ensure that these important wetlands are accounted for when planning for wetland protection, restoration, and management.

This report summarizes work completed in fulfillment of two EPA Region 10 Wetland Program Development Grants (CD-00J263010 and CD-00J49101). The goal of this work was to improve wetland data managed by the Washington Natural Heritage Program (WNHP) as it relates to the Washington Department of Ecology's Wetland Rating System and also to inform wetland conservation actions. The structure of the report presents is intended to provide a framework from which to glean conservation informaiton for a variety of users and applications.

This project is focused on wetlands and riparian areas ranging from coastal areas to the Cascade Crest in western Washington. Wetlands of High Conservation Value may be designated either because they support a rare and/or high-quality wetland plant association or a State listed sensitive, threatened, or endangered plant species (no matter if the rare plant is considered an upland or wetland species). <u>However, the focus of this report is on Plant Association-based WHCV</u>. This is because (1) it is difficult to determine (*a priori*) which rare plant species occur in wetlands and (2) many of the analyses conducted for this report are specific to ecosystem characteristics. A complementary effort is underway for eastern Washington and is expected to be completed by December, 2015. The outcome of this project and the ongoing in eastern Washington will be an updated list of statewide wetland conservation priorities.

Six basic questions were used to frame this project:

- What types of wetland elements occur in western Washington?
- What is their biodiversity significance?
- Where are the known Wetlands of High Conservation Value in Washington?
- What is the current protection status of those Wetlands of High Conservation Value?
- Where are potential new Wetlands of High Conservation Value in western Washington?
- What are the trends in ecological integrity, wetland functions, and stressors associated with Wetlands of High Conservation Value?

Natural Heritage methodology (Master et al. 2009; Faber-Langendoen et al. 2009a, Faber-Langendoen et al. 2008b) was used to answer many of these questions. Additional information such as an evaluation of stressors and wetland functions was collected at each site which allowed a cursory inquiry into the relationships between these variables and conservation values. The end result is an updated characterization of western Washington's wetland conservation priorities, hereafter referred to as the 'Western Washington Wetland Conservation Profile.' Analysis was based on existing data and additional data collected as part of this project.

This project provides important information about locations of western Washington's most significant wetlands for conservation. This information will be valuable to conservation managers as well as to those responsible for wetland permitting decisions and land use planning. For example, the results of this project will inform priorities established in the biennial *State of Washington Natural Heritage Plan* (the current edition: WADNR 2011). *Natural Heritage Plan* priorities are a key component of evaluating sites for Washington Wildlife and Recreation Program (WWRP) funding. As such, this project will help guide where the State of Washington spends millions of dollars to protect irreplaceable habitat.

Methods

The methods used to implement the project are summarized according to the specific question being addressed.

<u>What types of wetland ecosystem elements occur in western Washington?</u> Standardized, regional classification schemes are useful for constraining natural variability of ecosystems thereby allowing users of the classification to effectively communicate, assess, and plan for conservation, management, and restoration of a given ecosystem type. WNHP has been using multiple classification schemes to guide the identification of wetland conservation priorities. These classifications have sometimes been used for differing objectives and consequently have presented some confusion among partners about the relationships and/or priority of the various classification units for wetland conservation work. In addition, WNHP has realized that these classifications may be inadequate in accounting for the full suite of ecological templates and corresponding biological diversity that occur in Washington. In response WNHP developed a single classification scheme to describe the diversity of wetlands types in western Washington. This new classification scheme is called the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* and is essentially a modification of the USNVC hierarchy. The purpose of the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* is to provide a hierarchical classification that enables WNHP to track biodiversity within spatially explicit ecological templates. The primary objective is to ensure WNHP's efforts in prioritizing conservation targets are based on a comprehensive assessment of the variety of ecological templates and biological variety that characterize Washington's wetland resource. The modification made to the USNVC was the insertion of the Natural Community Type classification level. Natural Community Types are an existing classification scheme used by the WNHP. These were updated and revised to better reflect the diversity of ecological templates associated with western Washington wetlands and then placed within the appropriate USNVC Groups as a means of organizing USNVC Plant Associations according to primary ecological drivers. A list of wetland plant associations found in western Washington was derived from a variety of publications. In addition, WNHP collected data from nearly 400 vegetation plots as part of this project's field work. WNHP then compared and analyzed these data (plots and previously identified plant associations) to produce a standardized list of USNVC Plant Associations occurring in western Washington wetlands.

What is their biodiversity significance? Most of the western Washington wetland plant associations have Global and State Conservation Status Ranks. NatureServe's Conservation Status Rank calculator was used to assign State conservation status ranks to those Plant Associations that lacked ranks or have old ranks which needed updating. The calculator is a Microsoft Excel-based tool that uses a series of metrics related to distribution, ecological integrity, trends and threats to assign a Conservation Status Rank for each plant association. The ranks range from S1 (critically imperiled or very rare and/or threatened with extinction) to S5 (demonstrably secure; very common).

Where are the known Plant Association-based Wetlands of High Conservation Value in Washington? The information addressed in the previous two questions as well as information about a specific location's ecological integrity are used to to determine whether a particular wetland meets Wetlands of High Conservation Value (WHCV) criteria which are the presence of either: (1) a rare and/or high-quality Plant Association and/or (2) the presence of a rare plant tracked by WNHP. Data sources for those WHCV have been compiled over a 30-year time frame. A GIS analysis was conducted to determine what the landscape-scale relationships of known Plant Association-based Wetlands of Conservation Values (WHCV) are. Distribution patterns according to ecoregions, geological substrates, and landscape integrity were analyzed. Source data included spatial locations of WHCV from WNHP; western Washington ecoregions, Washington Dept. of Natural Resources 1:100K geology map, NatureServe's landscape integrity model, and Level 1 Ecological Integrity Assessment (developed for this project). The inventory needs of each wetland type were determined via an anlaysis of the number of known occurrences of each wetland type.

What is the current protection status of Plant Association-based Wetlands of High Conservation Value? The Protected Areas Database of the U.S. (PAD-US) is the official inventory of protected open space in the United States. This geodatabase was obtained from U.S. Geologic Survey to overlay the known locations of Plant Association-based WHCV. PAD-US includes public lands held in The spatial data in PAD-US includes public lands held in trust by national, state and some local governments and by some non-profit conservation organizations. All lands in the database are assigned GAP conservation status codes to indicate the level of protection. For this project, the codes were translated into three protection status categories: (1) Protected; (2) Public Land/Unknown Protection Status; and (3) Private Land/Not Protected. The protection status of a WHCV was assessed by intersecting the spatial location of WHCV with the PAD-US and incorporating any other information that was useful for assigning a protection status category to each WHCV.

Where are potential new Wetlands of High Conservation Value in western Washington? A Level 1 Ecological Integrity Assessment (EIA; remote-sensing based assessment of ecological integrity of individual wetlands) was used to identify wetlands which have the potential to meet the criteria for being a Wetland of High Conservation Value. The analysis was coarse but helps focus future field survey efforts toward those wetlands surrounded by relatively intact buffers and landscapes. The Level 1 EIA used here is an overall index that aggregates four metrics characterizing ecological integrity of the buffer and surrounding landscape of a particular wetland. No metrics were used to assess Size or Condition of the wetland. The approach was based on a method developed by NatureServe. Thus, the Level 1 EIA is a direct assessment of the buffer and landscape context and a surrogate measure (or predictor) of on-site condition of a given wetland. The method was applied to all Palustrine and Lacustrine wetlands contained on digital versions of National Wetland Inventory maps.

What are the trends in ecological integrity, wetland functions, and stressors associated with Wetlands of High Conservation Value? A total of 256 Plant Association-based Wetlands of High Conservation Value at 109 unique sites were visited during the course of this project. This represents 36% of the 718 WHCV in western Washington. In order to expedite field time and ensure that we were able to visit as many sites as possible, not all WHCV at a given site were assessed using the EIA methods. Of the 256 visited, 81% (207) were assessed using the Level 2 EIA while the remaining 19% (49) were updated based on field observations. Field work conducted at this site focused on collected data on vegetation composition, ecological integrity, wetland functions, and stressors.

Vegetation plot data was collected to help with classification of western Washington wetland types and provide an overview of floristics within each wetland type. Vegetation releve plots (typically $100m^2$ for herbaceous and shrubland types and $400m^2$ for forested types) were established in most of the wetland sites visited. The releve plots were subjectively placed within vegetation stands that appeared to be associated with a relatively homogenous ecological setting. In other words, plots were attempted to be placed within homogenous vegetation types and ecotones were avoided when possible. The plot was classified to USNVC Group, Natural Community Type, and Association. GPS locations and water chemistry (when applicable) measures such as pH, electrical conductivity, and temperature were collected within the plot.

A Level 2 Ecological Integrity Assessment, a rapid, field-based method, was used to determine current ecological condition of each WHCV relative to historic natural range of variability (Rocchio and Crawford 2011). The Level 2 EIA provides rapid measures of buffer size and condition, vegetation composition and structure, degree to which hydrological processes are intact, soil condition, and size.

The Western Washington Wetland Rating System (Rating System) was used to rapidly assess potential performance of wetland functions (see Hruby 2004b for full methods). The Rating System was applied to the spatial boundaries of HGM classes rather than limiting it to WHCV. Thus, EIA data and Rating System data do not necessarily reflect the same spatial locations on the ground. Generally, the area to which the Rating System was applied was greater than the area occupied by one WHCV. Consequently, if there were more than one WHCV at a particular site they often shared the same Rating System scores.

Stressors were documented at each site using NatureServe's Stressor checklist methods (Master et al. 2009). At each site a predefined list of stressors was used to document the presence, scope, and severity of stressors associated with four categories: (1) Landscape Stressors; (2) Vegetation Stressors; (3) Soil Stressors; and (4) Hydrology Stressors. An overall impact rating was determined by aggregating the impact rating of the four categories and using a logic matrix to determine an overall impact rating for the site. The Stressor Impact Ratings were converted to a numeric score in order to allow for correlation analysis with EIA and Wetland Rating System data.

A Pearson correlation analysis and scatterplots were used to discern whether any trends were observed between ecological integrity, wetland functions, and stressors. The specific comparisons made were:

- Level 1 vs. Level 2 EIA rank
- Level 2 EIA rank vs. Wetland Rating System score
- Level 2 EIA rank vs. Stressor score
- Wetland Rating System score vs. Stressor score.

Results & Discussion

What types of wetland elements occur in western Washington? The Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington resulted in an improved understanding of the diversity of ecological templates associated with vegetation patterns in western Washington wetlands. There are eight levels in the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington*. Seven of those are standard USNVC levels (Table 10). The other level is Natural Community Type, a classification level developed by WNHP. Fifteen USNVC Groups encompass all the wetland vegetation types in western Washington. Within those 15 Groups, 87 Natural Community Types and 272 Plant Associations were identified as occurring in western Washington wetlands. The highest numbers of Natural Community Types were found in the Vancouverian Wet Shrubland Group (16) and Vancouverian Wet Meadow & Marsh Group (13). The Vancouverian Wet Meadow & Marsh Group had the highest total number of Associations (60). The Vancouverian Wet Shrubland Group (33 Associations) and North Pacific Bog & Acidic Fen Group (32 Associations) also had high numbers of Associations. These totals suggest a higher range of ecological variability (e.g., Natural Community Types) and higher vegetation diversity (Associations) than in Groups with lower numbers. The Groups with low number of Natural Community Type and Associations include the North Pacific Vernal Pool Group, Temperate Pacific Wet Mudflat Group, and Vancouverian Wet Cliff, Waterfall, Hanging Garden Group. The fact that these Groups have received much less classification, research, and inventory than other wetland types may be one reason for the low numbers of types. On the other hand, what we do know about these wetlands suggests that although their vegetation is unique the types are likely not very diverse due to them being influenced by a single primary ecological driver within a very narrow range of landscape positions. Conversely, the North Pacific Bog & Acidic Fen Group, Vancouverian Wet Meadow & Marsh Group, and Vancouverian Wet Shrubland Group all have multiple ecological drivers (water source, water chemistry, soil type, and hydrodynamics) that occur in a variety of landscape positions.

What is their biodiversity significance? Global Ranks have been previously assigned to 81% of the 272 Plant Associations occurring in western Washington wetlands. No Global Ranks were assigned for this project as that process involves Natural Heritage scientists from each of the States and/or Provinces in which the element occurs and is outside the scope of this project. WNHP assigned State ranks to 82 Associations that were missing or needed updated State ranks resulting in all 272 Associations having a State Conservation Status Rank, although 8% (22) have a SU (i.e. unrankable) rank due to lacking adequate data to determine conservation status within Washington.

When comparing distribution of ranks, there is a larger discrepancy between rare (i.e., G/S1 – G/S3) and common or secure (i.e. G/S4 – G/S5) plant associations at the State level than at the Global scale. The distribution of Global Conservation Status Ranks across wetland and riparian plant associations in western Washington was relatively equal between rare (G1-G3; 46%) and common (G4-G5; 35%). This suggests that Washington's wetlands support a nearly equal amount of wide-ranging and/or abundant types as they do endemic, narrowly distributed, and/or highly threatened types. Washington's potential contribution toward the conservation of the latter types is significant due to the fact that these types are either endemic to Washington or the Pacific Northwest and/or are highly threatened across their entire range. The same analysis of State Conservation Status Ranks shows that the majority of plant associations are ranked as being rare or highly threatened (S1-S3; 74%) in Washington, even if they aren't rare or threatened across their global range. This is likely due to a few factors including: (1) Washington is at the edge of the association's range; (2) the type is endemic to Washington or the region; and/or (3) the stressors associated with association in Washington have made it more vulnerable than occurrences outside the State.

The distribution of rare plant associations across Groups can provide a coarse assessment of the conservation significance of any given Group. A few Groups are significant in terms of the high proportion of globally rare plant associations affiliated with them in Washington. Sixty eight percent of the associations in the North Pacific Hardwood Conifer Swamp Group are considered to be globally rare (G1-G3). Many of these associations are endemic to Washington and adjacent parts of Oregon and British Columbia. In addition, these associations have experienced much loss and degradation from logging and development and very few high quality examples remain. Similar reasons explain why 64% of the associations in the North Pacific Maritime Poor Fen & Bog Forest & Woodland Group are globally rare. Many of those associations have a narrow and restrictive global range and many have been impacted by logging and hydrological alterations to peatlands. Riparian areas are often exposed to direct loss from agriculture, logging, development and a variety of stressors including hydrological alterations and invasive species which is the primary reasons why 57% of the associations in the North Pacific Lowland Riparian Forest and Woodland Group and 60% in the North Pacific Montane Riparian Woodland Group are considered globally rare. Similarly, coastal wetlands have experienced numerous impacts ranging from dikes, invasive species, geomorphic alterations, etc. which explain why 59% of associations in the Temperate Pacific Salt and Brackish Marsh Group are globally rare.

The distribution of State Conservation Status Ranks across Groups differs from Global Conservation Status Ranks, primarily in that nearly ¾ of Groups had a high proportion of state rare associations. In addition, some of the Groups with a high proportion of state rare associations were not among those with highest proportion of globally rare associations including North Pacific Bog and Acidic Fen Group, North Pacific Neutral-Alkaline Fen Group, Vancouverian & Rocky Mountain Montane Wet Meadow Group, Vancouverian Freshwater Wet Meadow & Marsh Group, and Vancouverian Wet Shrubland Group. This is due to a few reasons: (1) some associations may be at the periphery of their range in WA (e.g., North Pacific Bog and Acidic Fen Group); (2) globally common associations have been greatly reduced in extent and/or integrity due to human stressors (e.g., Vancouverian Freshwater Wet Meadow & Marsh Group and Vancouverian Wet Shrubland Group); and (3) the fact that 52 State rare Associations do not have Global ranks assigned either due to that fact they are believed to be endemic to Washington or there is not enough information to assign ranks across their global range.

Very few or no plant associations have been described as occurring in the North Pacific Vernal Pool Group (one association), Temperate Pacific Freshwater Wet Mudflat (three associations), and Vancouverian Wet Cliff, Waterfall, Hanging Garden Group (no associations). These low numbers may reflect a lack of survey and classification effort targeted on these wetland types. Thus, additional classification and inventory work may identify additional plant associations as occurring in those Groups. Alternatively, these Groups reflect very restricted and narrow ecological templates which may limit the number of plant associations that would occur in these habitats.

Where are the known Plant Association-based Wetlands of High Conservation Value in Washington? In total, there are 1,340 WHCV in western Washington. Of those 1,340 WHCV, 718 are based on wetland plant association occurrences in WNHP's database. These are found at 300 unique sites (e.g., more than one WHCV can occur within a single wetland site). There are 622 WHCV that only have wetland-dependent rare plants present (e.g. no rare or high-quality plant associations were documented in the same location). These are located at 482 unique sites. There may be other rare plant locations which occur in wetlands that are not included in this estimate. There are only 39 unique sites where both wetland ecosystem and rare plants occur together.

Most of the 718 known WHCV occur in the lowlands of the Puget Trough and along the outer coast. Fewer occur in southwest Washington and the southern portion of the Puget Trough due to a long-history of agriculture and timber harvesting and a lack of glaciation which left many unique environments for wetland formation in the northern Puget Trough. The lack of mapped or documented WHCV in upper elevations is primarily due to the majority of survey work being conducted in the lowlands.

WHCV Distribution by Ecoregion:

- The Northwest Coast ecoregion receives large amounts of rain and has a relatively mild climate resulting in unique coastal Natural Community and Plant Association types, including the only known domed bog in the western United States.
- The Northwest Coast also supports the highest number of salt/brackish marsh wetlands of high conservation value. About 1/3 of these have some form of protection.
- Glaciation in the Puget Trough ecoregion has left a high concentration of bogs and poor basin fens. Many of these peatlands have been destroyed or degraded in the urbanized areas of King, Pierce, and Snohomish counties but there are numerous bogs/basin fens in less urbanized areas of the Puget Sound region that remain somewhat intact.
- Puget Trough riparian areas are another conservation priority in this region due to their degradation from a high density of development and agriculture.
- One of western Washington's most endangered wetland types—wet prairies—is primarily found in Clark, Cowlitz, and Lewis counties (they are also found in very few locations in the southern Puget Sound region).
- The southern portion of the Puget Trough ecoregion has received less inventory/ classification attention mostly due to the extensive agriculture and timber extraction that occurred in the region.
- There are numerous marsh/wet meadows, forested swamps and riparian forest types that are primarily limited to the Columbia River floodplain. Despite significant degradation

from hydrological alteration, agriculture, and development, many of these wetlands remain conservation targets due to their unique ecological templates and resulting floristics.

- Tidally-influenced, freshwater wetlands occur along the lower reaches of rivers, streams, and sloughs within the Northwest Coast ecoregion and near the mouths of major rivers in the Puget Trough ecoregion. Many of the Associations found in these wetlands are restricted to the tidally-influenced yet freshwater environment.
- Based on current knowledge, the area around the southwestern base of Mount Adams supports what may be the highest concentration of peatlands in the montane regions of western Washington. The peatlands in this area are larger than commonly observed elsewhere in the West Cascades, North Cascades, or Olympic Mountains and support a flora that is reflective of both western and eastern Washington

WHCV Distribution by Geologic Substrate: The majority (74%) of WHCV are associated with three geological templates: (1) Glacial origin; (2) Alluvium and (3) water. Geological templates associated with 'glacial origin' include continental and alpine glacial till, drift, outwash and glaciolacustrine deposits and accounted for 37% of WHCV. The overwhelming majority of WHCV in the North Pacific Bog and Acidic Fen Group (68%) and North Pacific Maritime Acidic Fen and Bog Forest & Woodland Group (70%) are associated with geologic substrates of glacial origin. Substrates of glacial origin were also the most abundant for WHCV in the Vancouverian Wet Shrubland (47%), North Pacific Maritime Hardwood-Conifer Swamp Group (39%), Western North American Temperate Freshwater Aquatic Bed Group (29%), and North Pacific Neutral-Alkaline Fen Group (26%).

As expected, alluvial substrates accounted for the second highest percentage (21%) across all Groups. Alluvial substrates accounted for 56% of WHCV in the North Pacific Lowland Riparian Forest & Woodland Group. Twenty six percent of WHCV in the same Group were associated with glacial substrates. This may be an example of errors resulting from discrepancy in scale at which North Pacific Lowland Riparian Forest & Woodland Group WHCV are mapped relative to the precision with which alluvial/glacial deposits are mapped at a 1:100K scale.

Water was the third highest substrate associated with WHCV (16%). These are likely wetlands which occur adjacent to water bodies such as ponds, lakes, rivers, or marine waters. This is also reflected in the relatively high proportion of WHCV associated with water in the Temperate Pacific Salt and Brackish Marsh Group (42%), Vancouverian Freshwater Wet Meadow & Marsh Group (23%), and Western North American Temperate Freshwater Aquatic Bed Group (24%) as these wetlands are often associated with open water bodies.

Per the DNR Geology map, only 6% of WHCV were associated with Peat Deposits. This "substrate" clearly overlaps with others and adds some confusion to the analysis. For example, by definition the peatland Groups (North Pacific Bog and Acidic Fen Group, North Pacific Maritime Acidic Fen and Bog Forest & Woodland Group, North Pacific Neutral-Alkaline Fen Group) are all associated with peat deposits but this analysis suggested only a minority of those sites were associated with peat. This is likely an issue with scale as the geology map is likely only mapping large peat deposits.

The remaining geologic substrates are each associated with 5% or less of the total number of WHCV. A few interesting patterns within those types are that serpentine fens, which are a type within the North Pacific Neutral-Alkaline Fen Group, are associated with ultramafic bedrock. The most common Group on substrates of volcanic origin was the North Pacific Neutral-Alkaline Fen Group. Wet prairies, which are a type within the Vancouverian Freshwater Wet Meadow & Marsh Group, are associated with Missoula flood deposits in the Willamette Valley and glacial outwash in the Puget lowlands. They are also known to be associated with alluvium in the Columbia River floodplain.

WHCV Distribution by Landscape Integrity: Landscape integrity was measured using two methods: (1) the Landscape Integrity Model (Comer and Hak 2009) and (2) Level Ecological Integrity Assessment. The Landscape Integrity Model is a GIS-based algorithm which enters various land use GIS layers (roads, land cover, water diversions, groundwater wells, dams, mines, etc.) weighted according to their perceived impact on ecological integrity, into a distance-based, decay function to determine what effect these stressors have on landscape integrity. Each pixel in then assigned a score which results in a map depicting landscape integrity. According to this analysis, most WHCV are found in areas with low integrity. This is likely a function of the fact that most EOs are located in the lowlands where roads, land cover, etc. are prevalent thus resulting in these areas being modeled as low integrity.

Measuring landscape integrity with a Level 1 EIA provide a more site-specific perspective on landscape integrity. The Level 1 EIA uses adjacent land use to predict onsite ecological integrity of a given wetland. In contrast to the Landscape Integrity Model, this method showed that most (79%) WHCV have a high (e.g. excellent to good) Level 1 EIA rank. This isn't surprising since during the initial surveys for WHCV in the 1980's and 1990's, sites were prioritized for field surveys based on the relative integrity of the surrounding landscapes, as observed on aerial photographs. A large percentage of known WHCV resulted from these early surveys.

Inventory Needs: The distribution of known WHCV across wetland ecological types provides an overview of the level of inventory effort needed for each level of the classification hierarchy. For example, inventory priorities should be set on those wetland types with few to no WHCV associated with them. Conversely, wetland types with numerous WHCV associated with them are a lower inventory priority.

In an effort to standardize inventory priorities, each level of the USNVC hierarchy from Group to Plant Association type were categorized as having High, Moderate, or Low inventory needs. The results are shown in Appendix A. At this time, this analysis is simply based on the number of known WHCV (or element occurrences). In order to discern whether low WHCV numbers is a result of a lack of inventory versus lack of high-quality occurrences, future revisions of this analysis may consider level of past survey efforts that may have focused on (or not) specific types. This is more difficult to assess as inventories have often occurred opportunistically or specific targets were not stated.

The list can be further prioritized by focusing on those types with the lower (i.e., more rare) Global and State ranks first within each of the high, moderate, or low inventory need categories. Additional inventory work is needed for numerous Natural Community and Plant Association types.

What is the current protection status of Plant Association-based Wetlands of High Conservation Value? Wetland protection can be defined using many different criteria and for a variety of purposes. Protection status of WHCV is here considered from two perspectives: (1) the number of WHCV that occur on lands devoted to protecting biodiversity and (2) the number of WHCV represented within the statewide system of natural areas. There is overlap between these two assessments but the latter is a more restrictive analysis.

Protection Status of WHCV: Of the 718 Plant Association-based Wetlands of High Conservation Value, 31% are considered protected while the remaining 69% either have no protection (64%) or occur on public land (5%) with unknown or inadequate protection status (Appendix A). The protection status across USNVC Groups, Natural Community Types, and USNVC Plant Associations is shown in Appendix A and D. This information can be used to identify which WHCV lack protection and thus direct conservation actions to sites supporting those wetland types. However, determining protection priorities is a complicated process that considers the conservation status rank (e.g., the relative risk of extinction/rarity; G/S rank), ecological integrity of individual occurrences, and current level of protection of each wetland type. Those data are included in Appendix D but WNHP has not systematically analyzed those pieces of data to identify a finer-level level of protection priorities. WNHP may conduct this analysis in the future but in the meantime WHCV currently lacking protection should be considered priorities for conservation action.

WHCV in Need of Natural Area Representation: Of the 718 Plant Association-based Wetlands of High Conservation Value, 178 (25%) are represented within the statewide system of natural areas. Of the 272 Plant Associations in western Washington, 34% (93) are within the natural areas system. However, since Plant Associations can occur in more than one Natural Community Type there are 427 unique combinations of Natural Community Types & Plant Associations. Of those 427, 23% (100) are represented in the natural areas system. The Northwest Coast ecoregion contains the highest number (77 or 43%) of WHCV represented in natural areas. The Puget Trough also contains a high number (47 or 26%). At the Group level, the majority of WHCV represented in natural areas within the North Pacific Bog & Fen and Temperate Pacific Salt & Brackish Marsh Groups are found in the Northwest Coast ecoregion. Fifty four percent (13 of 24) of the North Pacific Maritime Hardwood-Conifer Swamp WHCV found in natural areas are in the North Cascades ecoregion. Sixty five percent (13 of 20) of the North Pacific Neutral-Alkaline Fen WHCV found in natural areas are in the Puget Trough ecoregion, although all but one of those are on serpentine fens found almost exclusively on Cypress Island. These types of patterns as well as consideration of threats and conservation status ranks of each elements will provide the foundation from which WNHP will ultimately assign Natural Heritage Plan Priorities (i.e. Priority 1, 2, 3, or Adequate) to each of the elements listed in Appendix A.

Where are potential new Wetlands of High Conservation Value in western Washington? The results of the GIS analysis suggested that there are numerous National Wetland Inventory (NWI) wetland polygons that may meet the criteria of an Plant Association-based Wetland of High Conservation Value. Many of the potential Plant Association-based Wetlands of High Conservation Value appear to occur along river and/or stream corridors, especially on the western portion of the Olympic peninsula and in upper elevations of the Olympic Mountains and Cascades. There are also numerous wetlands in the Puget Sound basin, especially on the Kitsap peninsula and near the foothills of the Cascades that had a high Level 1 EIA rank. Other areas of high potential include the flat lowlands of Lewis and Cowlitz counties (possibly wet prairies), and near the Columbia River in the Willamette Valley ecoregion.

It is important to note that the analysis used here was coarse and limited in accuracy by the underlying base map (i.e., Ecological Systems maps). The results do not mean high potential wetlands will qualify as WHCV only that the integrity of the immediate and surrounding landscape is of sufficient quality to suggest onsite ecological conditions may have high integrity. The analysis did not attempt to model what type of wetland the NWI polygon may represent, which is another criteria used to determine Plant Association-based Wetland of High Conservation Value status. Despite these shortcomings, this analysis may prove useful to prioritize future field surveys toward those sites more likely to meet WHCV criteria.

Finally, the Level 1 EIA assigned every NWI polygon an EIA rank (see accompanying geodatabase). This rank provides coarse information about the overall range of ecological conditions of NWI wetlands in a particular landscape. As such, the Level 1 EIA ranks can be used for a variety of landscape or watershed scale analyses including creating watershed wetland profiles (Johnson 2005), designing watershed wetland ambient monitoring protocols (Lemly et al. 2011), guiding site-level field surveys (Rocchio and Crawford 2009; Faber-Langendoen et al. 2012), and assist in identifying a reference network of wetlands (Faber-Langendoen et al. 2012).

<u>What are the trends in ecological integrity, wetland functions, and stressors associated with Wetlands of High Conservation Value?</u>

Types of WHCV Sampled: The majority of WHCV sampled were peatlands (North Pacific Bog & and Fen Group (33%), North Pacific Neutral-Alkaline Fen Group (18%), and North Pacific Acidic Fen & Bog Woodland Group (14%). North Pacific Maritime Hardwood-Conifer Swamp Group (11%) and Vancouverian Wet Shrubland Group (9%) were the next two highest Groups sampled. Except for the North Pacific Bog & Fen Group, these proportions are roughly similar roughly similar to the proportion of WHCV represented by these Groups.

Vegetation Composition of WHCV Sampled: A total of 374 vegetation plots were sampled during this study. The number of plots sampled per USNVC Groups varied. The North Pacific Bog & Acidic Fen Group (131 plots) had over twice as many plots as the next highest Group (North Pacific Maritime Hardwood-Conifer Swamp Group with 49 plots). The North Pacific Lowland Riparian Forest & Woodland Group, Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group, and Western North American Temperate Freshwater Aquatic Bed Group were undersampled relative to other Groups.

North Pacific Bog & Acidic Fen Group, North Pacific Maritime Hardwood-Conifer Swamp Group, and Vancouverian Freshwater Wet Meadow & Marsh Group had the highest vascular plant species richness across all plot relative to other Groups. Although North Pacific Bog & Fen Group had the second highest total richness it had one of the lowest average species richness on a per plot basis. These numbers reflect field observations suggesting that individual bogs and poor fens are typically low in diversity due to the very acidic and nutrient poor conditions that characterize these wetlands (Rydin and Jeglum 2006). However, because there is wide variation in the types of plant associations that occur in the North Pacific Bog & Fen Group the total richness of plants across the Group is high. This same pattern is observed with the Vancouverian

Freshwater Wet Meadow & Marsh Group which has the highest total species richness and highest number of plant associations but also one of the lowest average species richness per plot. Vancouverian Freshwater Wet Meadow & Marsh sites are often dominated by a few competitive and dominant species which may explain the relatively low average richness per plot. However, there is a significant diversity of vegetation types that, cumulatively, result in high total species richness for the Group. The Western North American Temperate Freshwater Aquatic Bed Group had the lowest species richness (13 species documented across plots) as well as the lowest richness per plot. These aquatic communities are typically monotypic and have low diversity. However, it is also likely submergent species were missed during data collection as observations were often limited by water depth and muck. On a per plot basis, the North Pacific Lowland Riparian Forest & Woodland Group and North Pacific Maritime Hardwood-Conifer Swamp Group had the highest totals. These are typically nutrient rich sites with high structural and microtopographic diversity which would explain high richness at given site. The North Pacific Maritime Hardwood-Conifer Swamp Group also had the third highest total richness. The low total richness for the North Pacific Lowland Riparian Forest & Woodland Group may be due to the relatively low number of plot that were sampled.

Temporal Changes in Ecological Integrity WHCV Sampled: Most of the 718 Plant Association-based WHCV in WNHP's BIOTICS database have an EO rank (i.e., ecological integrity rank) that were assigned using a guided best professional judgment approach, where WNHP ecologists applied their field experience with site-level data either collected or located in published research. These ranks are referred to hereafter as "Existing EO Ranks". Most of the existing EO ranks for western Washington wetlands are > 15 years old. In 2004, NatureServe formed the Ecological Integrity Assessment Workgroup to develop a more systematic and transparent approach to assigning EO ranks. The result was the Ecological Integrity Assessment (EIA) method. Level 2 (rapid, field-based) EIA ranks were assigned to 207 Plant Association-based WHCV visited for this project. Of these 207 WHCV, 134 had existing EO Ranks. For these 134 sites, a comparison was made between existing EO ranks and Level 2 EIA ranks to discern whether ecological conditions have changed at an individual site since the original EO ranks were assigned.

One 134 WHCV that were compared, 15% (40) showed no change in their rank (i.e. Level 2 EIA ranks were the same as existing EO ranks), 26% (66) showed an increase in their rank (i.e., Level 2 EIA ranks were higher than existing EO ranks), 11% (28) had a decrease in their EO rank (i.e., Level 2 EIA ranks were lower than existing EO ranks). The most common type of changes were an increase of half rank (25; e.g., an increase from AB to A), whole rank (20; and increase from B to A), and decrease in half rank (19; e.g., drop from B to BC; Figure 18).

King County had the highest number of Plant Association-based WHCV that decreased in rank, however King County also had the largest number of WHCV sampled compared to other counties. It would seem logical that WHCV located within King County, one of the most urbanized counties in the State, would experience degradation in the past 15-25 years. However, because the existing EO ranks do not have accompanying individual metric scores (like with the EIA ranks) it is difficult to discern whether the decrease is due to ecological changes. Additional research is required to make conclusions regarding explanatory patterns of changes in integrity. Possibilities include (1) true ecological change; (2) variation in methods associated with assigning the existing EO ranks versus the EIA ranks; or (3) variation in observer interpretation and subsequent application of rank assignments.

Due to the disproportionate sample size across USNVC Groups it is difficult to find any patterns of degradation across Groups. However, based on what was sampled, most Groups showed an increase in EO ranks. Possible explanations include a more strict assignment of existing EO ranks relative to how EIA ranks are assigned or the possibility that land use change around the WHCV has changed in the intervening years that improved the overall EO rank (e.g., if the surrounding landscape was logged when the existing EO rank was assigned 20+ years ago, that site would have received a low score for Landscape Context; however, if the same landscape had not been logged since, then today that site might get a higher score for Landscape Context resulting in a higher EIA rank today).

Predicting Onsite Ecological Integrity Using a Level 1 EIA: EIAs can be applied to multiple spatial scales and with a variety of data types using a three-level approach including Level 1 (remote sensing), Level 2 (rapid ground-based), and Level 3 (intensive ground-based) metrics (USEPA 2006). This three-level approach provides a hierarchical, spatially integrated framework for monitoring and assessment resulting in effective strategies and efficient use of resources (USEPA 2006). Having EIA Ranks from multiple levels (e.g., Level 1 and Level 2), allows calibration and validation of the more coarse level. For example, Level 2 EIA ranks are assumed to be more accurate than Level 1 EIA Ranks due to the fact that the former is ground-based and the latter is depends on remote sensing datasets. The 207 Plant Association-based WHCV with Level 2 EIA ranks were also assigned a Level 1 EIA rank allowing for a preliminary correlation analysis. The correlation showed an expected but noisy trend ($r = 0.36$). Generally, as Level 1 scores decrease so do Level 2 scores, although there is significant noise throughout the scatterplot. Thus, the ability of the Level 1 EIA to predict onsite condition (as measured by the Level 2 EIA) is not very accurate. This may suggest that the land use weights or weighting protocol used in the Level 1 EIA need to be modified to better match the Level 2 EIA results. For example, down weighting certain land uses may result in overall lower Level 1 scores and thus improve the ability of the Level 1 to predict onsite conditions. Or, additional inputs into the Level 1 EIA could be used to better predict onsite conditions. Such decisions need to be determined via a sensitivity analysis which was not conducted as part of this project. On the other hand, onsite stressors may account for the observed variability, as those impacts are not accounted for in a Level 1 EIA but are specifically addressed in a Level 2 EIA. This hypothesis is supported when Level 1 EIA scores are compared independently to Level 2 Landscape Context and Condition scores. There is a discernible correlation ($r = 0.48$) between Level 1 EIA and Level 2 Landscape Context scores that is stronger than the correlation between Level 1 EIA and Level 2 Condition scores ($r = 0.28$). This suggests that onsite stressors may be the more likely cause of the relatively noisy relationship between Level 1 and Level 2 EIA scores. Unfortunately, remote sensing data capable of measuring onsite stressors is lacking.

Relationship Between EIA and Wetland Rating System: There was no discernible correlation between Level 1 ($r = -0.13$) or Level 2 ($r=-0.15$) EIA scores with the Wetland Rating System score. This result may reflect the lack of samples points from wetlands that are in very poor ecological condition. On the other hand, the Wetland Rating System gives more points to wetlands that occur in landscape where anthropogenic activities increase the likelihood that a wetland has the opportunity to perform (i.e., "improve") water quality and hydrologic functions.

For example, a wetland which occurs within an urbanized landscape has a higher potential to improve water quality than a wetland which occurs in a landscape with a relatively natural land cover, and as such would receive a higher Wetland Rating System score. In contrast, the metrics measured for a Level 2 EIA generally score higher in a landscape with higher natural land cover.

The Wetland Rating System is comprised of a Water Quality, Hydrologic, and Water Quality Function Score. When EIA scores were compared to these individual function scores a positive correlation was found with Habitat Function scores. Level 1 EIA and Habitat Function scores had a noisty but discernible trend (r = 0.35). The relationship is somewhat stronger between Level 2 EIA and Habitat Function scores (r = 0.41). This correlation is not surprising given that many of the same characteristics (e.g., plant structure and composition, landscape connectivity and buffer condition) are assessed by both the Level 2 EIA and Wetland Rating System and provides some support to the notion that ecological integrity can be a surrogate measure of habitat quality, at least by the measures used in these two methods.

Relationship Between Stressors and Ecological Condition and Function: A strong negative correlation (r = -0.68) exists between Level 2 EIA and Overall Stressor scores suggesting the Level 2 EIA is documenting changes in ecological condition associated with anthropogenic stressors. Although more data points are needed from highly impacted wetlands, this analysis suggests the Level 2 EIAs developed for western Washington wetlands (WNHP 2010) are performing as intended and serves as an initial calibration of the EIA models. Future analysis should focus on the relationship between individual metric scores and the Overall Stressor scores to determine which metrics are performing adequately and what, if any calibration measures are needed to improve metric performance.

A weaker but positive correlation exists between Wetland Rating System and Overall Stressor Scores. As noted previously, the Wetland Rating System gives more points to wetlands that occur in landscape where anthropogenic activities increase the likelihood that a wetland has the opportunity to perform (i.e., "improve") water quality and hydrologic functions. This explains why there is a positive rather than a negative correlation between the Wetland Rating System and Overall Stressor scores. As with most of the analyses discussed in this section, the lack of samples from highly impacted wetlands limits conclusive statements about the trends observed.

<u>Plant Association-based Wetlands of High Conservation Value as Reference Standard Wetlands:</u> The concept of minimally disturbed condition (MDC), or the ecological condition of sites in the absence of significant human disturbance, is one approach for defining reference standard wetlands (Stoddard et al. 2006). Stoddard et al. (2006) consider the MDC to be the "best approximation or estimate of biotic integrity." The EIA method is essentially based on the MDC concept. Since MDC (as assessed via the EIA) was used to help identify and characterize WHCV, many WHCV have been identified as reference standard wetlands. It is important to keep in mind that these reference standard sites are best for scenarios where comparison with wetlands with minimal or no human disturbance is desired. Such objectives might include identifying restoration potential and benchmarks, mitigation performance standards (Faber-Langendoen et al. 2006; 2008), conservation priorities, or to assess ecological response to human-induced disturbance.

The highest EIA ranks of any given wetland type (i.e. WHCV) were used to identify reference standard sites. For many wetlands, these are WHCV with an EIA rank of excellent integrity (e.g., “A” rank). However, because of varying degrees of loss and degradation on the landscape not all wetlands have remaining examples close to historical conditions (e.g., wet prairies). For those wetland types, the highest ranked examples would qualify as reference standard sites for that wetland type. For example, the highest quality example of wet prairie remaining in western Washington has an EIA Rank of “C” (fair integrity). Thus, although the site is significantly degraded relative to historical conditions because it is the best remaining example of wet prairie it would be identified as a reference standard wetland. The approach taken here was to select sites with the highest EIA/EO rank for each wetland type. Presence within a Natural Area Preserve or other similarly protected area was also considered since these sites are likely to persist in the long-term.

Appendix D (an accompanying Excel workbook) has a list of reference standard sites derived from the 718 Plant Association-based WHCV. A total of 152 unique reference standard sites were identified for 193 unique combinations of Natural Community Types & Plant Associations. Reference Standard Sites were located in all western Washington counties. The list should not be interpreted as exhaustive or based on a comprehensive inventory of sites that might possibly meet the reference standard criteria. It is a first iteration based on known WHCV and field experience of the authors. As new inventory data becomes available the list may change. Reference standard sites have not been identified for all wetland types. Future work by WNHP will seek to identify reference standard sites for these types.

Conclusions

This project has also produced multiple products that contribute to wetland conservation in western Washington. Incorporating a revised classification of wetland types within the U.S. National Vegetation Classification provides a systematic accounting of the ecological and vegetation diversity associated with western Washington wetlands and riparian areas. The classification provides a means for tracking the distribution of ecological patterns across the landscape. A subsequent assessment of the conservation significance of each of the units associated with the classification, ongoing inventory for determining the location of those wetlands, and an assessment of current protection status/needs has produced a dataset which can lead to more effective conservation actions, provide restoration benchmarks, and assist in regulatory decisions.

Some additional information produced for the wetlands visited during the course of this project includes ecological integrity, stressor checklists and wetland function ratings. This information has allowed for a cursory analysis of the relationships between these variables which provides some insight into the unique inferences possible with each of these datasets. Some of these variables are correlated (stressor and ecological integrity) while others are not (ecological integrity and wetland function rating). It is important that users of these data understand the assumptions underlying each of these wetland assessment approaches and how their results provide unique and often contradictory information about wetland “quality”.

In the context of the Wetland Rating System, WNHP collaborated with Washington Department of Ecology to establish a protocol that will allow consultants and other ecologically trained individuals to propose a site as a WHCV. WNHP will review submitted data then work with those individuals to determine whether sites meet the WHCV criteria. This new process is described in the updated Wetland Rating System manuals accessible on Washington Department of Ecology's website.

All of the information presented in this report will assist WNHP in achieving its programmatic objectives of setting conservation priorities. This information is also used by many land trusts, conservation organizations and local, state, and federal agencies for conservation planning. This information will feed into the process of establishing Natural Heritage Plan priorities. Natural Heritage Plan priorities are a key component of evaluating sites for Washington Wildlife and Recreation Program (WWRP) funding. As such, information collected, analyzed, and synthesized for this project will influence where the State of Washington spends millions of dollars to voluntarily protect irreplaceable wetland habitat.

Conservation Outcomes of this Project.

Product	Conservation Outcomes
Revised classification of western Washington native vegetation (Appendix A; forthcoming publication on WNHP website): Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington	Provides a systematic mechanism to account for the diversity of ecological templates associated with wetland biodiversity. This information can then be applied toward guiding conservation actions, informing restoration benchmarks (when coupled with EIA), and assisting with regulatory decisions
Updated conservation status ranks	A systematic assessment of biodiversity values (based on distribution, trends, threats, and rarity) which can then be applied toward prioritizing conservation actions.
Floristic Quality Assessment for Washington (Rocchio 2013; http://www1.dnr.wa.gov/nhp/refdesk/communities/fqa.html)	A standardized method for assessing the integrity of vegetation communities associated with both wetland and upland ecosystems. Results have multiple applications including monitoring, establishing restoration or even mitigation benchmarks, informing management actions and prioritizing conservation actions
Coarse assessment of ecological integrity of every NWI polygon (i.e., Level 1 EIA GIS file submitted with report)	Provides an assessment of ecological integrity of every mapped wetland (NWI) in western Washington. May be useful for watershed-scale planning and analysis. Further calibration of the results is needed.
Updated information about ecological integrity, stressors, and wetland functions for 256 Wetlands of High Conservation Value (36% of total WHCV in western Washington).	Ensures WHCV data is up to date. Data concerning trends may help understand or at least pinpoint additional research questions regarding the complex interactions and relationships between anthropogenic stressors, wetland functions, and ecological integrity. Data collected suggest that wetland with high ecological integrity do not always have the highest potential for performing certain functions. Conversely, wetlands with high potential of function performance do not always have high ecological integrity.
Summary of protection achievements and needs for WHCV within each ecoregion	Provide a scorecard for conservation success and needs. Such information can pinpoint exactly what types of wetlands within each ecoregion should be high priority targets for protection.
Inventory needs for wetland Natural Community and Plant Association types	Data about many Natural Community and Plant Association types are lacking. This information can help focus future field inventory work on those types of wetlands in most need of such attention.
Revised process for accounting for wetlands	WNHP has not inventoried every western WA wetland. Thus, it

Product	Conservation Outcomes
meeting WHCV criteria not in WNHP's database	is likely wetlands may be encountered by other scientists that may meet the WHCV criteria. In the past, these wetlands were not able to be counted as a WHCV. WNHP is working with WA Dept. of Ecology on a process that would allow WNHP to review data from an outside source to conclude whether the wetland would be included as WHCV. The specifics of this process are being developed but it may include a standard form that scientists need to submit to WNHP and a window during which WNHP has the opportunity to respond. This process will be described in future revisions of the Wetland Rating System (Hruby, T., personal communication)
Network of Reference Standard Sites	A total of 152 unique reference standard sites were identified for 200 unique combinations of Natural Community Types & Plant Associations. The list is a first iteration based on known WHCV and field experience of the authors. As new inventory data becomes available the list may change. Reference standard sites have not been identified for all wetland types. Future work by WNHP will seek to identify reference standard sites for these types.

Next Steps

The information presented in this report is based on data collected over a 30-year time frame and represents 718 Plant Association-based WHCV at 300 unique sites that span the entirety of western Washington. This is a substantial body of work but data gaps still exist. WNHP has not visited each wetland in western Washington thus additional sites that may meet WHCV criteria may occur on the landscape. Most inventory work has been conducted in the lowlands of western Washington. This is primarily because the lowlands are where the greatest threats and urgency are for conservation. However, addressing gaps in knowledge of wetland types and conservation significance at higher elevations is recommended in order to fully understand the biodiversity values of western Washington wetlands. In addition, some ecosystem types have received more inventory attention than others. The information presented here should not be considered static. Ongoing land use changes and other anthropogenic stressors continually expose wetlands to new and changing agents of degradation. Periodic updates to this Wetland Conservation Profile are recommended to account for those changes.

WNHP is currently working on completing a wetland conservation profile for eastern Washington (EPA WPDG CD-00J64201-0) which will have a similar format as presented in this document. That project is expected to be completed by December, 2015. Another EPA WPDG (CD-00J78501) is in progress and is focused on completing a statewide reference standard wetland network, developing publicly accessible web-based map viewer and content about Washington's wetland types, the location of WHCVs and reference standard sites. As part of that project, WNHP will also be developing and offering training for wetland professionals interested in learning how to apply the Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington and Ecological Integrity Assessment method.

Acknowledgments

We appreciate the support of the U.S. Environmental Protection Agency, Region 10 for this project. Specifically, we'd like to thank Linda Storm for her guidance and assistance with many aspects of the project, both administrative and technical.

Linda Kunze's past work on classification, inventory, and conservation priority selection has had a huge impact on wetland conservation in Washington. More recently, Linda provided input on classification updates and her input was very much appreciated.

Likewise, we appreciate the data John Christy (Wetland Ecologist, Oregon Biodiversity Information Center) shared and his insights into regional wetland classification and ecology.

Tom Hruby and Patricia Johnson (Washington Department of Ecology) were very helpful in assisting us with initial project focus. We most appreciate the ongoing dialogue concerning how to address use of undocumented Wetlands of High Conservation Value into the Wetland Rating System process.

We are very thankful for the cooperation and assistance numerous landowners provided to allow access to their properties. Specifically, Columbia Land Trust, Green Diamond Resource Company, Rayonier, Hancock Timber Resource Group, Sierra Pacific Industries, Green Crow Corporation, The Campbell Group LLC, Inc., and Port Blakely Tree Farms.

The Northwest, Olympic, Pacific Cascade, and South Puget Sound regional staff of the Washington Department of Natural Resources were also very helpful in assisting us with maps, keys, and a variety of other information about accessing sites on State Trust lands.

The Floristic Quality Assessment would not have been possible without the input of the Washington FQA panels and we are very grateful for their involvement.

This project was completed with funding from the U.S. Environmental Protection Agency Region 10 under Wetland Program Development Grant Assistance Agreement No. CD-00J263010 and CD-00J49101 to the Washington Department of Natural Resources Natural Heritage Program.

1 Introduction

Land managers, planners, and the public need tools to better understand the resource value of individual wetlands in order to make informed decisions to minimize loss or to protect wetland integrity and ecosystem services (Hruby 2004a, b). An important wetland value is their contribution to biodiversity. Wetlands provide habitat for numerous plant and animal species and are floristically diverse ecosystems. Wetlands only represent approximately 2% of Washington's landscape but over 66% of terrestrial vertebrates utilize wetlands (Sheldon et al. 2005). Approximately 30% of the native flora of western WA has a FACW or OBL wetland indicator status (614 of 2022 native species) and is undoubtedly a conservative estimate of the percentage of plant species supported by wetlands. Of the plant species considered Endangered, Threatened, or Sensitive by the Washington Natural Heritage Program (WNHP), 45% (147 of 328) are limited to or often found within wetlands or riparian areas. Certain wetland types support a higher proportion of rare plants than other types. For example, peatlands and wet meadows/seasonal wetlands support the highest proportion of wetland rare plant species compared to other wetland types (Table 1). Peatlands, wet meadows, and riparian area each support more than 10% of all of Washington's rare plants (Table 1). Variable climatic conditions, geologic diversity, landscape contexts, and phytogeography result in wide diversity of wetland plant associations on the landscape. The total number of plant associations (based on the U.S. National Vegetation Classification) currently documented by WNHP as occurring within or with a high likelihood of occurring in Washington is approximately 800. Of those, approximately 48% (~386 plant associations, 272 of which occur in western Washington) are associated with wetlands and riparian areas. These plant associations represent unique ecological conditions and can be viewed as coarse filters for the full suite of biodiversity (from large ungulates to soil microbes) found in wetlands. In summary, although they only represent approximately 2% of the landscape, wetlands and riparian areas support and contribute to a significant percentage of Washington's biodiversity.

Information about wetland biodiversity values is critical for conservation planning, wetland restoration and management, and application of various regulatory programs. The Washington Wetland Rating System (Rating System) is a tool to provide a basis for developing standards for protecting and managing wetlands. The Rating System provides a systematic process for categorizing wetlands based on their sensitivity to disturbance, their significance, their rarity, the ability to replace them with restoration/mitigation, and the functions they provide (Hruby 2004a, b). The Rating System places wetlands into four categories from Category I (irreplaceable wetlands, which are relatively undisturbed, rare or provide a high level of, or unique functions) to Category IV (wetlands that are heavily disturbed or provide the lowest level of functions). These rating categories are intended to be used to develop criteria for protecting and managing wetlands and prevent loss of their associated values (Hruby 2004b). Determining buffer widths, mitigation ratios, biodiversity values, and permitted uses are examples of the types of decisions the Rating System can assist with (Hruby 2004a, b). Knowing the location of Category I wetlands is integral to protecting the most irreplaceable and significant wetland resources in Washington State.

One criterion for designating Category I Wetlands is whether they are considered to be Wetlands of High Conservation Value (formerly called Natural Heritage Wetlands). Wetland of High Conservation Value is a label applied to those places on the ground that the Washington Natural

Heritage Program (WNHP) has identified as a conservation priority due to their biodiversity values. These wetlands either support a rare and/or high-quality wetland plant association or a State listed sensitive, threatened, or endangered plant species. WNHP's database contains the locations of known WHCV and is an integral resource to identify WHCV. However, much of the information about Wetlands of High Conservation Value in this database is dated (> 20 years old) and primarily limited to western Washington lowlands (Kunze 1984, 1986, 1987, 1988, 1989, 1990, 1991). Although Kunze's surveys represent a significant effort, many ecological changes have occurred in the intervening 20-30 years, including increased development and spread of non-native species (Puget Sound Partnership 2009). WNHP has records of Wetlands of High Conservation Value in other parts of the State, although these sites were not a product of a statewide, focused effort to identify the most significant wetlands for conservation. Thus, many areas of Washington have not been systematically surveyed for wetlands of high conservation value, including montane and subalpine elevations and the entirety of eastern Washington. Such data gaps restrict the State's ability to ensure that these important wetlands are accounted for when planning for wetland protection, restoration, and management.

Table 1. Distribution of Rare Plants (i.e. considered Endangered, Threatened, or Sensitive by the Washington Natural Heritage Program) by Wetland Type. Note: Some species occur in more than one wetland type)

	Total Number of Associated Rare Plants	**% of Wetland Rare Plants (147)**	**% of Upland + Wetland Rare Plants (328)**
All Peatlands	43	29%	13%
Bogs & Poor Fens	22	15%	7%
Moderately Rich Peatlands	9	6%	3%
Rich Peatlands	12	8%	4%
Marsh	16	11%	5%
Wet Meadow / Seasonal Wetlands	42	29%	13%
Wet Prairie	6	4%	2%
Vernal Pool	18	12%	5%
Swamps	16	11%	5%
Riparian	34	23%	10%
Alkaline/interior saline	7	5%	2%
Interdunal	1	1%	0%
Wet Cliffs/Spray Zones	12	8%	4%
Seep/Springs	16	11%	5%
Salt Marsh/Tidal	1	1%	0%

1.1 Project Overview

This project is intended to provide important information about locations of Washington's most significant wetlands for conservation. This report specifically describes the first two phases of a multi-phased project intended to improve wetland data managed by the Washington Natural Heritage Program (WNHP). Phases 1 & 2 (the subject of this report; 2010 EPA Region 10 Wetland Program Development Grant CD-00J26301 and 2011 EPA Region 10 Wetland Program Development Grant CD-00J49101, respectively) focused on western Washington, where wetland impacts are most common due to higher population densities. Phase 3 (2012 EPA Region 10 Wetland Program Development Grant CD-00J64201-0) is focused on eastern Washington and Phase 4 (2013 EPA Region 10 Wetland Program Development Grant CD-00J78501) is in-progress and is focused on completing a statewide reference standard wetland network, developing publicly accessible web-based map viewer and content about Washington's wetland types, and developing and offering training for wetland professionals interested in learning how to apply WNHP's wetland classification and Ecological Integrity Assessment method.

Natural Heritage methodology (Master et al. 2009; Faber-Langendoen et al. 2009a, Faber-Langendoen et al. 2009b, NatureServe 2009) was used to increase the resolution of available information pertaining to the location, condition, and biodiversity values of Wetlands of High Conservation Value. Additional information such as an evaluation of stressors and wetland functions was assessed at each site visited during the 2011 and 2012 field surveys and allowed a cursory inquiry into the relationships between these variables and conservation values. The end result is an updated characterization of a subset of Wetlands of High Conservation Value (WHCV). Additional analysis was performed on the entire dataset of known WHCV documented in WNHP's Information System. The overall outcome is a synthesis of Washington's wetland conservation priorities presented as the 'Western Washington Wetland Conservation Profile' (Sections 6-12 of this document). The following questions frame the approach used to accomplish project objectives:

- What types of wetland elements occur in western Washington?
- What is their biodiversity significance?
- Where are the locations of known Wetlands of High Conservation Value?
- What is the current protection status and conservation needs of known Wetlands of High Conservation Value?
- Where are potential new Wetlands of High Conservation Value?
- What are the trends in ecological integrity, wetland functions, and stressors associated with Wetlands of High Conservation Value?

This report and the updated database of Wetlands of High Conservation Value is intended to inform land use planning, conservation actions, and wetland permitting decisions. Specifically, this information will provide the best available science needed to effectively identify the location of Wetlands of High Conservation Value, meet some of the scientific needs identified under the Growth Management Act (Hruby 2004b), and provide critical information for other land use planning that may affect Washington's wetland resource (e.g., Puget Sound Action Agenda / Puget Sound Partnership 2009). The results of this project will inform priorities established in the biennial *State of Washington Natural Heritage Plan* (the current edition: WADNR 2011).

Natural Heritage Plan priorities are a key component of evaluating sites for Washington Wildlife and Recreation Program (WWRP) funding. As such, this project will help guide where the State of Washington spends millions of dollars to voluntarily protect irreplaceable habitat.

1.2 Project Scope and Objectives

This project is focused on wetlands and riparian areas ranging from coastal areas to the Cascade Crest in western Washington (Figure 1). Wetlands of High Conservation Value may be designated either because they support a rare and/or high-quality wetland plant association or a State listed sensitive, threatened, or endangered plant species (no matter if the rare plant is considered an upland or wetland species). The focus of this report is on Plant Association-based Wetland of High Conservation Value. This is because (1) many of the analyses conducted for this report are specific to ecosystem characteristics and (2) it is difficult to determine (*a priori*) which rare plant species occur in wetlands. [Note: In the past, WNHP assigned rare plant species (i.e., Endangered, Threatened, or Sensitive) a 'W' if the plant was thought to be a wetland species. Element occurrences of these rare 'wetland' plants were considered a WHCV. However, the subjective determination of a rare plant being a 'wetland' species raised concerns that rare plant-based WHCV may be underestimaged. In other woreds, even if a rare plant has a low probability of occurring in a wetland, whenever it does, that wetland should still be considered a Wetland of High Conservation Value. Consequently, the process for using rare plants for designating Wetlands of High Conservation Value was reevaluated, in consultation with Washington Department of Ecology, for this project. The new approach is to consider any occurrence of a rare plant that occurs within a wetland (regardless of its overall probability of occurring in a wetland) as being worthy of the Wetland of High Conservation Value designation. This approach alleviated the need to make subjective determination of whether a rare plant is a "wetland" species. However, since WNHP does not conduct wetland delineations when rare plant occurrences are documented, the approach also limits the ability to identify which rare plant element occurrences in WNHP's database are Wetlands of High Conservation Value until wetland determinations have been made on the ground. Instead, project proponents using the Washington Wetland Rating System will need to overlay WNHP's GIS dataset (or contact WNHP) to determine whether any rare plant occurrences falls within the bounds of any wetland identified in their project area. If a rare plant currently documented in WNHP's information system does occur in such a wetland, that wetland is considered to be a Wetland of High Conservation Value, per the guidelines of the Washington Wetland Rating System (Hruby 2014a, b). As such, although WNHP has 622 rare plant occurrences labeled "Wetland" in their database (see Section 8.1), this could be an underestimate of the actual number of rare plants within wetland boundaries and thus any analysis based on that number was felt to be potentially misleading.]

The majority of field work was conducted in lowland areas since most known locations of Wetlands of High Conservation Value occur in low elevation environments and the fact that these tend to be the most threatened from human activities. However, high elevation wetland types and their biodiversity significance are less known and some effort was made to visit high elevation sites.

WNHP uses Natural Heritage methodology to identify Wetlands of High Conservation Value. Natural Heritage methodology provides documentation of what elements exist in a region (classification), how those elements are doing (assessing their condition or viability), and where precisely they are found (documenting and mapping locations). This information is synthesized into a Conservation Status Rank which reflects an element's risk of extinction based on rarity, threats, and trends. Information pertaining to the viability (species) or ecological integrity (plant associations) of an individual population or occurrence (an area of land or water in which an element is found) is synthesized into what is called an Element Occurrence Rank. Together the Conservation Status Rank and Element Occurrence Rank help prioritize which element

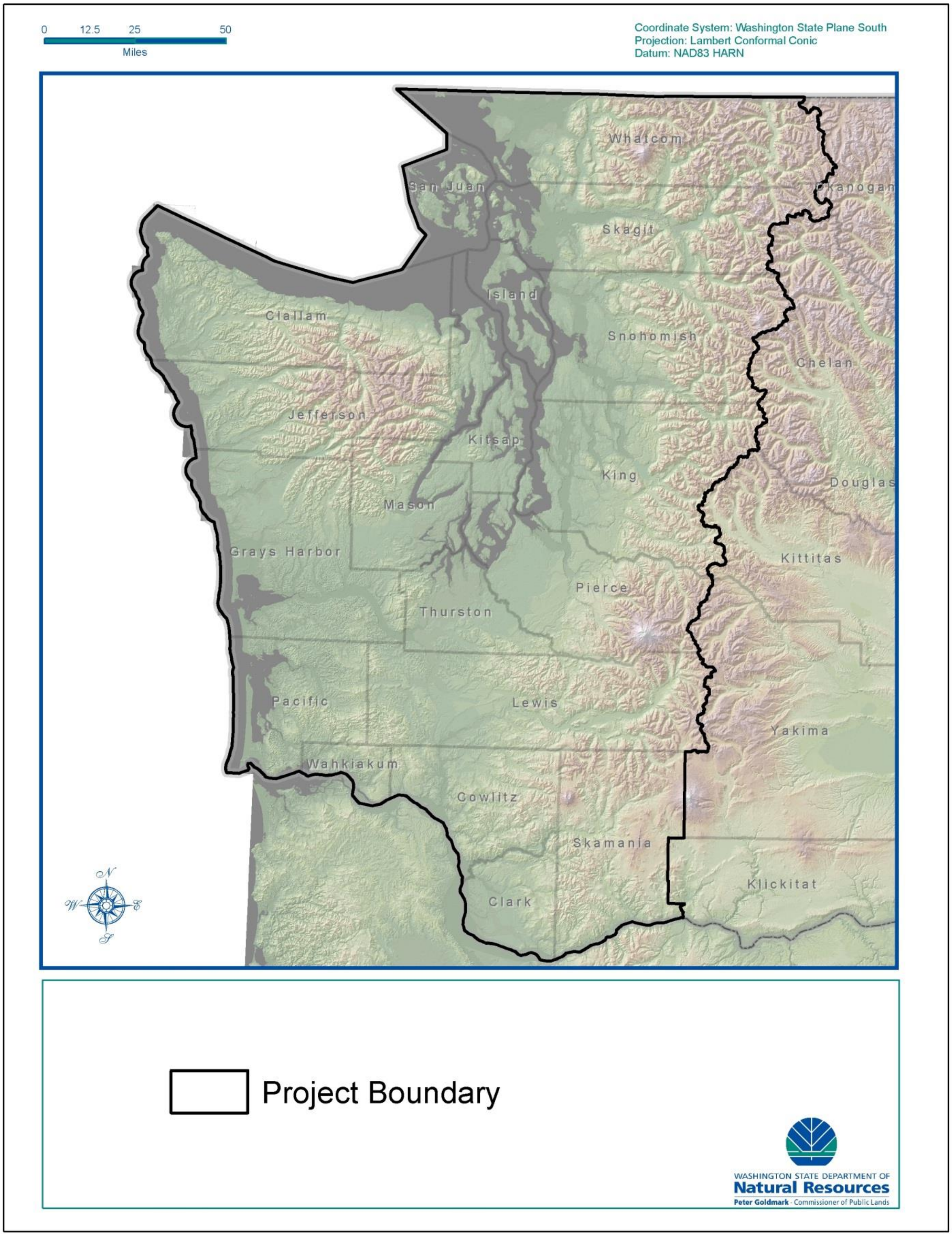

Figure 1. Project Area Location

occurrences meet criteria for WHCV. Only wetlands supporting rare plant species and/or rare or high-quality wetland plant associations are considered to be a 'Wetland of High Conservation Value' and included in WNHP's Information System.

Project objectives were to:

1. Revise and update classification of Washington wetlands
2. Update Conservation Status Ranks of wetland plant associations
3. Conduct field visits to a subset of known WHCV to update information about their currenet ecological condition and extent
4. Survey for undocumented or new WHCV
5. Summarize protection information about all known WHCV.
6. Explore relationships between ecological integrity, wetland functions, and stressors.

These objectives were organized into a series of questions which are described below.

1.2.1 What Types of Wetland Elements Occur in Western Washington?
Section 6 discusses wetland types in more detail.

The first step in determining wetland conservation priorities is to have a list of wetland elements that occur in the project area. An 'element' is either a species or ecosystem that occurs in an area of interest. It is the basic unit of Natural Heritage methodology.

For this project, *species elements* are those rare plants tracked by the Washington Natural Heritage Program (WNHP) listed here: http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html. In order to identify specific *ecosystem elements* a classification scheme is used to identify unique ecological units. WNHP currently uses multiple wetland classifications to identify wetland ecosystem elements: (1) plant associations, the finest-scale unit of the U.S. National Vegetation Classification (USNVC) supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009c), and the Ecological Society of America (Jennings et al. 2006); (2) natural wetland community types (Kunze 1994); and (3) Ecological Systems (Comer et al. 2003; Rocchio and Crawford 2008). For this project, an updated list of plant associations has been compiled by reviewing existing literature and including types revealed from field data collected for this project. The natural community type classification developed by Kunze (1994) was reviewed and updated to better reflect finer-scale ecological gradients and incorporated as an intermediate level within the USNVC between the Group and Plant Association (see Appendix A).

1.2.2 What is the Biodiversity Significance of the Wetland Elements?
Section 7 reviews the biodiversity significance of western Washington wetlands.

Once the list of elements is compiled, the next task for identifying conservation priorities is to determine the risk of extinction associated with each element. This risk is reflected aa a Conservation Status Rank, which considers rarity, trends, and threats associated with each element. A standardized approach is used to assign these ranks (Master et al. 2009; Faber-Langendoen et al. 2009b). For this project, State Conservation Status Ranks for plant associations were reviewed and updated when necessary. This process is essential to evaluate existing and potential new locations of Wetlands of High Conservation Value as they allow a prioritization of those wetland types most at risk of extinction.

1.2.3 Where Are Known Wetlands of High Conservation Value in Western Washington?

Section 8 presents the location of known Wetlands of High Conservation Value.

The list of wetland types and their conservation status defines the universe of possible conservation targets on the ground. However, additional information is needed to filter these possibilities to those sites that are of primary conservation importance. At the core of Natural Heritage methodology is the concept of the 'element occurrence', which is the spatial representation of a species or an ecological community at a specific location. An element occurrence generally delineates a species population or a patch of a given ecological community and represents the geo-referenced biological feature that is of conservation or management interest. WNHP considers additional factors to prioritize which element occurrences are conservation priorities. For plant species, abundance, occurrence patterns, vulnerability, threats, existing protection, and taxonomic distinctness are evaluated to determine State Status (http://www1.dnr.wa.gov/nhp/refdesk/lists/plantrnk.html). Any element occurrence (e.g., population) of a rare plant species tracked by WNHP is considered a conservation priority and, within the context of this project, would trigger the designation of a Wetland of High Conservation Value should such a species occur within a wetland.

Ecosystem priorities are determined with a slightly different approach. The quality or ecological integrity of the element occurrence (i.e., as determined by the ecological integrity assessment rank) is used in conjunction with the Conservation Status Rank to determine ecosystem conservation priorities at any given site. All occurrences of the rarest elements, even those in poor condition, are conservation priorities, while only the highest quality occurrences of more common elements are conservation priorities. A conservation priority matrix is used to guide these determinations and thus allow for a systematic determination of when a specific ecosystem element occurrence is designated as a Wetland of High Conservation Value.

1.2.4 What the Current Protection Status of Known Wetlands of High Conservation Value?

Section 9 describes the protection status and needs of Wetlands of High Conservation Value.

The number of Wetlands of High Conservation Value that currently have or lack adequate protection was assessed. This information provides an overview of the protection needs of wetlands identified as conservation priorities in western Washington.

1.2.5 Where are Potential New Wetlands of High Conservation Value in Western Washington?

Section 10 reviews the location of potential new Wetlands of High Conservation Value.

Wetlands mapped by the National Wetland Inventory were evaluated using a remote sensing-based ecological integrity assessment (i.e. Level 1 EIA) to determine probable locations of high-quality wetlands not currently recorded in WNHP information system. This analysis does not identify potential locations of rare plant species or of individual ecosystem types, but it does provide a means of prioritizing wetlands for ongoing and future inventory efforts.

1.2.6 What are the Trends in Ecological Integrity, Wetland Functions, and Stressors Associated with Wetlands of High Conservation Value in Western Washington?

Section 11 discusses these ecological trends for western Washington wetlands.

A variety of ecological data was collected during project field work to support an exploratory analysis of vegetation composition and the relationships between ecological integrity, selected wetland functions, and stressors associated with Wetlands of High Conservation Value in western Washington. This analysis provides another crucial piece of information associated with the characterization of wetland conservation priorities.

1.3 Products and Outputs

The following products were submitted with this report:

- *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* – described in Section 6.2. Presented in Appendix A. A stand-alone report is expected to be available on WNHP's website in 2015: http://www1.dnr.wa.gov/nhp/refdesk/pubs/index.html
- Floristic Quality Assessment report and list of 'coefficients of conservatism' for the Washington flora. Submitted to EPA as separate report; also online: http://www1.dnr.wa.gov/nhp/refdesk/communities/fqa.html
- Updated Conservation Status Ranks of wetland ecosystem elements in western Washington. Assigned a State Conservation Status Rank to 83 plant associations. All Conservation Status Ranks are listed in Appendix A.
- Updated Element Occurrence Ranks of wetland ecosystem elements in western Washington. Level 2 (field-based) EIA ranks were assigned to 207 element occurrences. Level 1 (GIS-based) EIA ranks were assigned for every element occurrence in western Washington. All updates were entered into WNHP's BIOTICS database and the included Wetland of High Conservation Value GIS file (see below.
- A GIS shapefile depicting the location of Wetlands of High Conservation Value in western Washington. Submitted with this report and will also be made available on WNHP's website: http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html
- A GIS shapefile with the Level 1 EIA Ranks of a subset of National Wetland Inventory Wetlands across Washington State. Submitted with this report and will also be made available on WNHP's website: http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html
- List of reference standard sites for some western Washington wetlands. Submitted as Appendix D

2 Project Area

This Section provides an overview of the ecoregions in western Washington. It is intended to provide ecological context for understanding the types, distribution, rarity, and threats associated with western Washington wetlands.

2.1 Climate Overview

Western Washington is under the influence of a maritime climate with mild temperatures, muted extreme temperatures, and prolonged cloudiness (Franklin and Dyrness 1988). Winter rain and snow and summer drought characterize the temperate, maritime climate of the region. High pressure systems which develop in the Pacific Ocean have a strong influence on the seasonal tracks of precipitation. Typically, two-thirds of the precipitation occurs between October and March when the Pacific high pressure system moves south allowing low pressure systems to approach from the Pacific Ocean (Franklin and Dyrness 1998). During that time frequent rain is brought into the lowlands and snow into the mountains. During late spring into early fall, a high pressure area develops off the coast of Oregon and Washington and, when persistent, generally keeps the Pacific Northwest fairly dry in the summer.

Climate in the low elevations west of the Cascades is characterized by mild year-round temperatures, abundant winter rains, and dry summers. Average annual precipitation in most places west of the Cascades is more than 30 inches. The western slopes of the Olympic Mountains typically receive around 120 inches per year, with some locations on the Olympic Peninsula exceeding 200 inches per year. Average annual precipitation in the Cascades typically exceeds 100 inches or more (Climate Impacts Group http://cses.washington.edu/cig/pnwc/pnwc.shtml).

The Cascade and Olympic mountains are barriers to eastward moving storms resulting in rainshadow development on the eastside of the mountains, sometimes significantly reducing precipitation. The Olympic rainshadow is the most dramatic, with 119 inches average annual precipitation at Point Grenville on the Pacific Coast, over 200 inches/year at Mount Olympus 45 miles to the northeast, and 17 inches/year at Sequim, another 30 miles northeast in the rainshadow.

2.2 Geology Overview

The geological history of western Washington has left a wide variety of geological substrates and landforms on the landscape creating a varied template for wetland formation. An overview of western Washington geology is provided below.

About 150 million years ago, the western edge of the North American continent, located approximately where Idaho, Oregon, and Washington meet today, began to collide with the easterly track of the Pacific plate resulting in the "docking" of new rocks to the North American continent (i.e. Superterrane I) and thereby extending the western edge of North America into eastern British Columbia and northeastern Washington (Williams 2002). About 50 million years ago, Superterrane II docked against the Superterrane I rocks extending the edge of the North American continent into most of contemporary British Columbia and northern Washington (Williams 2002). Approximately 20-30 million years ago, as the San Juan de Fuca plate subducted under North America, ocean floor basalts and their overlying sediments began pushing up against the North American plate and were uplifted to form the Olympic Mountains (Williams 2002).

As the subduction of the Pacific oceanic plate continued under North America, a series of volcanic eruptions began creating the foundation of the Cascade Mountains around 40 to 17 million years ago. Around nine million years ago, uplift of this foundation along with renewed volcanic activity built and continues to build the contemporary Cascade Range (Williams 2002). Granitic rocks and welded volcanic rocks resistant to erosion now comprise many of the higher peaks in the South Cascades (Pringle 2008). The series of stratovolcanoes currently found in the Cascade Range, including Mount Rainier (the oldest in Washington), Mount St. Helens, and Mount Adams, emerged through and built atop the older volcanic Cascades. More northerly stratovolcanoes such as Mount Baker and Glacier Peak emerged through the older landscapes in the North Cascades (Williams 2002). Erosive actions of gravity, wind and water erosion have steadily modified the mountains resulting in the steep topography of contemporary landscapes.

Periods of past glaciation had significant effects on the lowlands and coastal and Cascade ranges. Alpine glaciers modified and continue to modify the Cascades and the Olympic Mountains. The last maximum continental ice advanced 14,000 years ago during which the Canadian continental ice sheet covered the North Cascades and advanced to surround the Olympics on the east and north. This ice sheet advanced and retreated numerous times. The most recent continental ice advance was the Puget Lobe of the Vashon glacier which extended to just south of Olympia but landforms related to outwash from this ice mass extend further south and west into the Chehalis Basin (Pringle 2008). During the most recent period of glaciation, major episodes of alpine glaciation occurred 2-4 times in the southern Cascades of Washington (Pringle 2008). These alpine glaciers also reached into the lowlands of western Washington. Significant landforms left on the landscape by continental and alpine glaciation include scoured bedrock, U-shaped valleys, compacted till, kettle ponds, glacial debris deposits, and large amounts of outwash deposits of varying texture (Pringle 2008). Many of these features now support the numerous wetlands, especially peatlands, currently found in western Washington.

2.3 Topography and Hydrogeologic Settings

The topography of western Washington provides numerous hydrogeologic settings suitable for wetland formation. Wetlands are commonly found in landscape positions such as headwater areas, contemporary alluvial deposits adjacent to streams and rivers, old river terraces, kettle holes, morainal lakes, behind natural impoundments (e.g. beaver dams), swales, glacial scours, along the fringe of lakes and ponds, within intertidal zones, along coastal beaches, areas with perched water tables, shallow bedrock depressions, below late-lying snow patches, and on slopes where shallow or deep groundwater emerges (Kunze 1994; Kulzer et al. 2001; Sheldon et al. 2005). These landscape positions, along with hydrological processes, have a significant effect on the biotic and abiotic structure and function of a particular wetland. As such, it is useful to group them into hydrogeologic settings. One way to do this is through the application of the hydrogeomorphic classification (HGM) of wetlands (Brinson 1993). HGM classes of western Washington wetlands are discussed in Section 6.

2.4 Ecoregions of Western Washington

The ecoregions used by the Washington Natural Heritage Program (WADNR 2007) provide a logical structure to discuss the distribution of wetlands throughout the project area (Figure 2).

These ecoregions reflect similarity in biotic and abiotic characteristics, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. A brief summary of the climate, geology, and land cover/use of each ecoregion is discussed below.

2.4.1 Puget Trough Ecoregion

The Puget Trough consists of a broad rolling landscape which primarily occupies a continental glacial trough (from Thurston County to the Canadian border) and includes many islands, peninsulas, and bays in the Puget Sound area. The northern portion of the ecoregion includes lowlands surrounding the Puget Sound and the southern half extends south to include the upper basin of the Chehalis River and the Cowlitz river valley and the northern portion of the Willamette Valley (Portland Basin) in Clark County. (Figure 2). Relief is moderate and elevations are mostly below 1,000 feet.

2.4.1.1 Geology and Topography

This ecoregion lies in a topographic and structural trough between the Cascade Range to the east and the Olympic Mountains and Willapa Hills (e.g., Coast Ranges) to the west. The region is relatively broad but narrowing considerably in the southern end of the region (Figure 2). Other than a few areas in the San Juan Islands, most of the region occurs below 500 feet in elevation. Much of the topography of the region is a result of glaciation which initiated in the early Pleistocene when four periods of extensive glaciation occurred. Glaciation ceased between 200,000 to 740,000 years ago and then reinitiated during the late Pleistocene. Contemporary landscapes of the Puget Trough are primarily the result of the last continental glacier (the Cordilleran Ice Sheet) that moved through the region about 18,000 years ago. The ice advanced from what is now British Columbia to just south of Olympia. Surface runoff from the Cascades was dammed by the ice sheet and/or diverted south along the flanks and around the terminus of the glacier south of Olympia and out to the Pacific through the Chehalis River valley. These events left a landscape almost entirely created by glacial deposition or erosion. South of the outwash areas in the Chehalis River valley, the topography is mostly a result of stream erosion. However, alpine glaciers and their associated outwash deposits are found in the Cowlitz River valley into the Columbia River (Pringle 2008). Some post-glacial alluvial erosion and deposition has modified the landscape in riverine settings. Kettle holes, glacial till, moraines, glacial scours, meltwater outwash, proglacial lake deposits, and contemporary alluvial and shoreline landforms affect the distribution of wetland types and distribution across the Puget Trough.

The geology of the Portland Basin (Clark County) is unique withinthe ecoregion. About 12 million years ago, very fluid Columbia River basaltic lava flowed through the ancestral Columbia River gorge and reached the Pacific Ocean (WADNR 2007). During the Miocene and continuing through the Pliocene, the basin was filled by sediments of the ancestral Columbia River. About 12,700 to 15,300 years ago, ice dams on the Columbia River were breached resulting in torrential and massive flooding in the Columbia Basin as well as in the Willamette Valley. These floods are known as the Lake Missoula or Spokane floods and are the same ones that created the scablands of eastern Washington (WADNR 2007). The floodwaters that ponded in the Portland Basin deposited well-sorted sand, clay, and gravel (WADNR 2012). These deposits are one of the primary reasons (along with fire) that both dry prairie and oak woodlands (on coarse deposits) and wet prairies (on fine-textured deposits) once dominated this portion of the ecoregion.

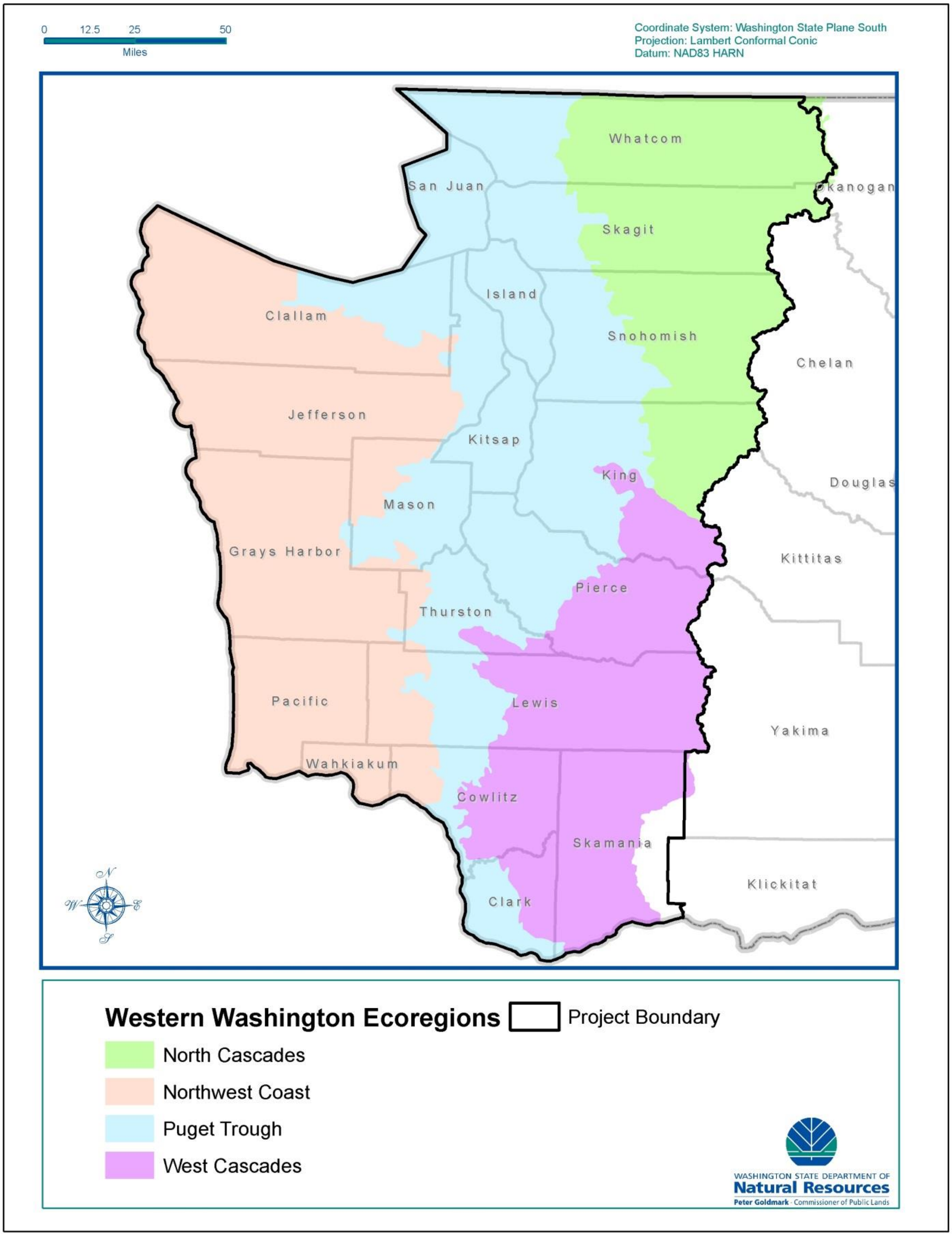

Figure 2. Ecoregions of Western Washington

2.4.1.2 Climate

The Puget Trough is characterized by a mild maritime climate. Prevailing wind directions are from the south to southwest during the wet season and from the northwest during the summer dry months. Factors such as distance from the Sound, rolling terrain, and influx of oceanic air through the Straits of Juan de Fuca and the Chehalis River valley, result in variation in temperature, length of the growing season, fog, rainfall, and snowfall (WRCC 2012). The growing season in the Puget Trough lasts from the middle of April until the middle of October.

Annual precipitation ranges from 32 to 35 inches in the northern portion of the Puget Trough (from Seattle to the Canadian border) while precipitation increases in the southern portion to ~ 50 inches in Olympia and ~ 48 inches in Centralia (WRCC 2012). Precipitation mostly falls as rain but an average of 10-20 inches of snow occasionally falls throughout the area. Snowfall and rain increase with a rise in elevation and distance from the Sound (approximate maximum average precipitation in the ecoregion is 70 inches/year). Snowfall melts relatively quickly and depths rarely exceed six to 15 inches. The rainshadow cast by the Olympic Mountains results in drier conditions in the northeastern portion of the Olympic peninsula, northern Kitsap peninsula, the San Juan Islands, and the western portions of Whatcom and Skagit counties. For example, Sequim, on the north end of the Olympic peninsula, only receives 17 inches/year.

Average January maximum temperatures range from 41^{o} to 45^{o} F while minimum temperatures range from 28^{o} to 32^{o} F. An increase in distance from the Sound results in decreased winter temperatures and increase summer temperatures. Temperatures rarely drop below 10^{o} to 15^{o} F. Average maximum temperatures range from 73^{o} F in the north to 78^{o} F near Olympia. Temperatures in the 90's occur a few days per year.

2.4.1.3 Land Cover/Land Use

Historically, forests of mostly old-growth Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western redcedar (*Thuja plicata*) covered much of the ecoregion. Most of this original forest has been logged, often numerous times. Contemporary forests are still dominated by these species but with much younger and smaller individuals. Bigleaf maple (*Acer macrophyllum*) and red alder (*Alnus rubra*) are also common forest dominants and tend to increase in abundance in more disturbed forests. Pacific Madrone (*Arbutus menziesii*) and occasionally Oregon white oak (*Quercus garryana*) are common associates with Douglas-fir on shallow or coarse-soils. Prior to conversion to agriculture or lost to development, dry upland prairies and Oregon white oak woodlands covered extensive areas of coarse glacial outwash, especially in the southern portion of the ecoregion. Frequent fire (much thought to be of anthropogenic origin) kept these prairies from being invaded by forest species. Very little of this prairie ecosystem remains on the landscape today. Estuaries are found along some of the inlets of Puget Sound. Marshes, swamps, riparian areas, and peatlands are very abundant across the landscape. Peatlands are concentrated in areas of past glaciation. Large, low-gradient rivers begin in adjacent mountains and flow through the ecoregion while small streams often originate at lower elevations. Lakes are numerous in the areas affected by past glaciation. With over 50% of the landscape converted to agricultural or urban uses, this ecoregion has the most urban development of any ecoregion in the State. The Portland Basin portion of the ecoregion (i.e., Clark County) was originally covered by a mosaic of lowland Douglas-fir and western hemlock forests and by dry and wet prairies, oak savannas, and extensive wetlands and deciduous riparian forests. Peatlands are rare in this portion of the ecoregion. Much of the area has been converted to agricultural use and development is widespread near Vancouver and spreading throughout Clark County.

2.4.2 Northwest Coast Ecoregion

The Northwest Coast ecoregion includes the low mountains of the Willapa Hills, the rugged Olympic Mountains, the coastal plain, ocean coast, and extends as far east as the Black Hills near Olympia (Figure 2). Most of the Olympic peninsula occurs within this ecoregion, although the areas between Port Angeles, Sequim, Port Townsend, and south to Quilcene are within the Puget Trough ecoregion (Figure 2).

2.4.2.1 Geology and Topography

The Olympic Mountains occupy the northern portion of the ecoregion and extend to nearly 8,000 feet. They were formed from the uplift of sedimentary (e.g. sandstones, mudstones, and shales) and volcanic rocks which were deposited over millions of years ago on a seafloor off the continental shelf (McNulty 2003). Pleistocene glaciations, associated with both alpine and continental ice sheets, dramatically eroded the Olympic Mountains into the jagged and steep topography characteristic of the contemporary landscape (McNulty 2003). Alpine glaciers tended to further erode drainages already begun by fluvial erosion resulting in a widening, straightening, and flattening of preexisting river valleys into characteristic U-shaped valleys. The headwaters of these glaciated valleys are often very steep. Continental ice sheets descended into western Washington numerous times during the Pleistocene. These ice advances wrapped around the northern and eastern base of the Olympic Mountains and, along with outwash streams flowing around the southern flank of the mountains effectively isolated the Olympics from nearby landforms. This isolation resulted in the Olympic Mountains serving as a refugium for many species during the periods of continental ice sheet advance, especially plants (Buckingham et al. 1995). The northern and eastern lobes of the continental ice sheet dammed many of the rivers draining off of the Olympic Mountains creating fjord-like lakes in the river valleys. The coastal plain of the western Olympic peninsula is underlain by glacial till and outwash (WADNR 2007).

The Willapa Hills occur in the southern portion of this ecoregion and form a continuous ridge from the Chehalis River valley to the Columbia River. They range in elevation from 1,000 to 3,000 feet and have a rounded topography composed of old, well-weathered soils. Unlike the Olympic Mountains to the north, the rocks of the Willapa Hills are not intensely deformed as they were not subject to subduction, tectonism or associated metamorphism. Thick sequences of sedimentary and volcanic rocks of Eocene through Miocene age are present (WADNR 2012). During the Pleistocene, the Chehalis River valley, which separates this portion of the ecoregion from the Olympic Mountains to the north, supported a major river draining meltwaters from the Puget ice lobe and from the western Cascade foothills. These meltwaters left coarse and fine-grained sediments which provided the template for the formation of both dry and wet prairies in this portion of the ecoregion. Barrier beaches characterize the low-lying coastline of the Willapa Hills region, behind which there are major estuaries such as Grays Harbor and Willapa Bay, two of the largest estuaries on the west coast of North America (WADNR 2007).

2.4.2.2 Climate

As with the other areas in western Washington, the seasonal movement of high pressure systems produces a wet-dry climatic cycle. Late fall through early spring is the “wet” season while the remaining portion of the year is relatively dry (Henderson et al. 1989). Precipitation ranges from

60 to 240 inches/year across the ecoregion (WADNR 2007). During the winter season, this ecoregion is subject to intensive oceanic storms which bring frequent periods of heavy precipitation and gale force winds to the ecoregion. Along the coast, annual precipitation averages between 79-118 inches and frequent fog and low clouds occur during the relatively drier summer months (Franklin and Dyrness 1988). Rain is the predominant form of precipitation below approximately 985 feet elevation. Coastal areas have the mildest climate in the Pacific Northwest, meaning the area has the least amount of seasonal variation in temperature and moisture than other areas (Franklin and Dyrness 1988). Rain and snow are predominant between 985 to 2460 feet and snow is the major form of precipitation at higher elevations (Buckingham et al. 1995). The southwestern and western slopes of the Olympic Mountains receive the highest amount of annual precipitation in the continental United States (WRCC 2012). Snow depth can reach over 20 feet in subalpine meadows (Henderson et al. 1989). Winter season snowfall ranges from 10 to 30 inches in the lower elevations and between 250 to 500 inches in the higher mountains. In the lower elevations, snow melts rather quickly and depths seldom exceed 15 inches. In midwinter, the snowline in the Olympic Mountains and the Willapa Hills is between 1,500 and 3,000 feet above sea level. The higher ridges are covered with snow from November until June. About 93% of annual precipitation falls between September and May leaving the summer months relatively dry (Henderson et al. 1989).

The Olympic Mountains create a very strong rainshadow resulting in drastic changes in precipitation within a relatively short distance. Over 200 inches of annual precipitation falls on the west side of the Olympic crest while only 20 inches occurs in the northeast portion of the peninsula (e.g. near Sequim) due to an intense rainshadow effect (Henderson et al. 1989). This is one of the steepest precipitation gradients in the world with only 34 miles separating the wettest location in the continental United States from the driest location along the Pacific coast, north of southern California (Buckingham et al. 1995).

The average maximum temperature in July is near 70° F along the coast and 75° F in the foothills (WRCC 2012). Minimum temperatures are near 50° F. In winter, coastal areas are generally the warmest areas in Washington. In January, maximum temperatures range from 43° to 48° and minimum temperatures from 32° to 38° F.

2.4.2.3 Land Cover/Land Use

The ecoregion is covered by highly productive, rain-drenched coniferous forests comprised of Sitka spruce (*Picea sitchensis*) and western redcedar along the fog-shrouded coast and a mosaic of western redcedar, western hemlock, and Douglas-fir in other areas. Historically, most of this forest was old-growth but logging has reduced much of these old forests. Along the Hoh, Quinault, Queets, and Bogachiel River valleys, old growth temperate "rainforests" are found on old alluvial terraces. Although species composition is similar to other forests in the ecoregion, the temperate "rainforests" are considered distinct by some researchers due to higher rainfall (140-167 inches), the immense size of the trees, the abundance of epiphytes, and herbivory associated with Roosevelt elk (*Cervus canadensis roosevelti*) (NPS 2008). Higher elevations support silver fir (*Abies amabilis*), western hemlock, and mountain hemlock (*Tsuga mertensiana*) forests and subalpine parklands and alpine habitats occur at the highest elevations within Olympic National Park (WADNR 2007). Coastal dunes and headlands support grassland and shrubland vegetation. Riparian areas are prevalent along the major river valleys and numerous creeks throughout the ecoregion. Peatlands are scattered throughout the ecoregion and found mostly on the coastal plain of the Olympic peninsula where they are associated with glacial till and outwash, primarily derived from alpine glaciers from the Olympic Mountains. In the southern portion of the ecoregion peatlands are also found in interdunal areas. Western redcedar swamps are also prevalent in the ecoregion. Large areas of tidal salt marsh occur in Grays Harbor and Willapa Bay.

Most of the ecoregion is under timber management. Almost all areas outside Olympic National Park have been and continue to be managed as industrial forests. Scattered but small areas of development occur along the coast (especially from Grays Harbor to the south) and along the Hwy. 101 corridor. About 5% of the ecoregion has been converted to agricultural or urban uses (WADNR 2007).

2.4.3 North Cascades Ecoregion

The North Cascades ecoregion includes the north section of the Cascade Range, a vast mountain chain that extends from northern California to British Columbia (Figure 2; WADNR 2012; Tabor and Haugerud 1999). The ecoregion ranges from Snoqualmie Pass north to the Canadian border and is limited on the east by the Cascade crest and the west by lowlands of the Puget Trough ecoregion (Figure 2).

2.4.3.1 Geology and Topography

The terrain of the North Cascades is composed of highly dissected terrain mostly ranging between 1,000 to 7,000 feet in elevation (WADNR 2007). The highest peaks are volcanoes that extend to over 10,000 feet. Some valley bottoms may be as low as 500 feet. Glacially carved, U-shaped valleys are prominent as are steep-gradient small stream drainages (WADNR 2007).

The ecoregion is underlain predominantly by sedimentary and metamorphic rock in contrast to the predominance of volcanic strata in the West Cascades ecoregion to the south. The vertical distance from valley floor to the mountain peaks ranges between 4,000 to 6,000 feet making the North Cascades one of the steepest mountain ranges in the conterminous United States (Tabor and Haugerud 1999). A complex mix of volcanic arcs, deep ocean sediments, basaltic ocean floor, ancient continents, and submarine fans create the geologic foundation of the North Cascades (Tabor and Haugerud 1999; WADNR 2012). Subsequent uplift, erosion, metamorphosis, plutonic intrusion, and additional uplift modified these pieces into the contemporary geologic mosaic that currently comprises the ecoregion (Tabor and Haugerud 1999). Two Quaternary stratovolcanoes, Mount Baker at 10,781 feet and Glacier Peak at 10,451 feet, rise above and dominate the volcanic arc which formed in the North Cascades (WADNR 2012). Both volcanoes are thought to be less than one million years old. Glaciation, landslides, and fluvial erosion have created the steep terrain, jagged peaks, and deep canyons currently found in the ecoregion (Tabor and Haugerud 1999).

Mountain glaciation has occurred repeatedly over the last 120,000 years. During the Holocene, the cordilleran ice sheet flowed over most of the North Cascade range and greatly modified the North Cascade landscape. Today, the ecoregion has over 300 glaciers and contains the greatest concentration of alpine glaciers in the conterminous United States (over half of the total number of glaciears found in the lower 48 states) (WADNR 2012). The geomorphic templates, soil textures, and drainage patterns resulting from glacial action have a significant effect on contemporary vegetation patterns (Franklin and Dyrness 1988).

2.4.3.2 Climate

Climate in the North Cascade ecoregion varies greatly between the western and eastern portions due to the barrier imposed by the North Cascade range on westerly storms. A dry continental climate occurs in the east portion of the ecoregion and mild, maritime conditions are found in the west. Precipitation is seasonally distributed with the majority of the total annual precipitation falling between late fall and early spring. The annual precipitation ranges from 60 to 160 inches (WADNR 2007; WRCC 2012). Precipitation at low elevations mostly consists of rain; high elevations have significant snowpack for many months; and middle elevations have significant snowpack which fluctuates over the course of the winter due to rain-on-snow events (Iachetti et al. 2006). In the southern Cascades the rainshadow is typically observed east of the Cascade crest (except rainshadow effects due to the much larger stratovolcanoes such as Mount Rainier). However, due to the width of the North Cascades, the rainshadow effect develops west of the Cascade crest. For example, an average of 100 inches precipitation falls at Upper Baker Dam while only 35 inches accumulates on Desolation Peak on Ross Lake, 25 miles to the east. Average snowfall ranges from 50 to 75 inches in the lower elevations and gradually increases with elevation to between 400 and 600 inches at 4,000 to 5,500 feet (WRCC 2012). The world record for annual snowfall was recently recorded at Mount Baker which received over 93 feet of snowfall (NOAA 2008). Snowfall often continues until late spring with maximum snow depth occurring in early March where it ranges from 10-25 feet above 3,000 feet (WRCC 2012). Above, 5,000 feet, snow may remain on the ground until early July (WRCC 2012).

Temperatures also vary from west to east with colder winters and warmer summers occurring in the eastern portion of the ecoregion (Agee and Kertis 1987). Average January maximum temperatures range from 40° F in the lower elevations to 30° F at the 5,500-foot elevation while minimum temperatures range from 30° F in the lower elevations to 20° F in the higher elevations (WRCC 2012). Above 4,000 feet minimum temperatures occasionally drop below freezing in midsummer.

2.4.3.3 Land Cover/Land Use

At low elevations, western hemlock, Douglas-fir, and western redcedar dominate forests while silver-fir and western hemlock forests are predominant in middle elevation forests. A mosaic of mountain hemlock and silver fir forests with subalpine parkland is common at higher elevations. Alpine heaths, meadows, and fell-fields are interspersed with bare rock and ice above tree-line. Broadleaf trees and conifers dominate riparian areas while Sitka alder (*Alnus viridis* subsp. *sinuata*) and vine maple (*Acer circinatum*) occupy many avalanche chutes and slopes. The steep topography limits wetland formation to areas affected by past glaciation, along rivers, or groundwater discharge sites. Peatlands and swamps are found in areas of groundwater discharge, on alluvial terraces, and high-elevation basins. Natural lakes created by glacial processes are abundant. Marshes and wet meadows are found along riparian zones, beaver dams and associated with depressions. Less than 2% of the ecoregion has been converted to urban and agricultural development.

2.4.4 West Cascades Ecoregion

Within Washington, this mountainous ecoregion extends from Snoqualmie Pass south to the Columbia River and from the Cascade crest west to the Puget lowlands (Figure 2). Elevations mostly range from 1,000 to 7,000 feet while the extremes consist of Mount Rainier at 14,410 feet and the Columbia River Gorge at 50 feet (WADNR 2007).

2.4.4.1 Geology and Topography

The ecoregion is characterized by steep ridges and river valleys in the west, a high plateau in the east, and both active and dormant volcanoes. The isolated volcanic peaks and associated high plateaus extend above surrounding steep mountain ridges which were formed primarily from extrusive volcanic rocks (WADNR 2007). The ecoregion is underlain by Cenozoic volcanics and much of the region has been affected by alpine glaciation.

The ecoregion's basement rocks were eroded to a plain during the Mesozoic, upon which sediments were deposited during the Eocene (WADNR 2012). These sediments are now represented by nonmarine shales, siltstones, and sandstones. Basalt and andesite volcanism of the Cascade arc was initiated during the Eocene and now comprise about 90% of bedrock in the ecoregion. From the Oligocene through Quaternary time, mountain building in the form of volcanism predominated and volcaniclastics, lahars, ash beds, and mud flows from volcanic centers filled depressions in the ecoregion (WADNR 2012). Areas near the volcanoes generally have pumice deposits of variable age, origin, and depth (Franklin and Dyrness 1988). The Cascade Mountains began to be uplifted during the late Miocene and coincident with the uplift, the ancestral Columbia River began to cut a canyon in the same general area as the present Columbia River Gorge (WADNR 2012). About 12 million years ago, the ancient Columbia River canyon experienced deposition of fluvial channel deposits followed by intra-canyon flows of Columbia River basalt (WADNR 2012). This very fluid lava flowed through the ancestral Columbia River gorge and reached the Pacific Ocean. During the Quaternary, gigantic landslides and cataclysmic floods, which resulted from breaches of lakes dammed by continental glaciers in the upper Columbia Basin (i.e. Spokane or Missoula floods), further eroding the Gorge (WADNR 2012).

Alpine glaciation was widespread in the Pleistocene and the cordilleran ice sheet pushed against the lower flanks of the northwestern portion of the ecoregion (Franklin and Dyrness 1988). Long lakes were formed in many of the lower mountain valleys in this area due to the impoundment of rivers by the cordilleran ice sheet and glaciolacustrine deposits mark their locations (Franklin and Dyrness 1988). The geomorphic templates, soil textures, and drainage patterns resulting from glacial action have a significant effect on contemporary vegetation patterns (Franklin and Dyrness 1988).

2.4.4.2 Climate

The climate of this ecoregion is wet and relatively mild. Average annual precipitation ranges from 55 to 140 inches, mostly falling from October through April as snow in the higher elevations and rain in the lower elevations (WADNR 2007). Like the North Cascades, snowfall ranges from 50 to 75 inches in the lower elevations and gradually increases with elevation to between 400 and 600 inches at 4,000 to 5,500 feet (WRCC 2012). Snowfall often continues until late spring with maximum snow depth occurring in early March where it ranges from 10-25 feet above 3,000 feet (WRCC 2012). Above, 5,000 feet, snow may remain on the ground until early July (WRCC 2012). Middle elevations can have significant snow pack that fluctuates over the winter with rain-on-snow events. Lower elevations accumulate little snow.

Average January maximum temperatures range from 40° F in the lower elevations to 30° F at the 5,500-foot elevation while minimum temperatures range from 30° F in the lower elevations to

20° F in the higher elevations (WRCC 2012). Above 4,000 feet minimum temperatures occasionally drop below freezing in midsummer.

2.4.4.3 Land Cover/Land Use

The ecoregion's moist, temperate climate supports an extensive and highly productive coniferous forest that is intensively managed for timber production. Prior to logging much of this forest was old-growth. Lowland forests are comprised of Douglas-fir and western hemlock. Silver fir, western hemlock, Douglas-fir, and noble fir (*Abies procera*) dominate middle elevation forests (WADNR 2007). Subalpine parklands and mountain hemlock and silver fir forests comprise higher elevation forests. The volcanic peaks support alpine heath, meadows and fell-fields among glaciers and rock (WADNR 2007). Grassy balds and oak woodlands occur in middle to lower elevations. Broadleaf trees and conifers dominate riparian areas. As in the North Cascades ecoregion, the steep topography limits wetland formation to areas affected by past glaciation, along rivers, around lakes and ponds, or groundwater discharge sites. Peatlands and swamps are found in areas of groundwater discharge, on alluvial terraces, and high-elevation basins but are not as abundant as in the Puget Trough. However, the concentration of montane fens around the base of Mount Adams may be the highest in the Washington Cascades. In this area, glaciation scoured volcanic fields leaving till and outwash materials suitable for wetland formation (Hildreth and Fierstein 1995). Natural lakes created by glacial processes are abundant. Marshes and wet meadows are found along riparian zones, beaver dams and associated with depressions. Approximately 2% of the ecoregion has been converted to urban or agricultural use.

3 Natural Heritage Methodology

3.1 Natural Heritage Methodology

[The following summary is primarily extracted from NatureServe's description of natural heritage methodology (http://www.natureserve.org/prodServices/heritagemethodology.jsp). For additional details see NatureServe (2002)]

The Washington Natural Heritage Program employs Natural Heritage Methodology to implement its mandates established by the State Legislature. Natural Heritage Methodology unites the efforts of hundreds of individuals and dozens of institutions on two continents working to advance the knowledge needed to effectively conserve biodiversity. This is accomplished by using standard procedures for gathering, organizing and managing information on biodiversity. Over the past quarter-century, natural heritage methodology has evolved to keep pace with the growth in scientific knowledge and advances in information technologies. Natural heritage methodology provides a rigorous set of procedures for identifying, inventorying, and mapping species and ecosystems of conservation concern; for gathering related information on conservation sites and managed areas; and for setting conservation priorities.

Natural heritage methodology has several basic characteristics:

- It supports a decentralized database network that respects the principle of local custodianship of data.
- It supports the collection and management of data at multiple geographic scales, allowing decisions to be made based on detailed local information, yet within a global context.
- It encompasses both spatial and attribute data, but emphasizes the type of fine-scale mapping required to inform on-the-ground decisions.
- It includes multiple quality control and quality assurance steps to ensure that data products have the reliability needed to inform planning and regulatory actions.
- It incorporates explicit estimates of uncertainty and targets additional inventory work to reduce levels of uncertainty.
- It integrates multiple data types, including: species and ecological communities; collections and other forms of observational data; biological and non-biological data.

The basic units of Natural Heritage methodology are "elements" of biodiversity (e.g., species and ecosystem types). The Natural Heritage network has gathered and organized data on over 84,000 such elements, including animals, plants, fungi, and terrestrial and communities. Scientific names, local and global conservation status, basic biological and ecological characteristics, management requirements, and the location and condition of species populations and community occurrences are among the types of data collected. The information is housed in customized databases that employ sophisticated geographic information systems.

At the core of the methodology is the concept of the element occurrence, the spatial representation of a species or ecological community at a specific location. An element occurrence generally delineates a species population or ecological community patch, and represents the geo-referenced biological feature that is of conservation or management interest. In the context of this project, wetland element occurrences are referred to as Wetlands of High Conservation Value.

Natural Heritage Methodology addresses three essential conservation questions:

- What are the elements of biodiversity (i.e., classification)?
- Where do the various elements occur (e.g., inventory)?
- What needs to be done to protect the individual elements (e.g., conservation planning)?

To answer these questions, natural heritage programs carry out a series of repeated steps. Each time the steps are repeated, the data are refined to give a better picture of biodiversity and of problems and progress in its conservation. The basic steps employed are:

- Develop a list of the elements of biodiversity in a given jurisdiction, focusing on better-known species groups (e.g., vertebrate animals, vascular plants, butterflies, bivalve molluscs), and on the ecological communities present. For this project, that list includes wetland ecosystem types and any rare plant that occurs in a wetland.
- Assess the relative risk of extinction of the elements to determine its biodiversity significance (e.g., conservation status rank) and set initial priorities for detailed inventory and protection.
- Gather information from all available sources for priority elements, focusing on known locations, possible locations, and ecological and management requirements.
- Conduct field inventories for these elements and collect data about their location, condition, and conservation needs.
- Process and manage all the data collected, using standard procedures that will allow compilation and comparison of data across federal, state, and local jurisdictional boundaries.
- Analyze the data with intent to refine previous conclusions about element rarity and risk, location, management needs, and other issues.
- Provide access to data and information products to interested parties so that it can be used to guide conservation, management planning, and other natural resource decision-making.

This project will address most of these steps for wetland and riparian ecosystem elements in western Washington. The following sections provide more detail about the components of Natural Heritage Methodology.

3.2 Elements of Biodiversity

Natural Heritage Programs use a "coarse filter / fine filter" approach to represent the different components of biodiversity in conservation planning. The coarse filter consists of all of the ecosystems (both terrestrial and aquatic) occurring within the state. The fine filter consists of rare species and rare ecosystems that may not be adequately protected via the coarse filter.

The basic assumption of this approach is that by ensuring the conservation of ecosystem types, the conservation of the common species that make up those types can be achieved in an efficient manner. Species and ecosystems that are rare or have very limited distributions warrant their own specific conservation efforts.

The success of this approach is dependent upon several factors, including having a well-developed classification of ecosystems, gaining protection for the full range of variability associated with each ecosystem type, and ensuring that the list of fine filter features includes all species and ecosystems that might not be 'captured' by applying the coarse filter. And of course, conservation efforts, if they are to be successful, must account for the various ecological processes that influence species and ecosystems.

3.2.1 Species

The Washington Natural Heritage Program primarily focuses on rare plant species. WNHP does have a zoologist on staff and maintains information on some animal species but the Washington Department of Fish and Wildlife distributes most of the location information on animal species in Washington. As such, the following discussion is focused on rare plants.

Although all species are elements of biodiversity, for the purpose of setting fine-filter, species conservation priorities WNHP only focuses on rare species. Determining which of Washington's plant species are rare is based upon the accumulation of a large body of information about the distribution and abundance of individual species. Formal scientific study of our flora began with the earliest European explorers. Botanists continued to add to the body of knowledge by providing plant specimens to local, regional, and national herbaria. In the last few decades, more intensive field inventories have contributed to an even greater understanding of the Washington flora, providing the foundation for knowing which species are rare and which are common (Camp and Gamon 2011).

C. Leo Hitchcock, professor of botany and herbarium curator at the University of Washington, compiled one of the first lists of Washington's rare species. In 1974 the Smithsonian Institution organized a workshop to identify species to be considered under the newly enacted Endangered Species Act (Camp and Gamon 2011). Hitchcock's list and input from another University of Washington botany professor, Arthur Kruckeberg, resulted in 86 Washington plant species being included in *Endangered and Threatened Plants of the United States* (Ayensu and DeFilipps 1978). In 1977, Melinda Denton, another University of Washington botany professor, led a group of botanists in refining Hitchcock's list. This list resulted in a total of 280 species that became the first "working list of rare plants" used by the newly established Washington Natural Heritage Program (Camp and Gamon 2011).

WNHP continues to evaluate the conservation status of plant species and reviews the list of rare plants every two years. Additions, deletions, and changes in status reflect the dynamic nature of the landscape, human land-use practices, and increasing knowledge of the flora. Currently over 300 vascular plants, six mosses and one lichen species have been categorized as Endangered, Threatened, Sensitive, or Possibly Extinct/Extirpated.

3.2.2 Ecosystems

In order to assign conservation priorities to ecosystems, a standardized list of all ecosystem types needs to be developed. However, the term 'ecosystem' is a conceptual term that characterizes areas that vary in size from an individual stand of trees to large landscapes. In order to better understand the diversity of ecosystems, ecologists have developed various ecosystem classification systems. Classification results in a reasonably definitive list of ecosystem types, and a common language to refer to those types, which then allows the setting of priorities necessary for conservation planning.

The Natural Area Preserves Act (Section 79.70 R.C.W.) mandates the development and maintenance of a "classification of natural heritage resources" by WNHP. Since its establishment, WNHP has worked to develop the classification of ecosystem types by compiling and updating existing classifications of native ecosystems in the state. Where classifications did not exist, WNHP has worked to develop new ones.

The Natural Heritage Program uses several classification systems which vary somewhat according to specific ecosystem types or project objectives:

- **Marine and estuarine classification** - Developed by Dr. Megan Dethier in 1990, this classification defines marine ecosystems based on depth, substrate, wave energy and the plant and animal species associated with the combination of habitat variables.
- **Wetland natural community classification** - Developed by Linda Kunze over 20 years ago, this classification defines ecosystems based on geomorphic province, hydrology, water chemistry, soils and vegetation. Plant associations are components of the wetland natural community types.
- **U.S. National Vegetation Classification** - Developed by NatureServe and its partners, including WNHP ecologists, this classification is a hierarchical system with physiognomic classes in the higher (coarser) levels and composition-based alliances and plant associations at the lowest (finest) levels (see Section 6.1.7). The USNVC is used to definite terrestrial ecosystem types, both upland and wetland (see Crawford et al. 2009 for an application of the USNVC).
- **Ecological Systems** – Developed by NatureServe (Comer et al. 2003), this classification reflects recurring groups of terrestrial plant communities that are found in similar climatic and physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. The classification facilitates mapping at meso-scales (1:24,000 – 1:100,000; Comer and Schulz 2007) and a comprehensive ecological systems map exists for Washington State (www.landscope.org or http://www.natureserve.org/getData/USecologyData.jsp). WNHP employs this classification for mapping, landscape-scale conservation planning, and as the basis for development of landscape- and site-scale ecological integrity assessments (see Section 4.2).
- **Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington** – this is a new classification schemed described for the first time in this document (see section 6.2). This classification uses the USNVC as the basis but establishes an additional unit in the hierarchy (between Groups and Plant Associations). This unit is essentially a refinement of WNHP's current Natural Community types (see Section 6.1.5).

3.3 Element Conservation Status Rank

The Conservation Status Rank, which is an integral part of Natural Heritage Methodology, indicates the conservation significance of an element and is used to assist in determining conservation priorities (NatureServe 2002; Master et al. 2009; http://www.natureserve.org/explorer/ranking.htm). The method used to assign a Conservation Status Rank facilitates a quick assessment of an element's rarity or risk of extinction. The conservation status of a species or ecosystem is designated by a number from 1 to 5, preceded by a letter reflecting the appropriate geographic scale of the assessment (G = Global and S = State or Subnational). The Global rank characterizes the relative rarity or endangerment of the element across its entire global range whereas the Subnational rank characterizes the relative rarity or endangerment within a subnational unit (in our case, the State of Washington.)

A G1 rank indicates critical imperilment on a global basis; the species (or ecosystem) is at great risk of extinction. S1 indicates critical imperilment within a particular state or province, regardless of its status elsewhere. Conversely, a G5 or S5 indicates that an element is demonstrably secure, widespread, and abundant throughout its global or state range.

Uncertainty in the Conservation Status Rank is expressed as a Range Rank. For example, G2G3 indicates a range of uncertainty such that there is a roughly equal chance of it being a G2 or G3 and that other ranks are less likely. A rank of GU or SU indicates that a rank is unable to be assigned due to a lack of information or due to conflicting information about status or trends. When the taxonomic distinctiveness of an element is questionable, it is given a modifier of "Q" in combination with a standard numerical G rank. For example G3Q, indicates that the element is considered globally vulnerable but that there is uncertainty about the taxonomic status of the element.

The ranks have the following meaning:

- **G1 or S1** = Critically imperiled throughout its global or state range because of extreme rarity or other factors making it especially vulnerable to extirpation. (Typically 5 or fewer occurrences or very few remaining individuals or acres)
- **G2** or **S2** = Imperiled throughout its global or state range because of rarity or other factors making it very vulnerable to extirpation from the state. (Typically 6 to 20 occurrences or few remaining individuals or acres)
- **G3 or S3** = Rare or uncommon throughout its global or state range. (Typically 21 to 100 occurrences)
- **G4 or S4** = Widespread, abundant, and apparently secure throughout its global or state range, with many occurrences, but the taxon is of long-term concern. (Usually more than 100 occurrences)
- **G5 or S5** = Demonstrably widespread, abundant, and secure throughout its global or state range; believed to be ineradicable under present conditions.
- **GU** or **SU =** Unrankable due to lack of information or due to substantially conflicting information about status or trends.
- **GH** or **SH** = Historical occurrences only are known, perhaps not verified in the past 20 years, but the taxon is suspected to still exist throughout its global or state range.
- **GNR** or **G?** or **SNR** or **S?** = Not yet ranked. Sufficient time and effort have not yet been devoted to ranking of this taxon.
- **GX or SX** = Believed to be extirpated throughout its global or state range with little likelihood that it will be rediscovered.

Global ranks are assigned through a collaborative process involving both NatureServe and individual Natural Heritage Program scientists. Subnational ranks are assigned by state or provincial scientists with the proviso that subnational rank cannot be rarer than indicated by the global rank. WNHP scientists have responsibility for assigning Washington's State ranks. A number of factors, such as the total range, the number of occurrences, severity of threats, and resilience contribute to the assignment of global and state ranks.

Natural Heritage scientists apply their field experience along with herbarium records, plot data, and published research to assign a G/S rank. Recently, NatureServe developed a Microsoft Excel-based calculator for systematically assigning Conservation Status Ranks (Faber-Langendoen et al. 2009b) which has improved repeatability and standardization of factors used to assign conservation status ranks.

3.3.1 Conservation Status of Rare Plants

WNHP utilizes the G/S ranks to inform a designation of Endangered, Threatened, or Sensitive status for plant species. In addition to G/S ranks, other factors are sometimes considered, including whether the species is suspected of being more widespread than the data indicate, whether the distribution pattern indicates more, or less, concern (e.g., local endemic vs. peripheral), whether there are significant demographic issues, and if habitat issues or concerns exist. Consideration of these other factors results in there being some overlap in these categories (Table 2). Such cases are determined by the judgment of WNHP's rare plant botanist with input from appropriate experts.

As mentioned previously, any occurrence (e.g. population) of an Endangered, Threatened, or Sensitive plant within a wetland would trigger that site as a Wetland of High Conservation Value.

3.3.2 Conservation Status of Ecosystem Elements

Global Conservation Status Ranks have not been assigned to 52 of the 272 known wetland or riparian plant associations which occur in western Washington. Similarly, 67 of those 272 plant associations have not been assigned State Conservation Status Ranks. Unassigned Global Ranks were not addressed in this project since that process entails a significant collaborative effort among various State, Provincial, and NatureServe scientists. However, WNHP used the Conservation Status Rank calculator to assign State Ranks to those 67 plant associations currently lacking them and also reviewed State Ranks of an additional 16 associations. Thus, at the end of this project, all known wetland or riparian plant associations will have been assigned a State Rank.

3.4 Element Occurrences

Actual locations of elements, whether they are single organisms, populations, or plant associations, are referred to as element occurrences (NatureServe 2002). The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of Natural Heritage Methodology. Because one of the primary objectives of WNHP is to prioritize conservation actions, only those element occurrences thought to be the most important for conservation are generally entered into WNHP's database.

An element occurrence is represented spatially (either on maps or in a GIS) by a point (if specific spatial boundaries are unknown) or polygon. An element occurrence is sometimes represented by more than one polygon. Even though two or more polygons may be spatially distinct if they are considered to be ecologically or genetically connected they are considered part of the same element occurrence.

Table 2. Determination of Endangered, Threatened, and Sensitive Status for Plant Species.

Global Conservation Status Rank	State Conservation Status Rank				
	S1	**S2**	**S3**	**S4**	**S5**
G1	G1S1	*	*	*	*
G2	G2S1	G2S2	*	*	*
G3	G3S1	G3S2	G3S3	*	*
G4	G4S1	G4S2	G4S3	G4S4	*
G5	G5S1	G5S2	G5S3	G5S4	G5S5

Legend	
Endangered	**Wetland of High Conservation Value (if plant occurs in a wetland)**
Endangered, Threatened, Sensitive	
Threatened	
Threatened or Sensitive	
Sensitive	
Not of conservation concern	

3.4.1 Rare Plant Element Occurrences
Known locations of any plant species considered to be Endangered, Threatened, or Sensitive are entered in WNHP's BIOTICS database as an element occurrence as such information becomes available. The locations of rare plants are obtained from a variety of sources including herbarium records, private consultants, government agency scientists, citizen scientists, and field inventory by WNHP staff.

3.4.2 Ecosystem Element Occurrences
Ecosystem element occurrences are prioritized for inclusion in WNHP's BIOTICS database based on a combination of the ecosystem element's G/S rank and the occurrence's ecological integrity rank (see Section 3.5.2). A decision matrix is used to determine whether a site-specific occurrence of a wetland plant association qualifies as an element occurrence and thus a "Wetland of High Conservation Value" (Table 3). Basically, all occurrences of rare wetland types, regardless of their condition, are considered element occurrences or Wetlands of High Conservation Value, while for more common wetland types only those in good to excellent condition are considered element occurrences.

3.5 Element Occurrence Ranks (Ecological Integrity Assessment Rank)
To assist in prioritizing element occurrences of a given species or ecosystem for conservation, an element occurrence rank (EO rank) is assigned according to the ecological viability (species) or integrity (ecosystem) of the occurrence (NatureServe 2002). This Element Occurrence Rank is intended to indicate which occurrences are ecologically the most viable (i.e. ecologically intact), thus focusing conservation efforts where they will be most successful.

Table 3. Decision Matrix to Determine Ecosystem Element Occurrences

Conservation Status Ranks		Ecological Integrity Assessment Rank			
Global Rank	State Rank	A Excellent integrity	B Good Integrity	C Fair integrity	D Poor integrity
G1/G2/GU	S1/S2				
G3/GU	S1/S2/S3				
G4/G5/GU	S1/S2				
G4/G5/GU	S3/S4/S5				
Red Shading = Element Occurrence/Wetland of High Conservation Value					

Generally speaking, EO ranks consider the following factors:

- **Size** – a measure of the area or abundance of the occurrence, relative to other known, and/or presumed viable, examples. Factors such as area of occupancy, population abundance, population density, population fluctuation, and minimum dynamic area (area needed to ensure survival or re-establishment after natural disturbance) are considered.
- **Condition/Quality** – an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence. Includes factors such as reproduction, age structure, biological composition, structure, ecological processes, and biotic interactions.
- **Landscape Context** – an integrated measure of fragmentation, land use, and condition of the landscape surrounding and element occurrence to the extent that they may impact ecological processes or disturbance regimes and connectivity. Connectivity includes such factors as a species having access to habitats and resources needed for life cycle completion, fragmentation of ecological associations and systems, and the ability of the species to respond to environmental change through dispersal, migration, or re-colonization.

Each of these factors is rated on a scale of A through D, with an "A" rank representing excellent viability/integrity and a "D" rank representing poor viability/integrity. These ranks are then averaged to determine an overall EO Rank for the occurrence (also rated on the A-D scale). If not enough information is available to rank an element occurrence, an EO Rank of "E" is assigned.

Due to varying factors associated with species viability versus ecosystem integrity, different methodologies have been developed for assigning EO ranks to species and ecosystems.

3.5.1 Rare Plant Element Occurrence Rank

All occurrences of endangered, threatened and sensitive plant species are entered into the WNHP's database. As such, EO Ranks have not had widespread use in Washington for rare plant occurrences. Those occurrences which are extant are used in the process of identifying Wetlands of High Conservation Value.

3.5.2 Ecosystem Element Occurrence Rank (=Ecological Integrity Rank)

An ecosystem element occurrence is assigned an EO rank according to the integrity of the ecosystem's composition, structure, and ecological function relative to its natural range of variability. In the past, the method used to assign EO ranks was based on a guided, best professional judgment approach, where Natural Heritage ecologists applied their field experience along with data they collected or located in published research to assign the rank (NatureServe 2002). In 2004, NatureServe formed the Ecological Integrity Assessment Workgroup to develop a more transparent and standardized approach for assigning EO Rank. That approach is called an Ecological Integrity Assessment (EIA).

The EIA is scaled both in terms of the scale of ecosystem type being assessed and the level of information required to conduct the assessment (Faber-Langendoen et al. 2006, 2008; Rocchio and Crawford 2011). WNHP has developed EIAs for nearly all Ecological Systems in Washington (WNHP 2010; http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html). The EIA was used for this project to determine ecological condition of sites visited during field work. The EIA is described in more detail in Section 4.

3.6 Determination of Wetland of High Conservation Value Status

This section describes the methods used to identify the locations of wetland conservation priorities in western Washington, hereafter referred to as "Wetlands of High Conservation Value." The Wetlands of High Conservation Value concept was developed for use in the Washington Department of Ecology's Wetland Rating System (Hruby 1993; 2004a,b). Originally called a Natural Heritage Wetland, the latest update to the Wetland Rating System changed the name to Wetlands of Conservation Value (Hruby 2014a,b). Wetlands of Conservation Value are defined as wetlands that "have been identified by the Washington Natural Heritage Program at the Department of Natural Resources (DNR) as either high quality undisturbed wetlands or wetlands that support rare or sensitive plant populations or rare plant communities." Essentially, if a rare plant or wetland element occurrence currently documented in WNHP's database is located within the bounds of a wetland being assessed by the Wetland Rating System, that wetland would be considered a Wetland of High Conservation Value.

3.6.1 Using Sensitive Plant Species to Designate Wetlands of High Conservation Value

3.6.1.1 Past Approach

In the past, WNHP assigned rare plant species (i.e., Endangered, Threatened, or Sensitive) a 'W' if the plant was thought to be a wetland species. Element occurrences of these rare 'wetland' plants were considered a Wetland of High Conservation Value. However, the subjective determination (or even use of wetland indicator status of OBL, FACW, etc.) of a rare plant being a 'wetland' species raised concerns that even if a rare plant has a low probability of occurring in a wetland, whenever it does, that wetland should be considered a Wetland of High Conservation Value. Consequently, the process for using rare plants for designating Wetlands of High Conservation Value was reevaluated, in consultation with Washington Department of Ecology, for this project.

3.6.1.2 New Approach

The new approach, agreed to by WNHP/DNR, Washington Department of Ecology, and U.S. Environmental Protection Agency, is to consider any occurrence of a rare plant that occurs within a wetland (regardless of its overall probability of occurring in a wetland) as being worthy of the Wetland of High Conservation Value designation. This approach alleviated the need to make subjective determination of whether a rare plant is a "wetland" species. However, since WNHP does not conduct wetland delineations when rare plant occurrences are documented, the approach also limits the ability to identify which rare plant element occurrences in WNHP's database are Wetlands of High Conservation Value until wetland determinations have been made on the ground. Instead, project proponents using the Washington Wetland Rating System will need to overlay WNHP's GIS dataset (or contact WNHP) to determine whether any rare plant occurrences falls within the bounds of any wetland identified in their project area. If a rare plant currently documented in WNHP's information system does occur in such a wetland, that wetland is considered to be a Wetland of High Conservation Value, per the guidelines of the Washington Wetland Rating System (Hruby 2014a,b). In cases where a new occurrence (i.e. not currently documented in WNHP's information system) of a state listed Endangered, Threatened or Sensitive species is identified by a qualified consultant or surveyor the protocols described in section 3.6.3 will be followed. Specific guidelines on this new approach are also included in the recent update of the Wetland Rating System (Hruby 2014a,b).

3.6.2 Using Ecosystem Elements to Designate Wetlands of High Conservation Value

As noted in Section 3.4.2, determination of Wetlands of High Conservation Value based on ecosystem element occurrences is based on a combination of their G/S rank and the occurrence's ecological integrity rank. Currently, Plant Associations are the ecosystem elements used to identify Wetlands of High Conservation Value.A decision matrix is used to determine whether a particular wetland ecosystem site qualifies as an element occurrence and thus a "Wetland of High Conservation Value" (Table 3). Basically, any ecological condition (e.g., ecological integrity assessment rank) of an extremely rare type (G1/G2 and S1/S2) or a high-quality (e.g. A Rank) example of a common type (G5) would qualify an ecosystem element to be considered an element occurrence or 'Wetland of High Conservation Value'. (See 3.4.2; Table 3)

3.6.3 Proposing New Wetlands of High Conservation Value to Washington Natural Heritage Program

Because WNHP has not been able to survey every wetland on the landscape, it is very likely there are yet to be documented Wetland of High Conservation Value to be found. Thus, the list of Wetlands of High Conservation Value is not static and changes as WNHP collects or receives new information. In situations where a new occurrence of a rare plant or rare or high-quality ecosystem is encountered but does not currently exist in WNHP's information system, then the information can be submitted to WNHP for possible inclusion in WNHP's database. In the past, if such an element was encountered but not in WNHP's database it couldn't be considered a Wetland of High Conservation Value. Recognizing this could result in many significant wetlands for conservation being miscategorized, WNHP and Washington Department of Ecology outlined a process which provides an opportunity for WNHP to review data as it is submitted by consultants, agency personnel, etc. The following guidelines will be used for such data:

1. WNHP will have 30 days to review submitted data and determine its reliability (e.g., the technical expertise of the individual who made the observation) and level of detail is sufficient for determining if the observation should be incorporated into WNHP's database.

2. If deemed reliable and containing sufficient information, WNHP will approve the data for inclusion into their database.

3. If WNHP does not have the capacity or time to respond within 30 days the wetland cannot be considered a WHCV within the context of the Wetland Rating System.

This process addresses WNHP's desire to gather more information concerning the location of rare/high-quality ecological communities and WDOE's need for a systematic quality control process before any such data be considered a Wetland of High Conservation Value.

Thus, if a rare plant species, rare plant association, or high-quality common plant association is encountered but is not currently documented in the WNHP's database, relevant information can be submitted to WNHP for consideration. Information required for documenting a new rare plant location can be found here: http://www.dnr.wa.gov/Publications/amp_nh_sighting_form.pdf. Necessary information about wetland plant communities includes the classification of the plant community and its current quality or integrity. Appendix A of this document contains the updated list of plant associations found in western Washington wetlands and riparian areas. WNHP will be completing a field guide and key to these types in the near future (expected late 2014/2015). Similar products will be completed for eastern Washington but are not yet available. Please periodically check WNHP's publication website for the availability of these resources (http://www1.dnr.wa.gov/nhp/refdesk/communities.html). To document current ecological integrity, WNHP recommends using the appropriate Ecological Integrity Assessment (EIA; http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html). Additionally, WNHP will be offering training courses to assist users in the application of the classification and EIA in 2015/2016. Upon completion of these products and training, WNHP would request that users submit the classification of the plant community and its associated EIA score (which indicates its quality) in order to provide WNHP staff the necessary information to make a conclusion about the designation of the site as a Wetland with High Conservation Value. Until those products are available, plot data with a relatively comprehensive species list and associated cover values and any information pertaining to the condition of the plant community relative to minimally disturbed conditions are needed for WNHP staff to determine if the site meets WHCV criteria.

4 Ecological Integrity Assessment Methods

4.1 Introduction

To assist in the analysis conducted for this project, two ecological condition assessment tools were developed: (1) Ecological Integrity Assessment scorecards and (2) Floristic Quality Assessment.

In conjunction with another project funded by the Washington Department of Fish and Wildlife, WNHP completed the development of Ecological Integrity Assessment (EIA) scorecards for the wetland and riparian ecosystem types found in western Washington (Rocchio and Crawford 2009; WNHP 2010). A description of the EIA is provided below.

4.2 Ecological Integrity Assessment Methods

As mentioned in Section 3.5.2, EO Ranks for ecosystems elements were assigned in the past using a best professional judgment approach (NatureServe 2002). The majority of EO ranks for ecological elements in WNHP's BIOTICS database are based on this approach. In 2004, NatureServe formed the Ecological Integrity Assessment Workgroup to develop a more transparent and standardized approach for assigning EO Ranks called the Ecological Integrity Assessment (EIA). WNHP has adopted the new EIA approach for assigning EO Ranks. Level 1 and Level 2 EIAs were used in this project for a variety of objectives but most importantly for updating or assigning EO Ranks to Wetlands of High Conservation Value surveyed for this project. An overview of EIA methods is described below. For additional details, please see Faber-Langendoen et al. (2006, 2008, 2009a) and Rocchio and Crawford (2011).

4.2.1 Introduction

Indicator-based approaches to assessing and reporting on ecological integrity (Harwell et al. 1999, Young and Sanzone 2002, USEPA 2002) are now being used by numerous organizations to assist with regulatory decisions (USACE 2003, 2005, 2006), to set mitigation performance standards, and to set conservation priorities (Faber-Langendoen et al. 2006, 2008).

NatureServe and the Natural Heritage Network have recently developed an approach for assessing ecological condition that is scaled both in terms of the scale of the target ecosystem type and the level of information required to conduct the assessment. This method is called the Ecological Integrity Assessment (Faber-Langendoen et al. 2006, 2008, 2009a) and is now being implemented for a variety of small- and large-scale projects (Rocchio and Crawford 2009, Lemly and Rocchio 2009, Tierney et al. 2009, Faber-Langendoen et al. 2012; Vance et al. 2012). WNHP has developed EIAs for nearly all Ecological Systems in Washington (WNHP 2010; http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html).

4.2.2 EIA Approach to Assessing Ecological Condition

The Ecological Integrity Assessment method (EIA) aims to measure the ecological integrity of a site through a standardized and repeatable assessment of current ecological conditions relative to what is expected within the bounds of natural variation for any given ecological system. The purpose of assigning an index of ecological integrity is to provide a succinct assessment of the current status of the composition, structure and function of occurrences of a particular ecosystem type and to give a general sense of conservation value, management effects, restoration success, etc. The EIA aims to standardize expert opinion and existing data up front so that a single, qualified ecologist could apply the EIA in a rapid manner to get an estimate of a site's ecological integrity. The EIA can improve an understanding of current ecological conditions which can lead to more effective and efficient use of available resources for ecosystem protection, management, and restoration efforts.

The EIA is a multi-metric index designed to document degradation of key biotic and abiotic attributes along a continuum from reference standard to highly degraded. The EIA approach is similar to that of the Index of Biotic Integrity (IBI; Karr and Chu 1999). The EIA is intended to measure current ecological condition as compared to the reference standard via measures of biotic and abiotic condition, size, and landscape context (Harwell et al. 1999, Andreasen et al. 2001, Parrish et al. 2003). Each metric is rated by comparing measured values with values expected under relatively unimpaired (reference standard) conditions, and the ratings are aggregated into a total score. The EIA uses a scorecard matrix to communicate the results of the assessment. A rating or score for individual metrics, as well as an overall index of ecological integrity are presented in the scorecard.

The EIA can be applied to multiple spatial scales (e.g., landscape or site-scale) and with a variety of data types (e.g., GIS or field-based). The EIAs are developed using a three level approach, including Level 1 (remote sensing), Level 2 (rapid ground-based), and Level 3 (intensive ground-based) metrics (USEPA 2006). This three-level approach provides a hierarchical, spatially integrated framework for monitoring and assessment resulting in effective strategies and efficient use of resources (USEPA 2006). In summary, the EIA framework provides a standardized currency of ecosystem integrity across all terrestrial ecosystem types.

4.2.3 Level 1 Ecological Integrity Assessment

4.2.3.1 Level 1 EIA Development

Level 1 EIAs are based primarily on metrics derived from remote sensing imagery. The goal is to develop metrics that assess the landscape context and the on-site conditions of an ecosystem. Satellite imagery and aerial photos are the most common sources of information for these assessments. Typically it is the stressors associated with the degradation of ecological integrity that are most observable with these sources of information, which often results in a Level 1 EIA being heavily focused on stressor-based metrics.

The Level 1 EIA developed and used for this project is an overall index that aggregates four metrics characterizing ecological integrity of the buffer and surrounding landscape of a particular wetland. No metrics were used to assess Size or Condition of the wetland. Thus, it is a direct assessment of the buffer and landscape context which are used as surrogate measures (or predictors) of on-site condition of a given wetland.

NatureServe has developed an automated approach to assessing buffer and landscape context metrics using GIS (Lyons 2009). This method was modified for use in this project (Appendix D). The method was applied to all known Wetlands of High Conservation Value and a subset of polygons contained within the National Wetland Inventory (NWI) maps (only vegetated Lacustrine and Palustrine polygons were targeted). Below is a summary of how the Level 1 EIA was employed to arrive at an EIA score/rank for a given wetland polygon.

NatureServe's Ecological Systems map (NatureServe 2012) served as the base layer from which metric calculations were derived. Each land cover unit found in the Ecological Systems map was categorized as either 'natural' or 'non-natural' land cover type (see Appendix D). In addition, all 'natural' land cover types were assigned a coefficient or weight of "1.0" while non-natural land cover weights were assigned a coefficient according to their perceived impact on ecological integrity, with low scores being assigned to those with the greatest impact (see Appendix D). The land cover designations and land use weights were then used to calculate four metric scores which are shown in Table 4. Each metric score ranged from 0.0 – 1.0. The metric scores were then plugged into a weight-based algorithm to calculate an overall Level 1 score for a given polygon (Table 4). This overall score was converted into letter and numeric Level 1 EIA ranks (i.e. A = 5; B=4; C=3; D=1). The conversion from raw metric score to Level 1 EIA score/rank is shown in Table 5. The Level 1 EIA ranks were then appended to the Wetland of High Conservation Value and National Wetland Inventory map GIS layers. The end result is that every Wetland of High Conservation Value and every vegetated Lacustrine and Palustrine NWI polygon in western Washington was assigned a Level 1 EIA score/rank.

4.2.3.2 Use of Level 1 EIA

The Level 1 EIA results were used for multiple purposes in this project.

- Level 1 EIA ranks of National Wetland Inventory polygons were used to assist in prioritizing field work for this project (see Section 5.1)
- Level 1 EIA ranks of National Wetland Inventory polygons were used to identify potential Wetlands of High Conservation Value (see Section 10).
- Level 1 EIA ranks of National Wetland Inventory polygons can also be used as a cursory assessment of ecological integrity of each polygon. Such data can be used for a variety of purposes such as landscape planning, incorporated into ambient monitoring protocols, etc. However, see Section 11.3.3 concerning Level 1 EIA accuracy.

4.2.4 Level 2 Ecological Integrity Assessments

The intent of rapid assessment methods, such as a Level 2 EIA, is to evaluate the ecological condition of a selected ecosystem using a specific set of observable field indicators or metrics. Level 2 EIAs rely primarily on relatively rapid (~2- 4 hour) field-based site visits in order to conduct direct, ground based surveys of ecosystem occurrences (Faber-Langendoen et al. 2008). The Level 2 EIA scorecard is then used to convey the relative integrity of a particular occurrence in a manner that informs decision-making, whether for restoration, mitigation, conservation planning, or other ecosystem management goals (Stein et al. 2009). The Washington Natural Heritage Program has developed EIAs specific to Washington's wetland and riparian ecosystems (WNHP 2010). These Washington-specific EIAs were used to rapidly assess the ecological integrity of wetlands visited during this project. The metrics and rating criteria used in the Level 2 EIA assessments can be found in the individual EIA documents located here: http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html

Level 2 EIAs were used in this project to assess on-the-ground ecological integrity of known and potential Wetlands of High Conservation Value that were visited. The bounded area to which the Level 2 EIA was applied equaled the spatial boundary of the targeted Wetland of High Conservation Value.

Table 4. Level 1 EIA Metrics Used for This Project

Level 1 EIA Metric	**Calculation**	**Range of Score**
LANDSCAPE CONTEXT		
Connectivity (up to 500 meters beyond wetland)		
M1 - *Connectivity: % Natural Land Cover (NLC) within 500 meters of wetland*	= (0.5(%NLC 50m buffer))+(0.3(%NLC 50-250m))+(0.2(%NLC 250-500m buffer))	**0.0 – 1.0**
Surrounding Land Use Index		
M2 - *Surrounding Land Use: Average Land Use Score (LU) for 50-500 meters within wetland*	= (0.65(Avg. LU 50-250m))+(0.35(Avg. LU 250-500M)	**0.0 – 1.0**
Buffer (within 50 meter of wetland)		
M3 - *Buffer Length (% of buffer with natural land cover)*	= % NLC abutting wetland polygon	**0.0 – 1.0**
M4 - *Buffer Condition (land use score within 50 meters of wetland)*	= Avg. LU 50m	**0.0 – 1.0**
SIZE		
No metric used		n/a
CONDITION		
No metric used		n/a
Overall Level 1 EIA Score = (M1*0.25)+(M2*0.25)+((0.5*((M3+M4)/2)))		**0.0 – 1.0**

Table 5. Conversion of Level 1 Raw Values to EIA Ranks

EIA Raw Value	EIA Score	EIA Letter Rank	Ecological Conditions
1.0 to 0.9	5	A	Excellent integrity; relatively intact; almost all natural land cover with minimal stressors
0.89 to 0.60	4	B	Good integrity; mostly natural land cover; some low-impact land uses
0.59 to 0.20	3	C	Fair integrity; about equal natural/non-natural land cover; moderate intensity land uses
<0.20	1	D	Poor integrity; almost all non-natural land cover; high intensity land uses

5 Field Methods

This section provides an overview of the field methods applied for this project. These methods informed analysis conducted for much of the content of Sections 6-12. Additional methods used to answer questions associated with the characterization of wetland conservation priorities (see Section 1.1) are discussed in their respective sections of this document (i.e., Sections 6-12.)

5.1 Prioritizing Field Surveys of Known Plant Association-based Wetlands of High Conservation Value

The objective of field-based data collection was to update classification and ecological integrity characteristics of known Plant Association-based Wetlands of High Conservation Value and to survey for additional wetlands that might meet criteria for Wetlands of High Conservation Value (see next section).

There are 718 (562 freshwater wetlands--and 158 tidal salt marsh) wetland Plant Association-based WHCV documented in WNHP's BIOTICS database. The 718 WHCV are located at 300 unique sites. [Note: Wetlands of High Conservation Value are what WNHP refers to as 'element occurrences' (EOs; see Section 3.4). Because more than one EO can occur within the boudnaries of a single wetland, it follows that more than one WHCV could be found at a single wetland or site.] Because the number of EOs exceeded what was possible to sample with available funding, it was necessary to prioritize field work.

The selection of targeted samples sites was implemented using the following process:

- Salt/brackish marsh and transition wetland WHCV were not targeted for field work but are included in other analyses.
- A Level 1 EIA of all existing WHCV was conducted (described in Section 4.2.3)
- Based on the Level 1 EIA analysis, the WHCV were split into two possible sample site groups: (1) those with the lowest quality (e.g., C or D rank) Level 1 EIA Rank and (2) those with the highest quality (e.g., A rank) Level 1 EIA rank. Low quality sites were targeted due to the assumption that they may be most likely to have degraded even further and thus may no longer meet WHCV criteria. High quality sites were selected to determine the degree to which the "best" remaining wetlands have remained intact since they were last assessed.
- An approximate equal number of sites per wetland type (approximately five per type) were selected from the Low and High Quality WHCV groups--these were subjectively chosen with an intended bias of capturing a diversity of plant association types across each ecoregion.

This process resulted in approximately 100 known WHCV to target for Phase 1 field surveys and approximately 134 for Phase 2 field surveys (Table 16).

5.2 Prioritizing Field Surveys for Undocumented Wetlands of High Conservation Value.

Another objective of this project was to identify undocumented Wetlands of High Conservation Value. The process used to identify potential WHCV sites was as follows:

- Field work conducted in the 1980s/1990s was prioritized based on a meticulous review of aerial photographs (Kunze's work). Wetlands observed on aerial photography were circled on a map and color coded according to survey priority. Wetlands surrounded by more intact buffers and embedded in more intact landscapes were given higher priority. For this project, these maps were digitized in ArcGIS and then intersected with known locations of Wetlands of High Conservation Value. Data were not available to know whether sites that did not overlap with WHCV were visited but then dropped from consideration or if they were simply not visited. Thus, those sites not overlapping with WHCV were assumed to not have been visited. Of the latter sites, only those categorized by Kunze as being high priority were selected as possible sample sites.

- The Kunze high priority sites were intersected with National Wetland Inventory Level 1 EIA "A" ranked sites. The assumption was that when Kunze originally identified the high priority sites it was because they were embedded in a relatively intact landscape. If they overlapped with a NWI wetland having a Level 1 A rank (which indicate the landscape around those sites remains relatively intact), then they remained high priorities for field surveys.

- For Phase 2, additional sites were selected based on data gaps and information needs for montane fens and rare wetlands associated with geothermal springs. Data sources for the former were mostly derived from Dewey (2011) and data for the latter were extracted from a database of geothermal springs developed by Washington Department of Natural Resources' Geology Division.

This process resulted in 25 wetlands to target for Phase 1 field surveys and 76 for Phase 2 field surveys (Table 16).

5.3 Office Preparations

Numerous tasks preceded field work, including

- gathering and photocopying existing data about known Wetlands of High Conservation Value from WNHP's general manual file;
- printing hard copy field maps for each targeted field site,
- contacting landowners to request permission to access private lands,
- scheduling field visits with public agency biologists and/or managers
- researching current and past land use
- conducting literature search for existing ecological data

5.4 Mobile Data Collection and Field Forms

Field data were collected electronically using an Ashtech MobileMapper 10. Field forms previously developed for the EIA, Washington Wetland Rating System, and Stressor Checklist were converted to digital versions using ArcPad Studio. These forms are employed via ArcPad on the MobileMapper 10 units, resulting in a georeferenced data point attributed with the data associated with each form. A PocketExcel spreadsheet was developed for collecting vegetation plot data on the MobileMapper 10 units. The field forms upon which the EIA, Stressor Checklist,

Table 6. General Site and Environmental Data Collected At Each Sample Site

Attribute	Comment	Attribute	Comment
Site Name		**Cowardin System/Class**	e.g., Palustrine - Emergent
Date of Visit		**HGM Class/Subclass**	e.g., Depressional - Closed
Observer		**Water Source**	e.g., precipitation, surface water, groundwater, anthropogenic etc.; estimate based on site indicators such as landscape position, vegetation, soil profile, and hydrologic indicators.
County		**Soil Texture**	Of upper 40 cm; used hand-texture method
Owner		**Peat Decomposition**	Predominant stage of peat decomposition in the upper 40 cm: Fibric, hemic, or sapric of upper 40 cm
Township, Range, Section		**Hydrological Regime**	e.g., saturated, permanently flooded, seasonally flooded, etc. based on hydrological and vegetation indicators of site.
GPS Location	Ashetech MobileMapper 10 unit was used to collect a GPS point within ArcPad.	**Soil Drainage**	Estimated based on soil texture, accumulation of organic matter and other soil/hydrology indicators; ranges from very poorly drained, moderately well drained, well drained, etc.
Site Description		**pH of free/soil water**	Measured with a Hanna hand-held pH & EC meter (model HI 98129); taken either from (in order of priority): (1) surface water (pools, water tracks); (2) free water in soil pit; or (3) from water squeezed from soil
Slope (degrees)		**Conductivity of free/soil water**	Measured with a Hanna hand-held pH & EC meter (model HI 98129); taken either from (in order of priority): (1) surface water (pools, water tracks); (2) free water in soil pit; or (3) from water squeezed from soil
Aspect	Compass degrees	**Temperature of free/soil water**	Measured with a Hanna hand-held pH & EC meter (model HI 98129); taken either from (in order of priority): (1) surface water (pools, water tracks); (2) free water in soil pit; or (3) from water squeezed from soil
Elevation	meters	**von Post index**	Scale of peat decomposition assessed via consistency of peat and clarity of water when sample is squeezed in hand; ranges from H1 – H10; H1 = completely undecomposed while H10 = completely

Attribute	Comment	Attribute	Comment
			decomposed
Topographic Position	e.g., toe slope, interfluve, terrace, depression, etc.	**Protection Rank**	Associated with Natural Heritage Methodology; ranges from P1 – P5; P1 indicates immediate protection actions are needed otherwise wetland may be lost. P5 indicates the wetland is adequately protected.
USNC Group/Ecological System	Based on classification outline in Section 6.2	**Management Rank**	Associated with Natural Heritage Methodology; ranges from M1 – M5; M1 indicates management actions are needed immediately or wetland could be lost or severely degraded. M5 indicates not management actions are needed.
Natural Community Type	Based on classification outline in Section 6.2	**Hydrological Dynamics**	Based on MacKenzie and Moran (2004); estimate of hydrodynamics based on field indicators; ranges from stagnant to distinct flooding/drawdown to highly dynamic
Plant Association	Based on classification outline in Section 6.2	**Hummock Height**	Average height in cm. At least 5 hummocks were measured. Note: this measure was only collected for a portion of Phase 2.

and vegetation plot digital forms are based are found in Appendix C. Wetland Rating Forms can be found in Hruby (2004b).

5.5 Field Data Collected

At each site the following types of data were collected:

- General site characteristics
- Vegetation composition and abundance
- Ecological condition data (using Ecological Integrity Assessment; see below)
- Potential performance of wetland functions (Hruby 2004b)
- List of stressors, following NatureServe methodology (Master et al. 2009)

Methods for collecting these data are described below.

5.5.1 General Site Characteristics

Data collected at each sample site are listed in Table 6. Most attributes were universally applicable. A few, such as Peat Decomposition, von Post index, and Hummock Height were only applicable to peatland sites.

5.5.2 Vegetation Data

Vegetation releve plots were established in areas with homogenous vegetation patterns that did not cross significant ecological gradients. Multiple vegetation plots were often collected from a single site. Plot size was 100 m^2 for herbaceous, dwarf shrub, and shrub types and 400 m^2 for forested types. Data collected for each plot included site name, plot ID, soil pH/conductivity/temperature, and plant association names (when known). For undescribed association types, a preliminary name was assigned. Crown cover (in classes) was recorded for all species observed in the plot. Cover of bryophytes was recorded when cover was greater than 1%. Bryophytes growing on logs were excluded from cover estimates. Cover classes were as followed (see Appendix C for plot form example):

> 1: trace 2: 0–1% 3: 1–2% 4: 2–5% 5: 5–10% 6: 10–25% 7: 25–50% 8: 50–75% 9: 75–95% 10: >95%.

Strata and height classes were also assigned to trees and tall shrubs:

> U=understory; C=co-dominant; D=dominant; O=old growth; 1=<0.5m, 2=0.5 -1m, 3=1-2m, 4=2-5m, 5=>5m;

The primary regional source for species identification is Hitchcock and Cronquist (1973). Wilson et al. (2008) was used to identify Carices. For this report, species names identified in Hitchcock were synonymized to the USDA PLANTS name. (March 2011; Rocchio 2013).

5.5.3 Ecological Integrity Assessment Data

A Level 2 EIA was employed for WHCV selected for field assessments. Thus, the EIA rank does not necessarily apply to the entire wetland, rather only the specific Plant Association or Natural Community type being targeted. Protocols for applying the EIA are described in Faber-Langendoen et al. (2009a) and Rocchio and Crawford (2011). These data were entered in the EcoObs (NatureServe's database for storing EIA related data) and WNHP's BIOTICS database.

5.5.4 Ecological Observations for Non-targeted Wetlands

As noted previously, some Wetlands of High Conservation Value were updated using a set of field-based observations rather than EIA data. The sample site selection process often directed field work to sites where more than one WHCV occurred. EIAs were used to update information for those WHCV selected for field sampling while general observations were made about the other WHCV that occurred at the same site. Observations included obvious signs of degradation such as presence of invasive species, alterations to hydrology, indications of excess sediment or nutrients, etc. Species lists were also often collected from these sites. These data were entered in WNHP's BIOTICS database.

5.5.5 Wetland Function Assessment (Wetland Rating System)

The Western Washington Wetland Rating System was used to assess the potential performance of a set of ecological functions. Specifically, the Wetland Rating System is comprised of a Water Quality, Hydrologic, and Habitat Function Score which are integrated into an overall score. The Rating System is applied to a single HGM wetland type. Protocols for applying the Rating System follow Hruby (2004b).

5.5.6 Stressor Data

Documenting stressors or direct threats independently from assessing ecological conditions can provide possible correlations between ecological integrity and specific stressors. Those correlations can assist in management recommendations, restoration actions, and conservation decisions. Stressors are defined as "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes" (Salafsky et al. 2008).

Stressors were documented at each site using NatureServe's Stressor checklist methodology (Master et al. 2009; Appendix C). At each site a predefined list of stressors is used to document the presence, scope, and severity of stressors associated with four categories of stressors: (1) Landscape Stressors; (2) Vegetation Stressors; (3) Soil Stressors; and (4) Hydrology.

Stressors may be characterized in terms of scope and severity. **Scope** is defined as the proportion of the wetland system that can reasonably be expected to be affected by the stressor within 10 years given continuation of current circumstances and trends. **Severity** is the level of damage to the ecosystem from the threat that can reasonably be expected with continuation of current circumstances and trends. For ecosystems, severity is typically assessed by known or inferred degree of degradation or decline in integrity to one or more key ecological attributes and is assessed within a ten-year time-frame.

For each category, stressors were listed if they were observed or inferred to occur, but were not included if they were projected but did not yet occur. The scope and severity of each stressor was then assigned to one of four categories. These ratings were then combined to determine an overall impact of that category using decision matrices (Table 7; Master et al. 2009). Similarly, an overall impact rating can be assessed by aggregating the overall impact rating of the four categories and using the decision matrix to determine an overall impact rating for the site.

For this project, the Stressor Impact Ratings were converted to a numeric score in order to allow for correlation analysis with EIA and Wetland Rating System data (Table 7; Nichols and Faber-

Langendoen 2012). For example, a stressor with 'large' scope and 'serious' severity would get a score of 5. Numeric scores are then summed for all stressors documented in the four categories (i.e., Landscape Stressors, Vegetation Stressors; (3) Soil Stressors; and (4) Hydrology Stressors) to calculate an overall site stressor score.

Table 7. Stressor Impact Ratings and Scores

Threat Impact Calculator		Scope			
		Pervasive	Large	Restricted	Small
Severity	Extreme	Very High=7	High=5	Medium=3	Low=1
	Serious	High=5	High=5	Medium=3	Low=1
	Moderate	Medium=3	Medium=3	Low=1	Low=1
	Slight	Low=1	Low=1	Low=1	Low=1

5.6 Data Storage

Data collected on the Ashtech MobileMapper 10 units were downloaded and stored in a variety of databases which are described below.

5.6.1 Vegetation Plot Database

Vegetation plot data is currently being stored in a Microsoft Excel workbook and will be moved into a Microsoft Access database used to store all of WNHP's plot data. Eventually the data will be stored in EcoObs (NatureServe's database for storing EIA related data).

5.6.2 EIA Database

EIA data is currently being stored in a Microsoft Excel workbook. NatureServe has initiated development of a nationally-standardized Ecological Integrity Assessment (EIA) database that will allow integration of wetland condition data across the United States. WNHP is currently partnering with NatureServe (using funding from EPA Region 10 Wetland Program Development Grant Assistance Agreement No. CD-00J64201-0) to modify the EIA database specifically for Washington State. This database will allow WNHP to store EIA data, calculate EIA metric scores, and produce a site summary of EIA data in a scorecard format. The EIA database will directly support the information currently stored in WNHP's Information System and improve management of data pertinent to identifying wetland conservation priorities.

5.6.3 WNHP's Information System

Most of the collected data are integrated into WNHP's Information System, specifically into the BIOTICS database and as attributes of a GIS file depicting the locations of Wetlands of High Conservation Value. The latter is available on WNHP's website (http://www1.dnr.wa.gov/nhp/refdesk/gis/index.html). In addition, hard copies of site data summaries are stored in WNHP's manual files.

WESTERN WASHINGTON WETLAND CONSERVATION PROFILE

Wetland landscape profiles describe the pattern of diversity, abundance, and spatial distribution of wetlands in a region. As such, they provide a standard for characterizing the resource, assessing the effects of management decisions, and pointing to future actions (Bedford 1996; Gwin et al. 1999; Johnson 2005). For this project, a wetland conservation profile of western Washington was developed as a means of summarizing wetland diversity and conservation significance, current levels of wetland protection and correlations to stressors and wetland functions. The purpose of this profile is to summarize and focus conservation actions to protect biological and ecological diversity associated with wetlands in western Washington.

The following sections discuss numerous analyses describing the various aspects of the Western Washington Wetland Conservation Profile.

Section 6 reviews the types of wetlands found in western Washington (based on a modification of the U.S. National Vegetation Classification). This classification of wetland vegetation provides the foundation upon which further analysis occurs in order to identify and prioritize wetland and riparian conservation priorities for western Washington. **Section 7** discusses the conservation significance of these types. Specifically, the rarity and threat of extinction associated with each type. **Section 8** describes the spatial distribution of Wetlands of Conservation Concern in western Washington. **Section 9** discusses the current level of protection of Wetlands of Conservation Concern and also reviews the protection needs of specific wetland types. **Section 10** reviews the location of wetlands that could potentially meet the criteria for being designated a Wetland of Conservation Concern. The analysis is based on a Level 1 EIA. **Section 11** explores vegetation composition and relationships between ecological integrity, wetland function, and human stressors based on data collected from the sites surveyed during this project. **Section 12** provides a synthesis of the wetland conservation profile for western Washington.

6 Wetland Types of Western Washington

The goal of classifying wetlands is to reduce variability associated with ecological characteristics in order to provide a logical and useful framework for mapping, studying, protecting, restoring, and managing wetlands. Because the reasons for classifying vary, there is no universally correct unit or approach to the classification of ecosystems (Whittaker 1962). Wetland classification (within Washington and elsewhere) has been approached from many different perspectives including water chemistry, geomorphology, water source, nutrient status, landscape position, soil type, vegetation physiognomy, and vegetation composition (USEPA 2002).

This Section will briefly review the most common systems used to classify wetlands in western Washington and then dicuss teh classification scheme used in this project for guiding the determination of wetland conservation priorities in western Washington.

6.1 Existing Wetland Classification Schemes Commonly Used in Washington State

6.1.1. General Wetland Types

Wetlands have been defined in numerous ways. The U.S. Army Corps of Engineers (Corps) has defined a wetland as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." (Environmental Laboratory 1987). The Corps uses this definition for the implementation of a dredge and fill permit system required by Section 404 of the Clean Water Act. From the Corps perspective, in order for an area to be classified as a wetland subject to federal regulations, it must have all three of the following criteria: (1) wetland plants; (2) wetland hydrology; and (3) hydric soils. The U.S. Fish and Wildlife Service (USFWS; Cowardin et al. 1979) define wetlands as "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water." The USFWS definition only requires one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes (wetland plants); (2) the substrate is predominantly undrained hydric soil; and/or (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. WNHP uses the more encompassing USFWS definition to define a 'wetland' ecosystem type.

Riparian areas often lack the characteristics embedded in the wetland definitions discussed above. However, because they are associated with surface and/or subsurface water and generally have distinct vegetation from surrounding uplands, the USFWS developed a definition for these areas (USFWS 2009): "Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland." WNHP uses the USFWS definition but restricts it to lotic water bodies (WNHP considers vegetation associated with most lentic ecosystem types as wetlands).

Using the USFWS definitions as a framework, a general categorization of wetlands found in western Washington is presented below. This is not a formal classification rather simply a grouping based on colloquial or common terms used to describe wetlands across North America. However, these wetlands types are generally distinguished by having unique soils, hydrology, and biotic communities.

Marsh: Marshes are frequently or continually inundated and dominated by emergent, herbaceous vegetation (Mitsch and Gosselink 1993). Water levels typically fluctuate, sometimes significantly, but are usually above the soil surface for much of the growing season. Marshes have mineral soils or if organic then they are typically highly decomposed muck. Marshes are typically nutrient rich. Common species include cattail (*Typha latifolia*), bulrushes (*Schoenoplectus* spp.), sedges (*Carex* spp.), and the nonnative reed canarygrass (*Phalaris arundinacea*). Marshes are found in all the ecoregions within the project area (Figure 2).

Wet Prairie: Within western Washington, wet prairies are a unique wetland type limited to the prairie/oak landscapes found on glacial outwash areas of the Puget Trough and in southwest Washington where Lake Missoula floods left a variety of deposits (Easterly et al. 2005; Wilson 1998). Wet prairies are similar to wet meadows in that they have a seasonally high water table that typically dries by the end of the summer. Wet prairies differ from wet meadows in that wet prairies historically experienced frequent fire resulting in a unique suite of species often not found in other wetland types. Wet prairies (and wet meadows) differ from marshes in that the water table is rarely more than a few inches above the soil surface and their soils often dry by the end of the growing season whereas marshes typically have much greater surface water inundation and, even though water levels often decline by the end of the growing season, their soils typically remain very moist to saturated. In western Washington, wet prairies are concentrated in the prairie landscape of Pierce and Thurston counties, the Upper Chehalis River basin, the Cowlitz River basin, and lowlands of Clark County (Easterly et al. 2005; Storm and Shebitz 2006; Wilson 1998; Figure 2).

Riparian Area: As defined here, riparian wetlands are those areas adjacent to lotic (i.e. moving water) areas such as streams, creeks, and rivers that are seasonally or at least periodically subjected to overbank flooding from the channel. Riparian vegetation varies according to the fluvial surfaces found in the riparian corridor such as gravel bars, sand bars, backwater areas, active floodplain terraces, or high or secondary terraces. Red alder (*Alnus rubra*), black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), Oregon ash (*Fraxinus latifolia*), western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*), and Pacific willow (*Salix lucida* ssp. *lasiandra*) are common species in riparian areas of western Washington. These wetlands are found in all of the ecoregions of the project area (Figure 2).

Swamp: These are wetlands dominated by trees or shrubs that occur in poorly drained environments with slowly moving or stagnant surface water. They most often occur in depressions and around seeps/springs. Swamps often experience seasonal inundation but typically have persistent soil saturation. Swamps are also found in areas of freshwater tidal inundation. Swamps can have mineral or organic soils, with the latter occurring as muck. Swamps typically have high amounts of nutrients. Red alder, Oregon ash, Sitka spruce, western redcedar, western hemlock, and mountain hemlock (*Tsuga mertensiana*) are common overstory species in western Washington swamps. Skunkcabbage (*Lysichiton americanus*) is a common herbaceous species. Nutrient poor forested swamps are found adjacent or in a complex with poor fens and bogs. These swamps are dominated by conifers and typically have an understory of ericaceous shrubs and occasional *Sphagnum* hummocks or patches. Nutrient rich swamps are typically dominated by deciduous trees, mix of conifer/deciduous trees, and shrubs such as *Salix* or *Spiraea*. Swamps are found locally in all of the ecoregions in the project area (Figure 2).

<u>Bogs & Fens</u>: Bogs and fens, collectively called peatlands, differ from other wetlands in having a substrate composed of relatively undecomposed organic material or peat. Most peatlands are persistently saturated and consequently are able to accumulate relatively thick layers of peat. The origin of the peat can be *Sphagnum* moss, *Hypnum* ssp., 'brown' mosses, sedges, or woody species. Peatlands are described with varied, confusing, and inconsistent terminology. Often the term "bog" is used in a colloquial sense to describe any peatland. However, there are technical differences among peatland types that demand a more restrictive set of terms (Moore and Bellamy 1974; Bridgham et al. 1996; Wheeler and Proctor 2000; Okland et al. 2001, Bedford et al. 2003; Rydin and Jeglum 2013). Ecological variation in water chemistry, floristics, hydrology, and topography result in a wide variety of peatland types. An understanding of this variation is necessary to account for the full suite of ecological services and biodiversity supported by these unique wetland types.

Bogs occur above the influence of groundwater and consequently nearly all water input is from precipitation (i.e., they are ombrotrophic). Consequently, bogs are acidic, nutrient-poor wetlands with a characteristic dominance of oligotrophic *Sphagnum* moss species and ericaceous shrubs like Labrador tea (*Ledum groenlandicum*), bog-laurel (*Kalmia microphylla*), and bog cranberry (*Vaccinium oxycoccos*). Stunted western hemlock, shore pine (*Pinus contorta* var. *contorta*), and occasional western redcedar are also commonly found in bogs. Most bogs are surrounded by a lagg (or moat) which can consist of fen or swamp vegetation. Fens are in contact with groundwater (in discharge areas) or surface water (along the fringes of ponds, lakes, and slow moving streams) and thus are more mineratrophic than bogs. The vegetation of bogs is depauperate and lacks mineratrophic species such as sedges (*Carex* sp.), non-ericaceous shrubs, and many forbs. **Fens** are typically dominated by graminoids, especially *Carex* species, non-ericaceous shrubs such as hardhack (*Spiraea douglasii*), bog myrtle (*Myrica gale*), dwarf birch (*Betula nana*), willow (*Salix* spp.), thinleaf alder (*Alnus incana*), and brown mosses. Oligotrophic to mineratrophic *Sphagnum* species can occur and even dominate in fens. Fens can also be treed with western redcedar, western hemlock and shore pine. There is a great deal of variation in the levels of acidity and nutrients in fens. Poor fens are relatively acidic and nutrient poor and often have very similar vegetation as bogs. Moderatley rich (intermediate) fens typically have a pH > 5.5 and are slightly more nutrient rich than poor fens. Moderatley rich fens often have a species composition that overlaps with both poor and rich fens. Rich fens have a pH near or > 7.0, have high levels of base cations and thus have different vegetation composition than poor or moderatley rich fens.

Peatlands are found in river valleys, around lakes and marshes, behind coastal sand dunes, in isolated glacial features, or on slopes. They generally form in glacial scours, kettles, isolated oxbows, old lake beds, or in areas of groundwater discharge. Bogs and poor fens, also known as "Sphagnum-dominated peatlands" (Kulzer et al. 2001), are most common in the Northwest Coast and Puget Trough ecoregions (Figure 2). Fens of all types are scattered throughout the North Cascades and Cascades ecoregions (Figure 2). Very few peatlands are currently known from the southern portion of the Puget Trough ecoregion (e.g. Lewis, Cowlitz, and Clark counties) within Washington (Figure 2) and many of those known have been modified by agriculture (Rigg 1958).

<u>*Vernal pools*</u>: Vernal pools occur in depressions with seasonal wetness within a Mediterranean-type climate. Vernal pools often have concentric rings of vegetation (Crowe et al. 1994), with each ring reflecting time-since inundation and/or level of inundation. Annual species are typically common in vernal pools. Within Washington, vernal pools are primarily found in the eastern portion of the state. However, they do sporadically occur in the San Juan Islands within depressions on bedrock (see North Pacific Hardpan Vernal Pool in Rocchio and Crawford 2008) as well as on clay hardpans within wet prairie complexes (Easterly et al. 2005). Some researchers have noted seasonal pools in the montane zone that may be similar to vernal pools as described here. More research of western Washington vernal pools is needed.

<u>*Tidal salt marshes/lagoons*</u>: Salt marshes occur in estuaries, around lagoons, bays, and behind sand pits along the outer coast and shorelines of Puget Sound. Tidal inundation and saline conditions characterize these wetlands. Saltgrass (*Distichlis spicata*), marsh Jaumea (*Jaumea carnosa*), pickleweed (*Salicornia* spp.), Lyngbye's sedge (*Carex lyngbyei*), seaside arrowgrass (*Triglochin maritima*), tufted hairgrass (*Deschampsia caespitosa*), and Pacific silverweed (*Argentina egedii* spp. *egedii*) are common species in salt marshes. Due to differences in elevation, degree of tidal inundation and salinity salt marshes are often characterized into different zones such as low and high marsh. Variation in soil texture can also result in different vegetation patterns. Salt marshes are found in the Northwest Coast and Puget Trough ecoregions.

6.1.2 Cowardin Classification

The "Classification of Wetlands and Deepwater Habitats of the United States" system, commonly called the Cowardin classification, was developed for resource managers to map wetlands and to provide uniformity of concepts and terms (Cowardin et al. 1979). The structure of the classification allows it to be used at any of its four hierarchical levels. National Wetland Inventory maps use Cowardin as the basis for their map legend. As such, Cowardin is one of the most commonly used wetland classification schemes, at least for coarse analyses and developing mapping products.

The classification hierarchy includes four major levels (Systems, Subsystems, Class, and Dominance Type) along with a set of modifiers for these types. Systems are the highest level and include Marine, Estuarine, Riverine, Lacustrine, and Palustrine. Marine and Estuarine Systems each have two Subsystems, Subtidal and Intertidal; the Riverine System has four Subsystems, Tidal, Lower Perennial, Upper Perennial, and Intermittent; the Lacustrine has two, Littoral and Limnetic; and the Palustrine has no Subsystems (Cowardin et al. 1979).

Classes are a subdivision of the Subsystems and are based on substrate, flooding regime, or vegetative life form. Classes are not strictly hierarchical in that the same Class may occur under more than one System or Subsystem.

The lowest level of the classification is Dominance Type which is named for the dominant plant or animal forms. Dominance types are developed by individual users of the classification

(Cowardin et al. 1979). Modifiers associated with water regime, water chemistry, soil type, and human disturbance can be applied to the Classes or Subclasses.

6.1.3 Hydrogeomorphic (HGM) Classification

The hydrogeomorphic classification, or HGM, emphasizes the hydrologic and geomorphic controls of wetlands (Brinson 1993). HGM assumes that these abiotic characteristics are of primary importance for grouping wetlands according to the similarity of the ecological functions they perform. HGM classes are distinguished based on a wetland's position in the landscape (i.e., geomorphic setting), the source of water, and the wetland's hydrodynamics (i.e. direction and fluctuation of water) (Brinson 1993). HGM uses a hierarchical classification with seven major hydrogeomorphic wetland classes: riverine, depression, slope, flats (organic soil and mineral soil), and fringe (estuarine and lacustrine). Within a specific geographic region, these classes can be further divided into regional subclasses. The Washington Department of Ecology has defined subclasses for some of the HGM classes which occur in the state (Table 8). The classes and subclasses are grouped into domains (western vs. eastern Washington) and regions (lowland, montane, Columbia Basin, etc.; Hruby et al. 1999; Sheldon et al. 2005; Table 8).

While Cowardin is often used to develop inventories and maps of wetland resources, HGM is typically used in the context of wetland function assessment. However, some researchers are now incorporating HGM concepts into regional mapping efforts (Tiner 2003; Brooks et al. 2011).

Table 8. HGM Classes and Subclasses in Washington

Class	Regional Subclasses			
	Lowlands of Western WA	**Lowlands of Eastern WA**	**Columbia Basin**	**Montane (East & West)**
Riverine	• Impounding • Flow-through	Present but subclasses not yet defined	Present but subclasses not yet defined	Present but subclasses not yet defined
Depressional	• Outflow • Closed • Interdunal	Present but subclasses not yet defined	• Alkali • Freshwater: long-duration • Freshwater: short-duration	Present but subclasses not yet defined
Slope	Class present but subclasses not yet defined	Present but subclasses not yet defined	Present but subclasses not yet defined	Present but subclasses not yet defined
Flats	Class present (i.e. organic flats or true bogs) but subclasses not yet defined	Probably does not occur	Mineral flats may occur but subclasses not yet defined	Probably does not occur
Lacustrine (Lake Fringe)	Class present but subclasses not yet defined	Present but subclasses not yet defined	Present but subclasses not yet defined	Present but subclasses not yet defined
Estuarine Fringe	• Tidal salt water	*Does not occur*	*Does not occur*	*Does not occur*

	• Tidal fresh water			

6.1.4 Ecological Systems Classification

NatureServe has developed a mid-scale ecological classification, useful for conservation and environmental planning (http://www.natureserve.org/getData/USecologyData.jsp). The classification, Ecological Systems, represent recurring groups of terrestrial (both upland and wetland) plant communities that are found in similar climatic and physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding (Comer et al. 2003). The classification describes over 800 upland and wetland ecological system types found in the United States, and in adjacent portions of Mexico and Canada. Ecological systems types facilitate mapping at meso-scales (1:24,000 – 1:100,000; Comer and Schulz 2007). Terrestrial ecological systems have formed the basis for map legends on national mapping efforts, including the inter-agency Landfire (http://www.landfire.gov/) and Gap Analysis Program efforts (http://gapanalysis.usgs.gov/gap-analysis/). The results of these large-scale mapping projects have been combined into a national map of ecological systems which can be downloaded from NatureServe's website: (http://www.natureserve.org/getData/USecologyData.jsp). A comprehensive ecological systems map exists for Washington State (www.landscope.org). The wetland and riparian Ecological Systems occurring in western Washington are shown in Table 9. However, due to their generally small size wetland Ecological Systems are greatly underrepresented or in some cases not even included in the statewide Ecological Systems map.

Ecological Systems incorporate temporal variability in biotic composition by including early-, mid-, and later-seral vegetation (i.e. plant associations) into one classification unit, assuming succession progresses within a 50 year time frame. Thus, Ecological Systems provide a spatial-ecologic perspective on the relation of U.S. National Vegetation Classification (USNVC) associations and alliances (fine-scale USNVC types), integrating vegetation with natural dynamics, soils, hydrology, landscape setting, and other ecological processes.

Table 9. Ecological Systems Associated with Wetlands & Riparian Areas in Western Washington.

Western Washington Wetland & Riparian Ecological Systems	
North Pacific Bog and Fen	North Pacific Montane Riparian Woodland and Shrubland
North Pacific Coastal Interdunal Wetland	North Pacific Shrub Swamp
North Pacific Hardwood-Conifer Swamp	Temperate Pacific Aquatic Bed
North Pacific Lowland Riparian Forest and Shrubland	Temperate Pacific Emergent Marsh
North Pacific Hardpan Vernal Pool	Temperate Pacific Mudflat
North Pacific Intertidal Wetland	Temperate Pacific Subalpine-Montane Wet Meadow
North Pacific Montane Massive Bedrock, Cliff and Talus (wet cliffs; spray zones)	Willamette Valley Wet Prairie

6.1.5 Natural Community Classification

Natural Community types are an ecological unit based on geomorphic province, hydrology, water chemistry, soils and vegetation. In the 1980's, the 1st version of wetland, riparian, and aquatic natural community types for Washington was developed (Kunze 1983). The second version of these types was presented in Appendix B of Strickland (1986). In 1994, a modification of these natural community types was presented in *Preliminary classification of native, low elevation, wetland vegetation in western Washington* (Appendix A of Kunze 1994). Version 4.0 of the Natural Community Type classification was statewide in scope and reflects the Natural Community Types that WNHP has been using (along with plant associations) to identify wetland and aquatic conservation priorities up to the publication date of this document (WADNR 2011). See Rocchio and Crawford (*In Progress*) for more detail about the various iterations of Natural Community type classification for Washington wetlands.

6.1.6 Vegetation Descriptions and Classifications

Vegetation classification is used to recognize and describe repeating assemblages of plants in similar habitats. Classification of these repeating assemblages can be based on site-level to regional-scale comparisons. Early research on wetland vegetation patterns in Washington primarily focused on describing or characterizing vegetation in peat-forming wetlands (Rigg 1922a, 1922b, 1925, 1940; Rigg and Richardson 1934, Osvald 1933, and Hansen 1941, 1943, 1944). Fitzgerald (1966) and Lebednik and del Moral (1976) studied vegetation and selected physical environmental parameters in a peat system in King County. Wiedemann (1984) classified coastal dune communities in Oregon and Washington, including deflation plain wetland communities. U.S. Forest Service ecologists, in developing forest classifications, included some forested and non-forested wetland associations (Henderson et al. 1989; Henderson et al. 1992; Topik et al. 1988). Christy and Putera (1993) described riparian and wetland vegetation along the lower Columbia River. Diaz and Mellon (1996) and McCain (2004) classified riparian plant communities of northwest Oregon and southwest Washington (West Cascades). Murray (2000), Christy and Putera (1993), and Christy (2004) describe wetland plant associations of northwest Oregon. Chappell (1999) classified riparian plant associations of the western Olympic peninsula while Peter (2000) did the same for the southeastern Olympic peninsula.

Some British Columbia classification efforts are relevant to the classification of western Washington wetlands. Hebda and Biggs (1981) described wetland communities in a large peat system on the Fraser River Delta. Orloci (1965) and Kojima and Krajina (1975) classified tree and shrub dominated wetland communities in the coastal western hemlock zone in British Columbia. Banner and Pojar, in a series of articles with others (1983, 1986, 1987a, 1987b), described wetland types which occur along the northern British Columbia coast. Most recently, MacKenzie and Moran (2004) described wetland vegetation as well as wetland ecological types for the entire province of British Columbia.

The most significant body of work for western Washington wetlands is the classification by Kunze (1994). This work, which was based on ten years' worth of data collection, describes a preliminary classification of native, low elevation, wetlands in western Washington. Wetlands were characterized within a hierarchy consisting of (from coarse- to fine- scale): Regions, Wetland Kind (i.e., Natural Community type), Hydrological Regime, Physiognomy, and Plant Community type (see Appendix A of Kunze 1994). The Plant Community types were based on plot data collected by Linda Kunze as well as synthesis with many of the classification works cited above.

The studies cited above may not be comprehensive but do reflect major vegetation classification efforts relevant to western Washington wetlands and riparian areas.

6.1.7 U.S. National Vegetation Classification System

The U.S. National Vegetation Classification (USNVC), supported by the Federal Geographic Data Committee (FGDC 2008), NatureServe (Faber-Langendoen et al. 2009c), and the Ecological Society of America (Jennings et al. 2006), has a hierarchical structure which provides a common language for the effective management and conservation of plant communities in the United States. The classification standard was developed over many years by the FGDC Vegetation Subcommittee (FGDC 2008), with members from a diversity of federal agencies, the Vegetation Panel of the Ecological Society of America, and NatureServe (http://usnvc.org/overview/). The intent of the USNVC is to allow federal agencies to produce uniform statistics about vegetation resources across the nation, facilitate interagency cooperation on vegetation management issues that transcend jurisdictional boundaries, and encourage non-Federal partners to utilize and contribute to a common system when working with their Federal partners.

The first iteration of the USNVC (FGDC1997) was based in part on an earlier international vegetation classification developed by the United Nations Educational, Cultural, and Scientific Organization (UNESCO 1973, Driscoll et al. 1984). Substantial revisions to the upper levels of the 1997 USNVC hierarchy were adopted by the FGDC in February 2008 (FGDC 2008). The 2008 USNVC consists of eight levels. The three upper levels are based primarily on physiognomic features; the three middle levels incorporate biogeographic and meso-climatic factors along with diagnostic species and life forms; and the two lower levels are based on floristics (FGDC 2008). The FGDC 2008 standard fully discusses the rationale and criteria of each hierarchy level (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/vegetation/NVCS V2_FINAL_2008-02.pdf).

The Association is the finest unit of the USNVC and has been used by WNHP as a primary unit to identify wetland conservation priorities (e.g., Wetlands of High Conservation Value). The Association is defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy (Jennings et al. 2002). Associations reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.

WNHP has played a key role in the identification and development of USNVC Associations for Washington State. WNHP ecologists accomplished this through synthesis of the various vegetation classification efforts conducted within or applicable to Washington (as cited above in previous section) as well as themselves collecting and analyzing vegetation plot data over the past 30 years. All of the existing information is synthesized with the intent to produce a syononymized list of USNVC Associations occurring in Washington. This process continues as new information become available. WNHP maintains a statewide database of plant associations and works with NatureServe to integrate these concepts into the USNVC.

6.2 *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* -- A New Classification Framework for Washington's Wetland Vegetation

Standardized, regional classification schemes are useful for constraining natural variability of ecosystems thereby allowing users of the classification to effectively communicate, assess, and plan for conservation, management, and restoration of a given ecosystem type. As noted above, WNHP has been using multiple classification schemes (e.g. USNVC Plant Associations, Natural Community Types, and Ecological Systems) to guide the identification of wetland conservation priorities. These classifications have sometimes been used for differing objectives and consequently have presented some confusion among partners about the relationships and/or priority of the various classification units for wetland conservation work. In addition, WNHP has realized that these classifications may be inadequate in accounting for the full suite of ecological templates and corresponding biological diversity that occur in Washington.

<u>In response to these concerns, WNHP has integrated various components of the classification schemes previously discussed with the intent of creating a hierarchy that accounts for the full suite of wetland/riparian ecological templates and biodiversity on the landscape.</u> This new classification scheme is called the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* and is essentially equivalent to the USNVC hierarchy except with one additional classification unit (Natural Community Types) added above the Plant Association leve. The classification will assist WNHP in meeting one of its primary programmatic objectives which is to "maintain a classification and inventory of WA's natural heritage resources and prioritize those resources for conservation action."

6.2.1 Purpose and Development

The purpose of the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* is to provide a hierarchical classification that enables WNHP to track biodiversity within spatially explicit ecological templates. The primary objective is to ensure WNHP's efforts in prioritizing conservation targets are based on a comprehensive assessment of the variety of ecological templates and associated biological diversity which characterize Washington's wetland resource. Accounting for both biotic and abiotic variation also improves the likelihood of conservation in the face of climate change as it has been noted that without adequate protection of both biotic and abiotic variability, the ability of ecosystems to adapt to potential climate change effects are diminished (Whitlock 1992).

The approach in developing the classification was to incorporate or use existing classifications to eliminate, where possible, redundancy and confusion with existing approaches. The *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* is essentially a modification of the U.S. National Vegetation Classification (Table 10). The modification was the insertion of a classification level between the Group and Association levels of the USNVC. This level (Natural Community Types) is used here *in lieu* of Alliances which is the official USNVC level between Groups and Associations. To date, Alliances have not been fully developed for the revised version of the USNVC (Table 10). Those Alliances which have been proposed were determined to not meet WNHP's need for an ecological unit that more explicitly encompasses primary ecological drivers. Thus, Natural Community Types were incorporated into the USNVC for use in classifying Washington's wetlands (<u>note</u>: Natural Community Types were developed by WNHP and are not an official part of the USNVC). The Natural Community Type unit is a modification of the Natural Community Types described above. HGM or hydrogeomorphic characteristics, elevation, and water chemistry were the most commons classifiers for distinguishing Natural Community Types within Groups. Field experience, distribution information, and literature were used to guide development of the individual Natural Community Types. The concepts were also vetted during field work for this project.

Association concepts are derived primarily from WNHP plot data and associations identified in existing classification publications. For the past 30 years, WNHP has been conducting ongoing metaanlysis of these data using both quantitative (e.g., ordination techniques) and qualitative (e.g. tabular comparisons) methods to produce a synonymized list of Plant Associations. This task was updated for this project.

See Rocchio and Crawford (*In Progress*) for a more detailed review of development of the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington*.

6.2.2 Summary of Types

The full hierarchy and specific plant associations included in the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* can be found in Appendix A. The following is a brief summary of the types found in the classification. For a more detailed discussion of the methods and results of the classification please see Rocchio and Crawford (*In Progress*).

There are eight levels in the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington*. Seven of those are standard USNVC levels (Table 10). One is a custom classification unit (Natural Community Types) developed by WNHP (Table 10).

Table 10. Hierarchy of the Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington

Classification Level
USNVC Formation Class
USNVC Formation Subclass
USNVC Formation
USNVC Division
USNVC Macrogroup
USNVC Group
Natural Community Type (WA specific)
USNVC Plant Association

The results of the classification are summarized in Table 11. The USNVC has eight Formation Classes (see http://usnvc.org/explore-classification/), two of which are cultural vegetation types. Of the six native vegetation Formation Classes, four encompass the range of wetland and

Table 11. Summary of Types in the Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington

USNVC Formation Class	USNVC Formation Subclass	USNVC Formation	USNVC Division	USNVC Macrogroup	USNVC Group	# of Natural Community Types	# of USNVC Associations
1 Forest to Open Woodland Class	1.B Temperate & Boreal Forest Subclass	1.B.3 Temperate Flooded & Swamp Forest Formation	1.B.3.Ng Vancouverian Flooded & Swamp Forest Division	Vancouverian Flooded & Swamp Forest Macrogroup	North Pacific Lowland Riparian Forest & Woodland Group	3	28
					North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	5	11
					North Pacific Maritime Hardwood-Conifer Swamp Group	7	22
					North Pacific Montane Riparian Woodland Group	2	5
2 Shrubland & Grassland Class	2.B Temperate & Boreal Grassland & Shrubland Subclass	2.B.5 Temperate & Boreal Bog & Fen Formation	2.B.5.Na North American Bog & Fen Division	North Pacific Bog & Fen Macrogroup	North Pacific Bog & Acidic Fen Group	7	32
					North Pacific Neutral - Alkaline Fen Group	9	25
		2.B.6 Temperate & Boreal Marsh, Wet Meadow & Shrubland Formation	2.B.6.Nb Western North American Shrubland, Wet Meadow & Marsh Division	Western North American Montane & Subalpine Wet Shrubland & Wet Meadow Macrogroup	Vancouverian & Rocky Mountain Montane Wet Meadow Group	5	14
					Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group	3	5
				Western North American Temperate Lowland Wet Shrubland, Wet Meadow & Marsh Macrogroup	Temperate Pacific Wet Mudflat Group	2	3
					Vancouverian Freshwater Wet Meadow & Marsh Group	13	60
					Vancouverian Wet Shrubland Group	16	33
				Western North American Vernal Pool Macrogroup	North Pacific Vernal Pool Group	1	1

USNVC Formation Class	USNVC Formation Subclass	USNVC Formation	USNVC Division	USNVC Macrogroup	USNVC Group	# of Natural Community Types	# of USNVC Associations
		2.B.7 Salt Marsh Formation	2.B.7.Nc Temperate & Boreal Pacific Coastal Salt Marsh Division	North American Pacific Coastal Salt Marsh Macrogroup	Temperate Pacific Tidal Salt & Brackish Marsh Group	3	17
5 Aquatic Vegetation Class	5.B Aquatic Vegetation Subclass	5.B.2 Temperate & Boreal Aquatic Vegetation Formation	5.B.2.Na North American Aquatic Vegetation Division	Western North American Aquatic Vegetation Macrogroup	Western North American Temperate Aquatic Bed Group	7	16
6 Rock Vegetation Class	6.B Temperate & Boreal Rock Vegetation Subclass	6.B.2 Temperate & Boreal Cliff, Scree & Rock Vegetation Formation	6.B.2.Nb Western North American Temperate Cliff, Scree & Rock Vegetation Division	Western North American Wet Cliff Vegetation Macrogroup	Vancouverian Wet Cliff, Waterfall, and Hanging Garden Group	4	0
					Totals	**87**	**272**

riparian vegetation in western Washington. Within those four Formation Classes, there are five Formation Subclasses, six Formations, six Divisions, eight Macrogroups, and 15 Groups. There are 87 Natural Community Types and 272 Plant Associations (Table 11). The highest numbers of Natural Community Types were found in the Vancouverian Wet Shrubland Group (19) and Vancouverian Wet Meadow & Marsh Group (13). The Vancouverian Wet Meadow & Marsh Group had the highest total number of Associations (60). The Vancouverian Wet Shrubland Group (33 Associations) and North Pacific Bog & Acidic Fen Group (32 Associations) also had high numbers of Associations. These totals suggest a higher range of ecological variability (e.g., Natural Community Types) and higher vegetation diversity (Associations) than in Groups with lower numbers (Table 11). The Groups with low number of Natural Community Type and Associations include the North Pacific Vernal Pool Group, Temperate Pacific Wet Mudflat Group, and Vancouverian Wet Cliff, Waterfall, Hanging Garden Group. The fact that these Groups have received much less classification, research, and inventory than other wetland types may be one reason for the low numbers of types. On the other hand, what we do know about these wetlands suggests that although their vegetation is unique the types are likely not very diverse due to them being influenced by a single primary ecological driver within a very narrow range of landscape positions. Conversely, the North Pacific Bog & Acidic Fen Group, Vancouverian Wet Meadow & Marsh Group, and Vancouverian Wet Shrubland Group all have multiple ecological drivers (water source, water chemistry, soil type, and hydrodynamics) that occur in a variety of landscape positions resulting in high diversity of vegetation types

6.3 Conclusions

The diversity of ecological templates and biotic diversity associated with western Washington wetlands is not well characterized by established and commonly used classification schemes. However, each of those classifications offers a unique perspective on the ecological variability associated with Washington's wetland resource. The objective of the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* was to assimilate existing classification schemes into a new framework that considers multiple ecological drivers associated with vegetation patterns in Washington's wetlands. The result is a classification that provides a standardized currency or language for describing Washington's wetland ecological diversity. By incorporating fine-scale ecological drivers and vegetation composition, the diversity of wetlands is much more apparent with the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* framework compared to existing classification schemes. Of course, each classification has its own purpose and the suggestion is not to put aside application of Cowardin, HGM, or any other framework for categorizing wetland variability. However, from the perspective of needing to catalogue wetland biodiversity, the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* provides a flexible framework for categorizing wetlands and riparian vegetation types from a variety of conceptual and spatial scales. As such, the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* is the framework used in this project to establish the types of wetlands which occur in western Washington.

7 Conservation Significance of Western Washington Wetland Plant Associations

7.1 Conservation Significance of Western Washington Wetland Plant Associations

Conservation significance is assessed via the assignment of conservation status ranks (i.e. Global/State Ranks) to each wetland type (as defined by the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington*). The conservation status ranks provide a succinct assessment of an element's rarity or risk of extinction. This rank has value as a standalone index but can also be used alongside other data to inform site-level conservation priorities (see Section 3.3). For this report, only conservation status ranks associated with plant associations are discussed, as ranks have yet to be assigned to other levels in the classification hierarchy. The use of the conservation status rank in determining locations of wetland conservation priorities is discussed below.

7.2 Methods

In the past, the method for assigning ranks was based on a best professional judgment approach, where Natural Heritage scientists applied their field experience along with herbarium records, plot data, and published research to assign a Global or State Conservation Status rank (G/S rank).

To date, Plant Associations and a few Ecological System types have been assigned Global/State ranks. These ranks have been assigned through a collaborative process involving best professional judgment of regional and State scientists and are based on a number of factors, such as the total range of the element, the number of occurrences, trends, severity of threats, overall viability/integrity of extant occurrences and resilience contribute to the assignment of global and state ranks.

Recently, NatureServe developed a Conservation Status Rank calculator (Faber-Langendoen et al. 2009b) which has improved repeatability and standardization of factors and criteria used to assign conservation status ranks. For this project, WNHP used this calcuator to assign state ranks to those Plant Associations that were lacking them and reviewed ranks for Associations whose taxonomic status was changed. <u>Any new or changed ranks resulting from this process are not considered final until they have undergone additional review by Washington Department of Natural Resources staff and management</u>. Thus, State Conservation Status ranks that were changed are tagged with a "Proposed" modifier until that review is concluded.

An analysis of the proportion of rare plant associations (e.g., those with G1-G3 or S1-S3 ranks) across USNVC Groups was performed. This assessment indicates the biodiversity significance of a given Group.

7.3 Results

The global and state ranks of the 272 plant associations are listed in Appendix A. Global Ranks had been previously assigned to 81% of the 272 wetland Plant Associations occurring in western Washington. No Global Ranks were assigned for this project as that process involves Natural Heritage scientists from each of the States and/or Provinces in which the element occurs and is outside the scope of this project. WNHP assigned State ranks to the 82 Associations that were missing State ranks resulting in all 272 Associations having a State Conservation Status Rank, although 8% (22) have a SU (i.e. unrankable) rank due to lacking adequate data to determine conservation status (Table 12; see Appendix A for a list of those ranks).

When comparing distribution of ranks, there is a larger discrepancy between rare (i.e., G/S1 – G/S3) and common or secure (i.e. G/S4 – G/S5) plant associations at the State level than at the Global scale. For example, S1-S3 associations account for 74% while S4-S5 plant associations accounts for only 18% (Table 12; Figure 4) while G1-G3 plant associations comprise 46% as compared to 35% for G4-G5 plant associations (Table 12; Figure 3).

The distribution of globally and state rare plant associations across USNVC Groups is shown in Figure 5; Figure 6). The proportion of Globally rare (G1-G3) associations is > 50% in nearly half (7 or 47%) of the 15 USNVC Groups (Figure 5) while 73% (11) of the same Groups contain ≥ 50% of State rare (S1-S3) associations (Figure 6). The Groups with a high proportion of globally rare associations include North Pacific Vernal Pool, North Pacific Hardwood Conifer Swamp, Temperate Pacific Freshwater Wet Mudflat, North Pacific Maritime Poor Fen & Bog Forest & Woodland Group, North Pacific Montane Riparian Woodland, Temperate Pacific Salt and Brackish Marsh, and North Pacific Lowland Riparian Forest and Woodland (Figure 5). All Groups, except Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland, Western North American Temperate Aquatic Bed, and Temperate Pacific Freshwater Wet Mudflat, had a high proportion of state rare associations (Figure 6). Even those three that were under 50% still were above 33% (Figure 6).

Table 12. Distribution of Conservation Status Ranks of Western Washington Wetland Plant Associations.

	Total Associations	**G1-G3 Ranked**	**G4-G5 Ranked**	**GNR***	**S1-S3 Ranked**	**S4-S5 Ranked**	**SU****
Number of Plant Associations	272	125	94	53	202	48	22
% of Total		46%	35%	19%	74%	18%	8%

*GNR = no rank assigned

**SU = rank is unassignable due to lack of information about the element

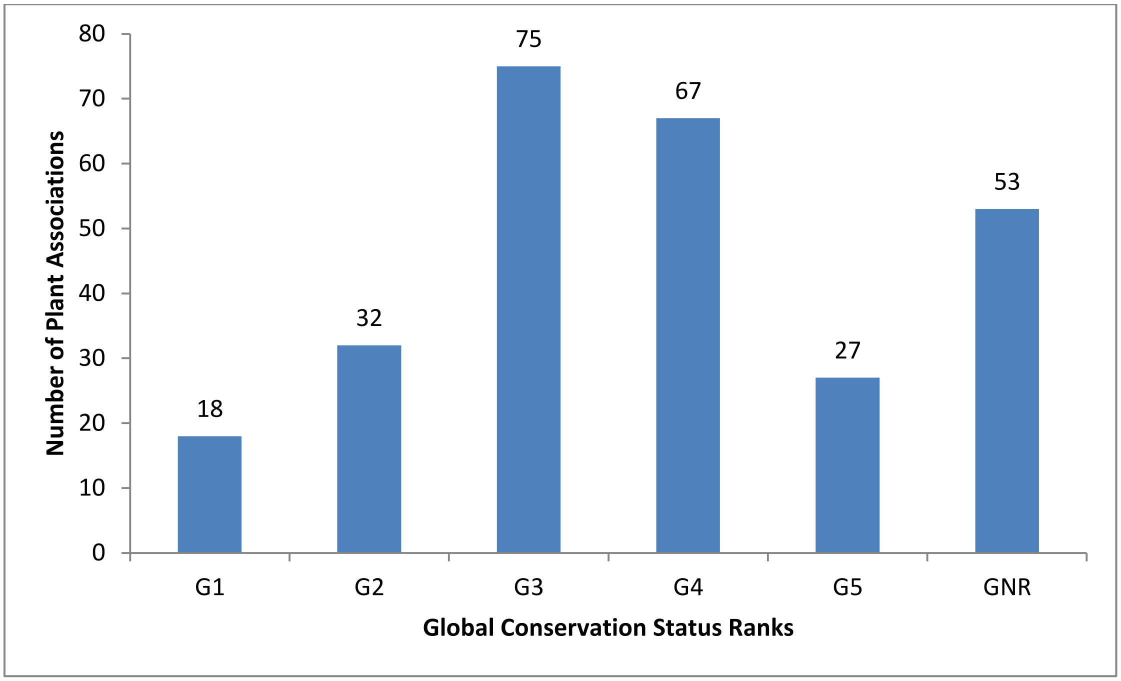

Figure 3. Global Conservation Status Ranks of Western Washington Wetland Plant Associations

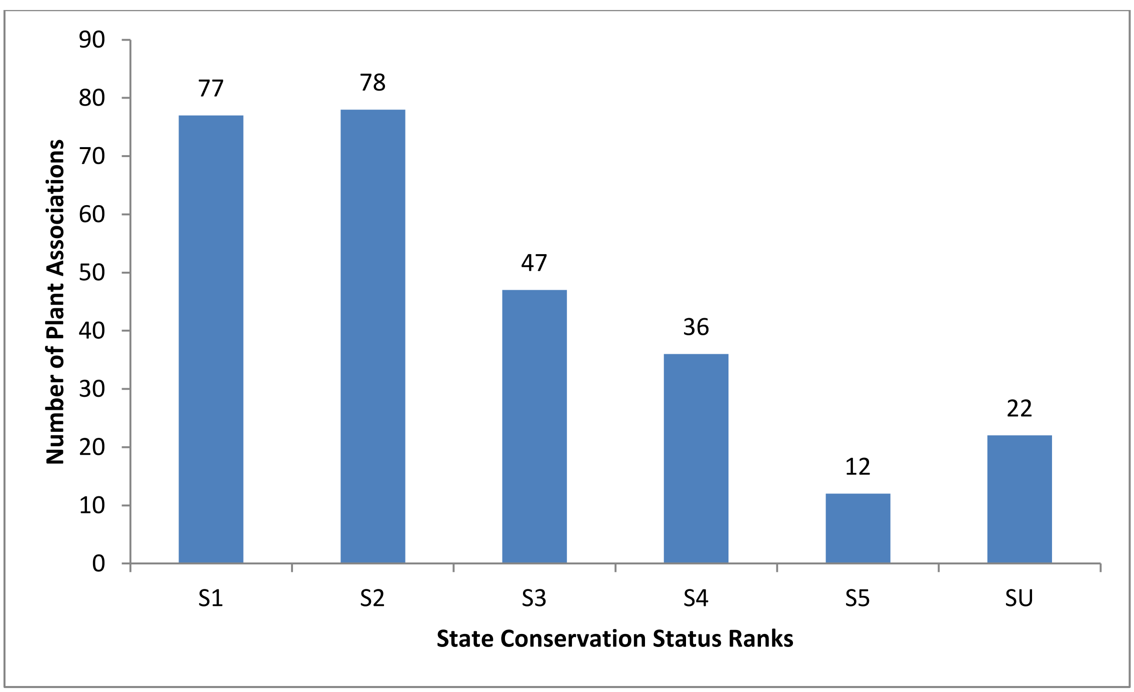

Figure 4. State Conservation Status Ranks of Western Washington Wetland Plant Associations

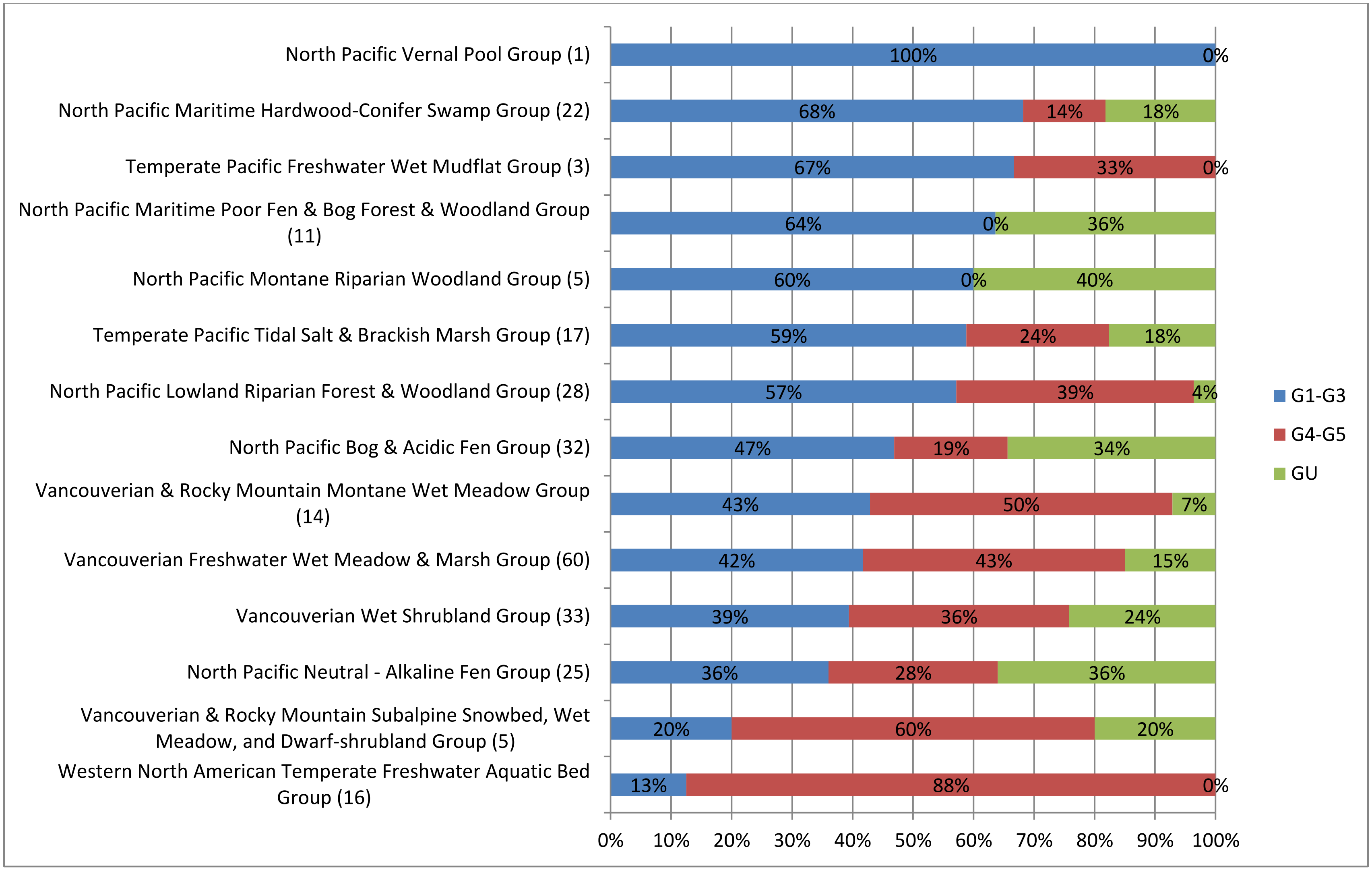

Figure 5. Distribution of Plant Association Global Ranks by USNVC Group (Includes range ranks that equal whole ranks, e.g. G3G4 is rounded down to G3). Number of plant associations per Group show in parentheses.

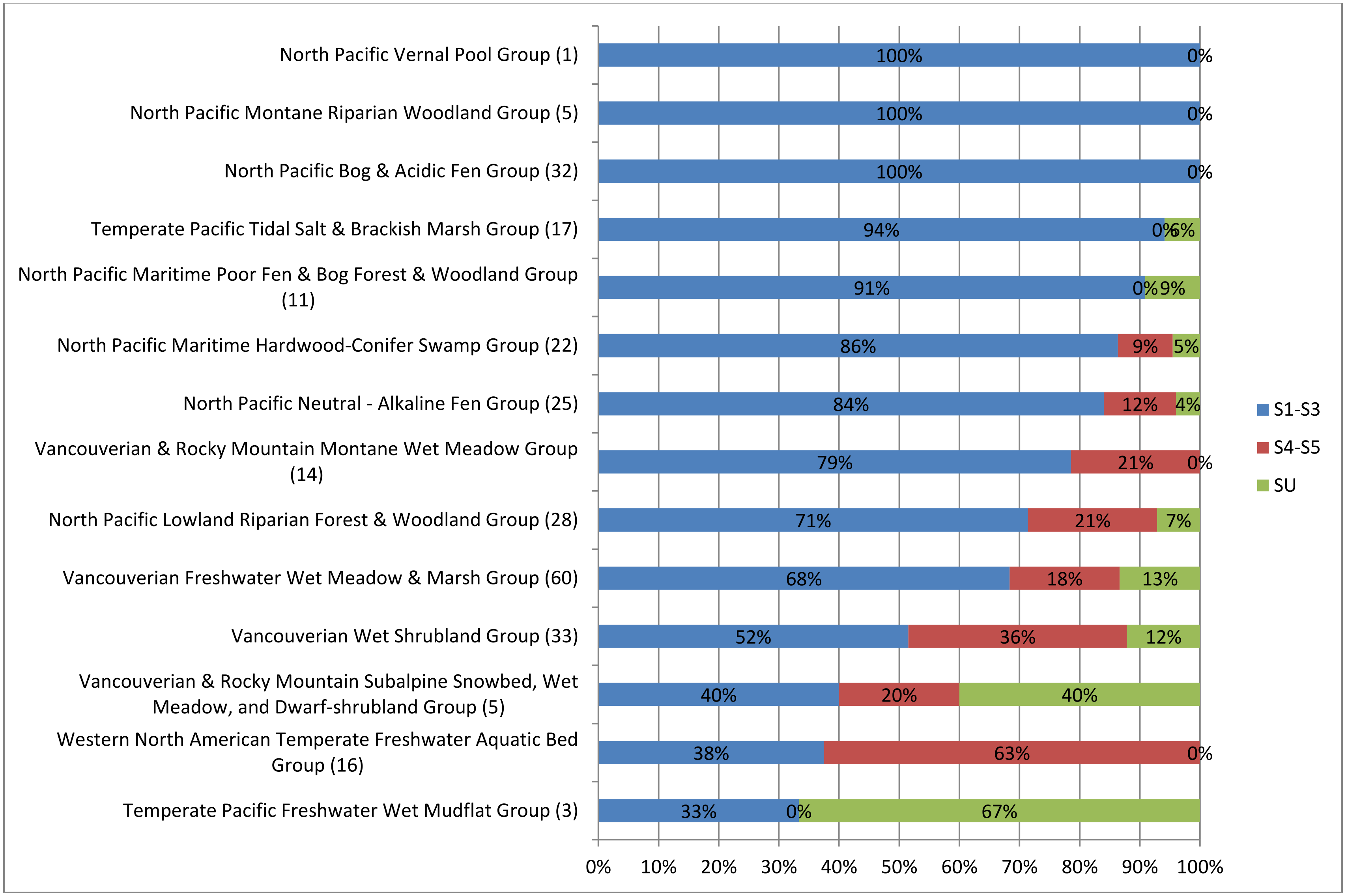

Figure 6. Distribution of Plant Association State Ranks by USNVC Group (Includes range ranks that equal whole ranks, e.g. S3S4 is rounded down to S3). Number of plant associations per Group show in parentheses..

7.4 Discussion and Conclusions

The distribution of Global Conservation Status Ranks across wetland and riparian plant associations in western Washington was relatively equal between rare (G1-G3) and common (G4-G5). This suggests that Washington's wetlands support a nearly equal amount of wide-ranging and/or abundant types as they do endemic, narrowly distributed, and/or highly threatened types. Washington's potential contribution toward the conservation of the latter types is significant due to the fact that these types are either endemic to Washington or the Pacific Northwest and/or are highly threatened across their entire range. The same analysis of State Conservation Status Ranks shows that the majority of plant associations are ranked as being rare or highly threatened in Washington, even if they aren't rare or threatened across their global range. This is likely due to a few factors including: (1) Washington is at the edge of the association's range; (2) the type is endemic to Washington or the region; and/or (3) the stressors in Washington have made the association more vulnerable than occurrences outside the State.

Each rare association and high-quality examples of common associations have value. However, the distribution of rare associations across Groups can provide a coarse assessment of the significance of any given Group. Sixty eight percent of the associations in the North Pacific Hardwood Conifer Swamp Group are considered to be globally rare. Many of these associations are endemic to Washington and adjacent parts of Oregon and British Columbia. In addition, these associations have experienced much loss and degradation from logging and development and very few high quality examples remain. Similar reasons may explain why 64% of the associations in the North Pacific Maritime Poor Fen & Bog Forest & Woodland Group are globally rare. Many of those associations have a narrow and restrictive global range and have been impacted by logging and hydrological alterations. Riparian plant associations are often exposed to direct loss from agriculture, logging, development and a variety of stressors including hydrological alterations and invasive species which may be why 57% of the associations in the North Pacific Lowland Riparian Forest and Woodland Group and 60% in the North Pacific Montane Riparian Woodland Group are considered globally rare. Similarly, coastal wetlands have experienced numerous impacts ranging from dikes, invasive species, geomorphic alterations, etc. and may explain why 59% of associations in the Temperate Pacific Salt and Brackish Marsh Group are globally rare.

The distribution of State Conservation Status Ranks across Groups differs from Global Conservation Status Ranks, primarily in that nearly ¾ of the Groups proportion of state rare associations was >50%. In addition, some of the Groups with a high proportion of state rare associations were not among those with highest proportion of globally rare associations including North Pacific Bog and Acidic Fen Group, North Pacific Neutral-Alkaline Fen Group, Vancouverian & Rocky Mountain Montane Wet Meadow Group, Vancouverian Freshwater Wet Meadow & Marsh Group, and Vancouverian Wet Shrubland Group. This may be due to a few reasons: (1) some associations may be at the periphery of their range in WA (e.g., North Pacific Bog and Acidic Fen Group); (2) globally common associations have been greatly reduced in extent and/or integrity with Washington due to human stressors (e.g., Vancouverian Freshwater Wet Meadow & Marsh Group and Vancouverian Wet Shrubland Group); and (3) that 52 State rare Associations do not have Global ranks assigned either because they are endemic to Washington or there is not enough information to assign ranks across their global range.

A few Groups have had little description of the types of plant associations associated with them including the North Pacific Vernal Pool Group (one association), Temperate Pacific Freshwater Wet Mudflat (three associations), and Vancouverian Wet Cliff, Waterfall, Hanging Garden Group (no associations). These low numbers reflect a lack of data, specifically very little focused survey and classification effort for these wetland types.

In summary, the patterns of Association rarity highlights the importance of individual Groups in terms of the role they provide in supporting global and state rare vegetation communities.

8 Distribution Patterns of Known Plant Association-based Wetlands of High Conservation Value

8.1 Introduction

Wetlands of High Conservation Value are determined by the presence of either: (1) a rare and/or high-quality Plant Association/Ecological Community and/or (2) the presence of a rare plant tracked by WNHP. In total, there are 1,340 WHCV in western Washington (Table 13; Figure 8). Of those, 718 are based on wetland ecosystem element occurrences (i.e. EOs) in WNHP's database (Table 13). These are primarily plant association occurrences plus six EOs based on a Natural Community type element (3rd iteration types; see Section 6.1.5). The 718 EOs are found at 300 unique sites or locations. In other words, more than one WHCV can occur within a single wetland site (Figure 7). There are 622 WHCV that only have wetland-dependent rare plants (rare plants considered to have Obligate or Facultative-Wetland wetland indicator status) present. These are located at 482 unique sites (Table 13). There may be other rare plant locations which occur in wetlands that are not included in this estimate (see Section 3.6.1). There are only 39 unique sites where both wetland ecosystem and rare plants co-occur (Table 13; Figure 7 shows an example). This seems like an unusually low number and may be due to the lack of both a botanical and ecological inventory occurring at the same sites.

The data presented here are extracted from WNHP's BIOTICS database (which includes updated information from this project). The locations of all (both rare plant-based and Plant Association-based) WHCV are presented in Figure 8 and are included in the GIS file that accompanies this report. **<u>However, the analysis presented in this and other Sections only focuses on Plant Association-based WHCV.</u>**

Table 13. Plant Association-based Wetlands of High Conservation Value According to Element Type

Element Type	Wetlands of High Conservation Value (or unique element occurrences)	Unique Sites
Only Plant Associations/Natural Community Types Present	718	300
Only Rare Plants Present	622	482
Both Plant Associations & Rare Plants Present	n/a	39
Total	**1,340**	**821**

8.2 Distribution Patterns of Wetlands of High Conservation Value

Most of the 718 known Wetlands of High Conservation Value (WHCV) occur in the lowlands of the Puget Trough and along the coast (Figure 8). Fewer occur in southwest Washington and the southern portion of the Puget Trough. Rare plant-based WHCV are somewhat more equally distributed across elevations (Figure 8).

The lack of Plant Association-based WHCV in upper elevations is primarily due to the majority of survey work being conducted in the lowlands. The lack of Plant Association-based WHCV in southern portion of western Washington is due

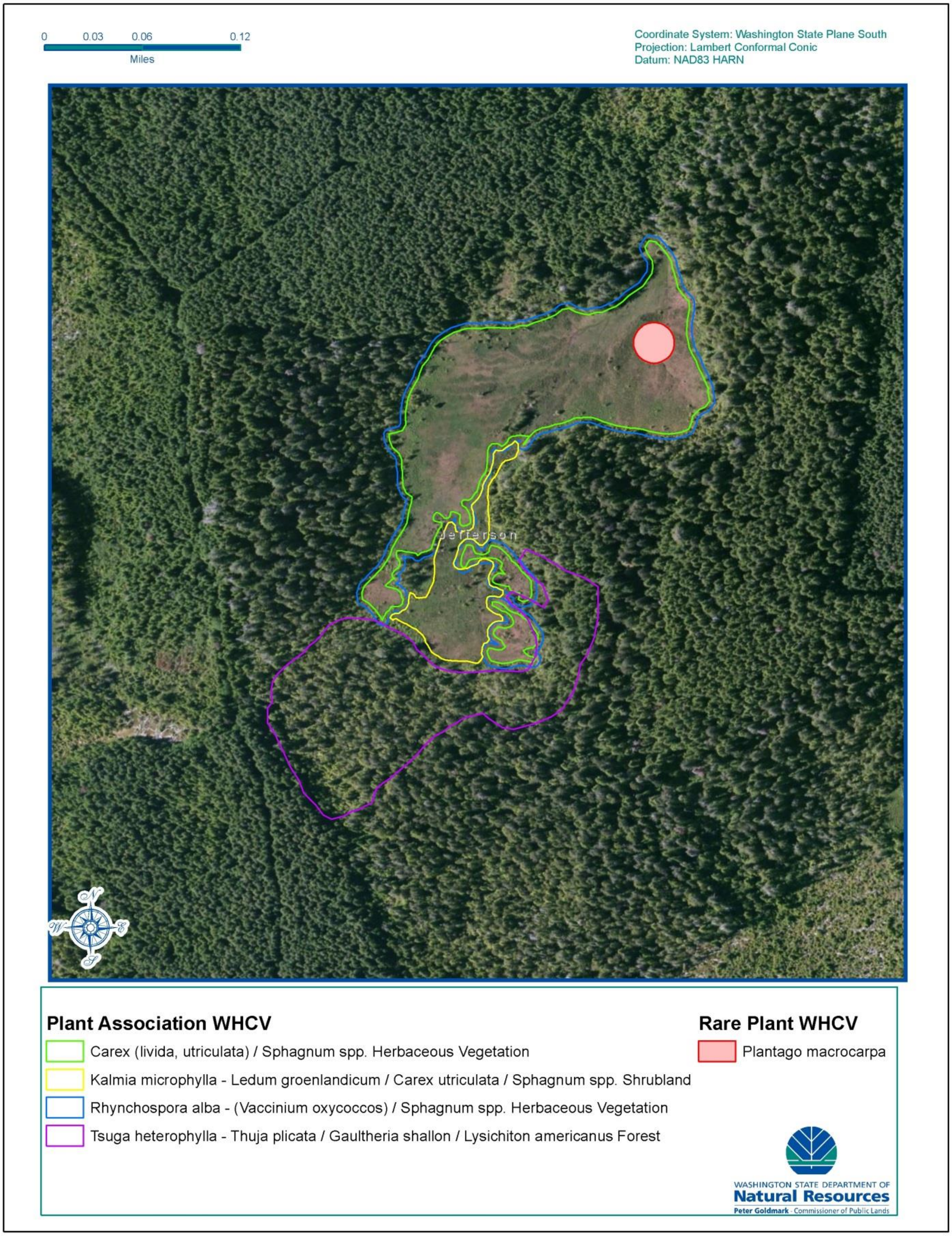

Figure 7. Example of Multiple Wetlands of High Conservation Value within a Single Site

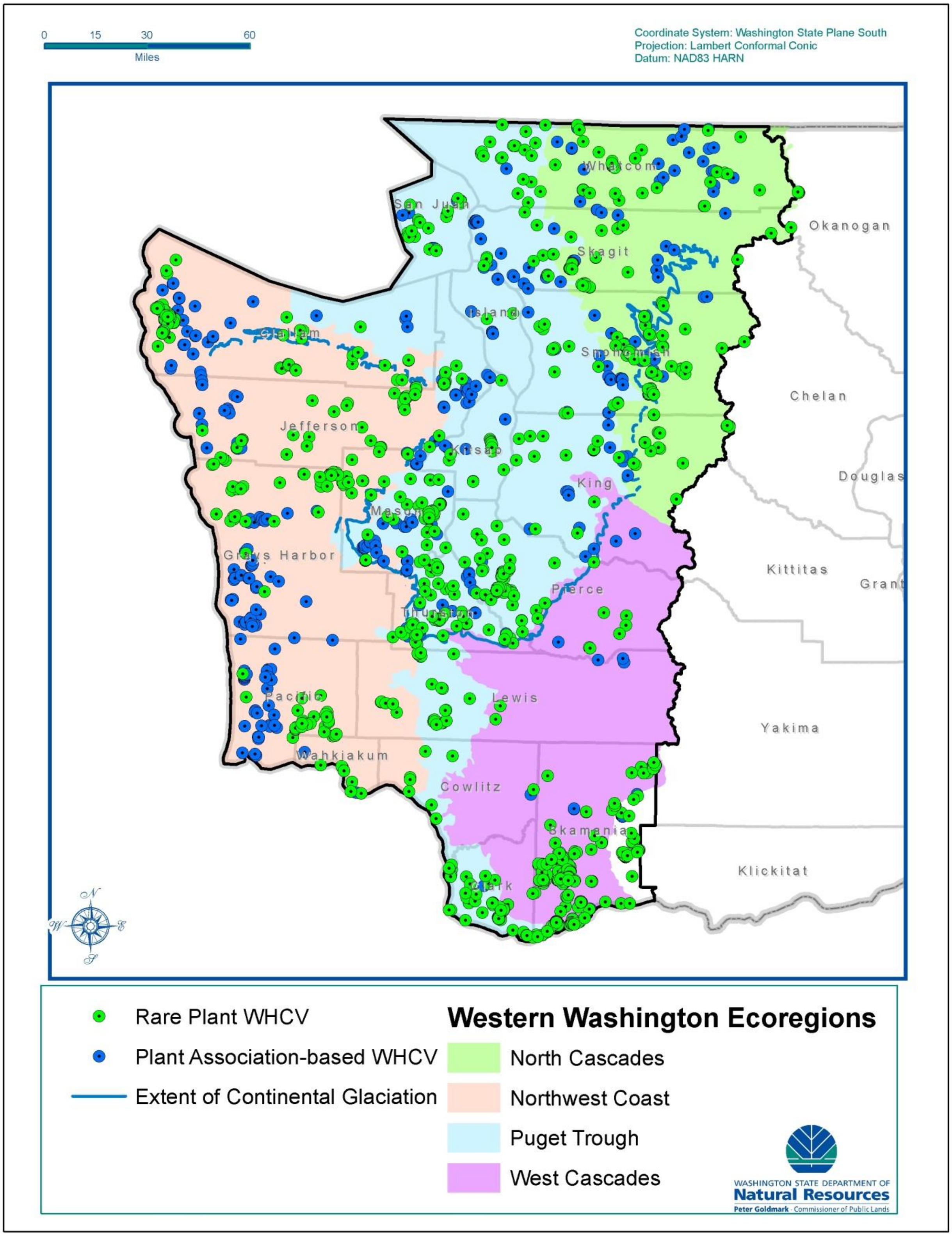

Figure 8. Distribution of All Wetlands of High Conservation Value in Western Washington

to a long-history of agriculture and timber harvesting and a lack of glaciation which left many unique environments for wetland formation in the northern Puget Trough.

8.2.1 Concentration of Plant Association-based Wetlands of High Conservation Value by Geographic Region

The distribution of Plant Association-based WHCV across ecoregions is shown in Figure 8 and Table 14. The Puget Trough ecoregion supports an abundance of WHCV (39% of total) across many USNVC Groups (Table 14). This is likely due to two primary factors: (1) the Puget Trough has experienced the most impact from agriculture and development and (2) much of this ecoregion has been affected by past glaciation (notice the continental ice limits in Figure 8 and the proportion of WHCV which occur on substrates with glacial origin in Table 15). The ecoregion supports one of the rarest wetland types in western Washington--wet prairies (part of the Vancouverian Freshwater Wet Meadow & Marsh Group). Many if not most of the wet prairies are now dominated by nonnative plant species but some rare plants associated with these unique wetland types still occur. The Northwest Coast ecoregion also supports a large number of WHCV (40% of total) due to having very unique ecological templates: (1) coastal beaches, lagoons, and salt marshes and (2) receives the highest rainfall amounts in the lower 48 of the United States; and (3) unique biogeographic patterns associated with some of the wetland species in that ecoregion (Table 14). The Puget Trough and Northwest Coast both support a high concentration of peatlands, salt marshes and lagoons (Table 14).

Much of the montane ecoregions, like the West Cascades and North Cascades ecoregions, have not been thoroughly surveyed by WNHP ecologists. This is primarily due to the assumption that conservation needs are greater in the 'lowland' ecoregions due to past and ongoing land use patterns which have eliminated or degraded many wetland types. Nonetheless, future inventory efforts are needed in these ecoregions to fully identify the conservation significance of western Washington wetlands.

In summary, the ecological templates and land use history associated with each ecoregion explain much of the distribution pattern of known EOs; however, the disparity of survey effort in the various ecoregions cannot be discounted as a factor in the distribution shown in Figure 8.

8.2.2 Distribution Patterns of Plant Association-based Wetlands of High Conservation Value by Geologic Substrate

The Washington Department of Natural Resources Division of Geology and Earth Resources' 1:100K Geology Map of Washington State was intersected with WNHP's GIS layer of WHCV to determine which geologic substrates are associated with WHCV in western Washington. Given that WHCV are mapped more precisely than the resolution of the geology map, this intersection is expected to have some spatial errors. Nonetheless, the results of this analysis show a general distribution of Plant Association-based WHCV across geologic substrates (Figure 9; Table 15).

Seventy four percent of WHCV are associated with three geological templates: (1) Glacial origin; (2) Alluvium and (3) water (Figure 9; Table 15). Geological templates associated with 'glacial origin' include continental and alpine glacial till, drift, outwash and glaciolacustrine deposits and accounted for 37% of WHCV. The overwhelming majority of WHCV in the North Pacific Bog and Acidic Fen Group (68%) and North Pacific Maritime Acidic Fen and Bog Forest

Table 14. Distribution of Plant Association-based Wetlands of High Conservation Value for Each Group across Ecoregions (value = number of Wetlands of High Conservation Value and percentage in parentheses = corresponding proportion)

Ecological System	West Cascades	Northwest Coast	North Cascades	Puget Trough	Total
North Pacific Bog & Acidic Fen Group	10 (6%)	65 (43%)	16 (11%)	60 (40%)	**151 (21%)**
North Pacific Lowland Riparian Forest & Woodland Group	1 (4%)	1 (4%)	10 (37%)	15 (55%)	**27 (4%)**
North Pacific Maritime Hardwood-Conifer Swamp Group	9 (11%)	31 (39%)	22 (28%)	17 (22%)	**79 (11%)**
North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	1 (2%)	32 (51%)	2 (3%)	28 (44%)	**63 (9%)**
North Pacific Neutral - Alkaline Fen Group	12 (21%)	11 (19%)	14 (25%)	21 (35%)	**57 (8%)**
Temperate Pacific Tidal Salt & Brackish Marsh Group	0	100 (63%)		58 (37%)	**158 (22%)**
Vancouverian & Rocky Mountain Montane Wet Meadow Group	3 (20%)	0	11 (73%)	1 (7%)	**15 (2%)**
Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group	1 (14%)	0	6 (86%)	0	**7 (1%)**
Vancouverian Freshwater Wet Meadow & Marsh Group	4 (7%)	23 (41%)	4 (7%)	24 (44%)	**55 (8%)**
Vancouverian Wet Shrubland Group	4 (5%)	24 (29%)	16 (19%)	41 (48%)	**85 (12%)**
Western North American Temperate Freshwater Aquatic Bed Group	1 (5%)	4 (19%)	2 (10%)	14 (39%)	**21 (3%)**
Total	**46 (7%)**	**291 (40%)**	**103 (14%)**	**278 (39%)**	**718**

& Woodland Group (70%) are associated with geologic substrates of glacial origin (Table 15). Substrates of glacial origin were also the most abundant for WHCV in the Vancouverian Wet Shrubland (47%), North Pacific Maritime Hardwood-Conifer Swamp Group (39%), Western North American Temperate Freshwater Aquatic Bed Group (29%), and North Pacific Neutral-Alkaline Fen Group (26%).

As expected, alluvial substrates accounted for the second highest percentage (21%) across all Groups (Figure 9; Table 15). Alluvial substrates accounted for 56% of WHCV in the North Pacific Lowland Riparian Forest & Woodland Group. Twenty six percent of WHCV in the same Group were associated with glacial substrates. This may be an error resulting from discrepancy in scale at which North Pacific Lowland Riparian Forest & Woodland Group WHCV are mapped relative to the precision with which alluvial/glacial deposits are mapped at a 1:100K scale.

Water was the third highest substrate associated with WHCV (16%; Table 15). These are likely wetlands which occur adjacent to water bodies such as ponds, lakes, rivers, or marine waters (Figure 9). This is also reflected in the relatively high proportion of WHCV associated with water in the Temperate Pacific Salt and Brackish Marsh Group (42%), Vancouverian Freshwater Wet Meadow & Marsh Group (23%), and Western North American Temperate Freshwater Aquatic Bed Group (24%) as these wetlands are often associated with open water bodies (Table 15).

Per the DNR Geology map, only 6% of WHCV were associated with Peat Deposits. This "substrate" clearly overlaps with others and adds some confusion to the analysis. For example, by definition the peatland Groups (North Pacific Bog and Acidic Fen Group, North Pacific Maritime Acidic Fen and Bog Forest & Woodland Group, North Pacific Neutral-Alkaline Fen Group) are all associated with peat deposits but this analysis suggested only a minority of those sites were associated with peat. This is likely a scale issue as the geology map is likely only mapping large peat deposits.

The remaining geologic substrates are each associated with 5% or less of the total number of WHCV (Table 15). A few interesting patterns within those types are that serpentine fens, which are a type within the North Pacific Neutral-Alkaline Fen Group, are associated with ultramafic bedrock. The most common Group on substrates of volcanic origin was the North Pacific Neutral-Alkaline Fen Group. Although not evident in Figure 9 or Table 15 (due to the analysis being performed at the USNVC Group level) wet prairies, which are a type within the Vancouverian Freshwater Wet Meadow & Marsh Group, are associated with Missoula flood deposits in the Willamette Valley and glacial outwash in the Puget lowlands. They are also known to be associated with alluvium in the Columbia River floodplain.

Table 15. Geological Substrates of Known Plant Association-based Wetlands of High Conservation Values

USNVC Groups	Alluvium	Beach/Coastal Deposits	Glacial Origin	Igneous Bedrock	Mass-wasting Deposits	Metamorphic Bedrock	Missoula Flood Deposits	Peat Deposits	Sedimentary Bedrock	Talus	Ultramafic Rock	Volcanic Origin	Water	Total
North Pacific Bog & Acidic Fen Group	13 (9%)	0	102 (68%)	0	2 (1%)	0	0	4 (3%)	9 (6%)	0	2 (1%)	6 (4%)	13 (8%)	**151 (21%)**
North Pacific Lowland Riparian Forest & Woodland Group	15 (56%)	0	7 (26%)	0	0	3 (11%)	0	0	0	0	0	2 (7%)	0	**27 (4%)**
North Pacific Maritime Hardwood-Conifer Swamp Group	22 (28%)	1 (1%)	31 (39%)	0	2 (3%)	9 (11%)	0	2 (3%)	2 (3%)	3 (4%)	0	5 (6%)	2 (3%)	**79 (11%)**
North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	4 (6%)	1 (2%)	44 (70%)	0	0	0	0	8 (13%)	3 (5%)	0	0	1 (2%)	2 (3%)	**63 (9%)**
North Pacific Neutral - Alkaline Fen Group	5 (9%)	0	15 (26%)	0	1 (2%)	1 (2%)	0	2 (4%)	5 (9%)	0	9 (16%)	10 (18%)	9 (16%)	**57 (8%)**
Temperate Pacific Tidal Salt & Brackish Marsh Group	56 (35%)	19 (12%)	7 (4%)	0	0	0	0	9 (6%)	0	0	0	0	67 (42%)	**158 (22%)**
Vancouverian & Rocky Mountain Montane Wet Meadow Group	2 (13%)	0	1 (7%)	0	1 (7%)	5 (33%)	0	1 (7%)	0	0	2 (13%)	1 (7%)	2 (13%)	**15 (2%)**
Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group	0	0	0	2 (29%)	1 (14%)	2 (29%)	0	0	0	2 (29%)	0	0	0	**7 (1%)**

USNVC Groups	Alluvium	Beach/Coastal Deposits	Glacial Origin	Igneous Bedrock	Mass-wasting Deposits	Metamorphic Bedrock	Missoula Flood Deposits	Peat Deposits	Sedimentary Bedrock	Talus	Ultramafic Rock	Volcanic Origin	Water	Total
Vancouverian Freshwater Wet Meadow & Marsh Group	17 (30%)	1 (2%)	11 (20%)	0	0	0	2 (4%)	6 (11%)	1 (2%)	0	0	4 (7%)	13 (23%)	**55 (8%)**
Vancouverian Wet Shrubland Group	18 (21%)	6 (7%)	40 (47%)	2 (2%)	0	5 (6%)	0	5 (6%)	1 (1%)	0	0	3 (4%)	5 (6%)	**85 (12%)**
Western North American Temperate Freshwater Aquatic Bed Group	2 (10%)	0	6 (29%)	0	0	0	0	2 (10%)	1 (5%)	0	4 (19%)	1 (5%)	5 (24%)	**21 (3%)**
Totals	**154 (21%)**	**28 (4%)**	**264 (37%)**	**4 (1%)**	**7 (1%)**	**25 (3%)**	**2 (<1%)**	**39 (6%)**	**22 (3%)**	**5 (1%)**	**17 (2%)**	**33 (5%)**	**118 (16%)**	**718**

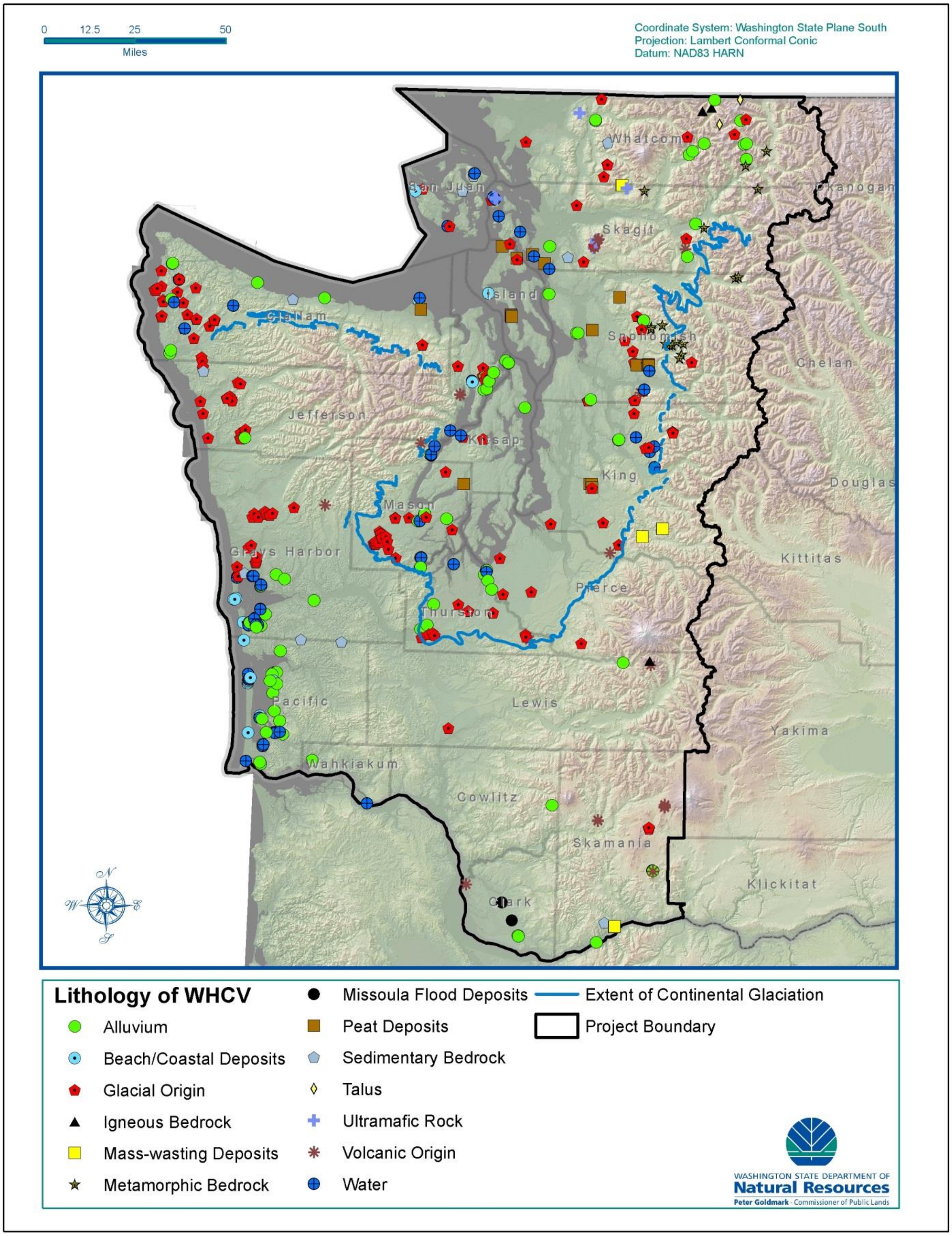

Figure 9. Distribution of Plant Association-based Wetlands of High Conservation Value on Geologic Substrates

8.2.3 Concentration of Plant Association-based Wetlands of High Conservation Value Relative to Landscape Integrity

Figure 10 shows the distribution of WHCV relative to landscape integrity. Landscape integrity was measured using the Landscape Integrity Model (Comer and Hak 2009), a GIS-based algorithm which uses various land use GIS layers (roads, land cover, water diversions, groundwater wells, dams, mines, etc.) weighted according to their perceived impact on ecological integrity, into a distance-based, decay function to determine what effect these stressors have on landscape integrity. Each pixel in then assigned a score which results in a map depicting landscape integrity (Figure 10). According to this analysis, most WHCV are found in areas with low integrity, although this is also a function of most EOs being located in the lowlands.

Landscape integrity can also be assessed using a Level 1 EIA. The Level 1 EIA uses adjacent land use to predict onsite ecological integrity of a given wetland (see section 4.2.3). Twenty percent of WHCV were not assigned a Level 1 EIA score due to lack of data in the model inputs. In contrast to the Landscape Integrity Model, this method showed that most (79%) WHCV have a high Level 1 EIA rank (e.g., A & B; Figure 11) with the majority having the highest integrity rank (51%). This isn't surprising since during the initial surveys for WHCV in the 1980's and 1990's, sites were prioritized for field surveys based on the relative integrity of the surrounding landscapes, as observed on aerial photographs. A large percentage of known WHCV resulted from these early surveys.

8.2.4 Concentration of Plant Association-based Wetlands of High Conservation Value by USNVC Group

A large percentage of the Wetlands of High Conservation Value are in the North Pacific Bog and Acidic Fen Group (151; 21%) and Temperate Pacific Salt and Brackish Marsh Group (152; 22%) (Table 14; Figure 12; Figure 13). These numbers reflect the fact that these two Groups are among those with the highest percentage of Global (Figure 5) and State (Figure 6) rare plant associations. Due to this and a regional conservation interest in these wetland types, these Groups have received more inventory attention than other wetland types. All other Groups have ≤ 12% of WHCV (Table 14; Figure 12; Figure 13). North Pacific Bog and Acidic Fen Group WHCV are primarily found in areas which experienced continental or alpine glaciation (Figure 12). The Temperate Pacific Salt and Brackish Marsh Group WHCV are located on the outer coast and shoreline of Puget Sound (Figure 13). North Pacific Lowland Riparian Forest and Woodland Group WHCV are widespread although conspicuously missing from the NW Olympic peninsula (Figure 12). This is likely due to a lack of focused survey in this area and possibly due to few remaining viable examples of this type due to impacts to riparian zones from widespread logging. Vancouverian Wet Shrubland Group WHCV are found primarily in three areas: (1) glaciated areas in the Puget lowlands; (2) Lake Ozette area on the NW Olympic peninsula; and (3) southwest Washington in freshwater tidal and interdunal wetlands (Figure 13). The Vancouverian Freshwater Wet Meadow & Marsh Group WHCV are widespread, although wet prairies WHCV (a Natural Community Type in this Group) are limited to glacial outwash areas in Thurston County and Missoula flood deposits in Clark County (Figure 13). The Western North American Freshwater Aquatic Bed Group WHCV are primarily found behind the limits of continental glaciation due to the numerous ponds, lakes, and peatland pools created as the ice retreated (Figure 13).

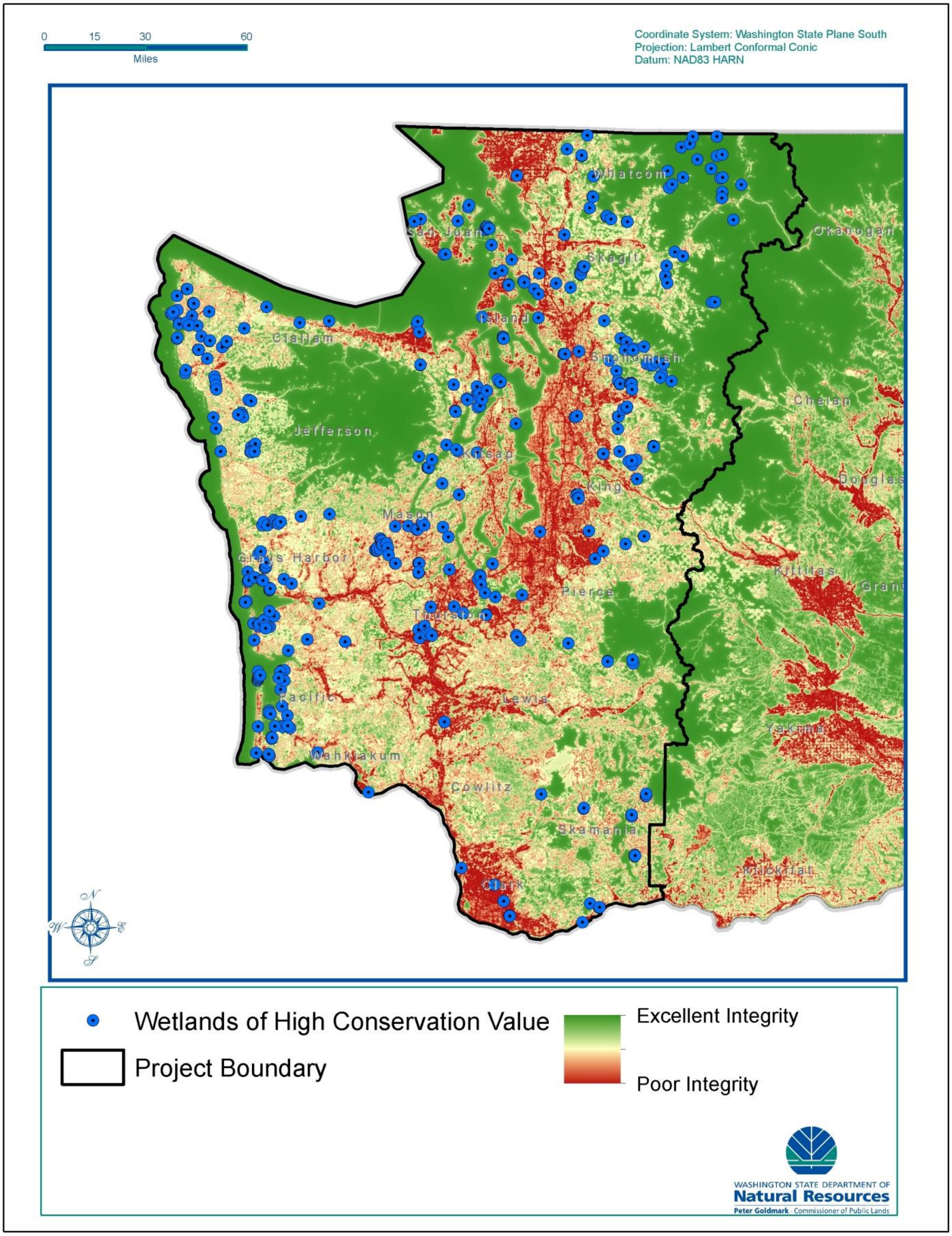

Figure 10. Distribution of Plant Association-based Wetlands of High Conservation Value Relative to Landscape Integrity (notice that water bodies, including marine waters, were defaulted to high integrity)

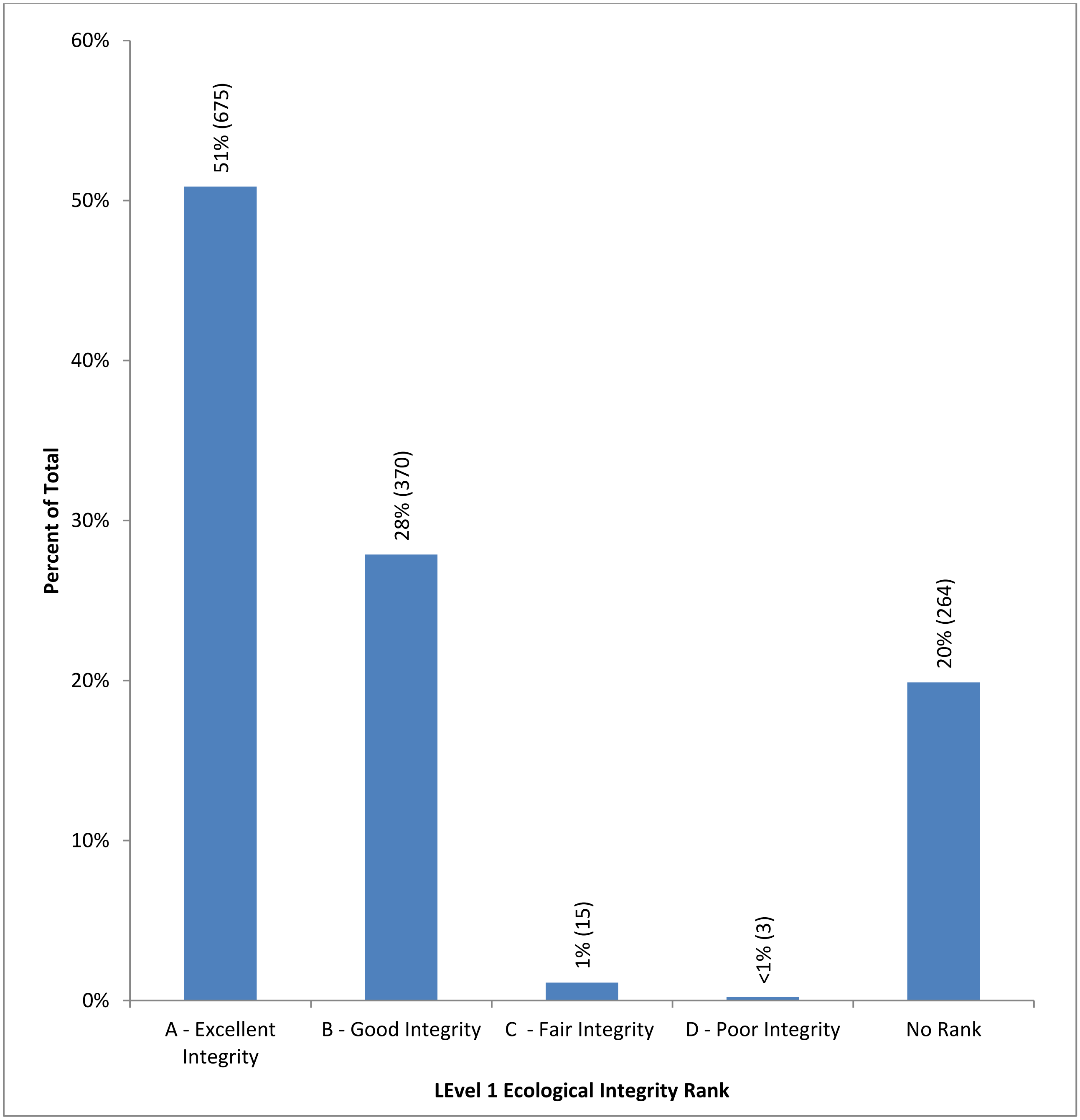

Figure 11. Distribution of Level 1 EIA Ranks of Plant Association-based Wetlands of High Conservation. (Percentages above bars are based on total number of features (i.e. individual polygons—a WHCV may be comprised of multiple polygons); values in parantheses are the number of features per rank)

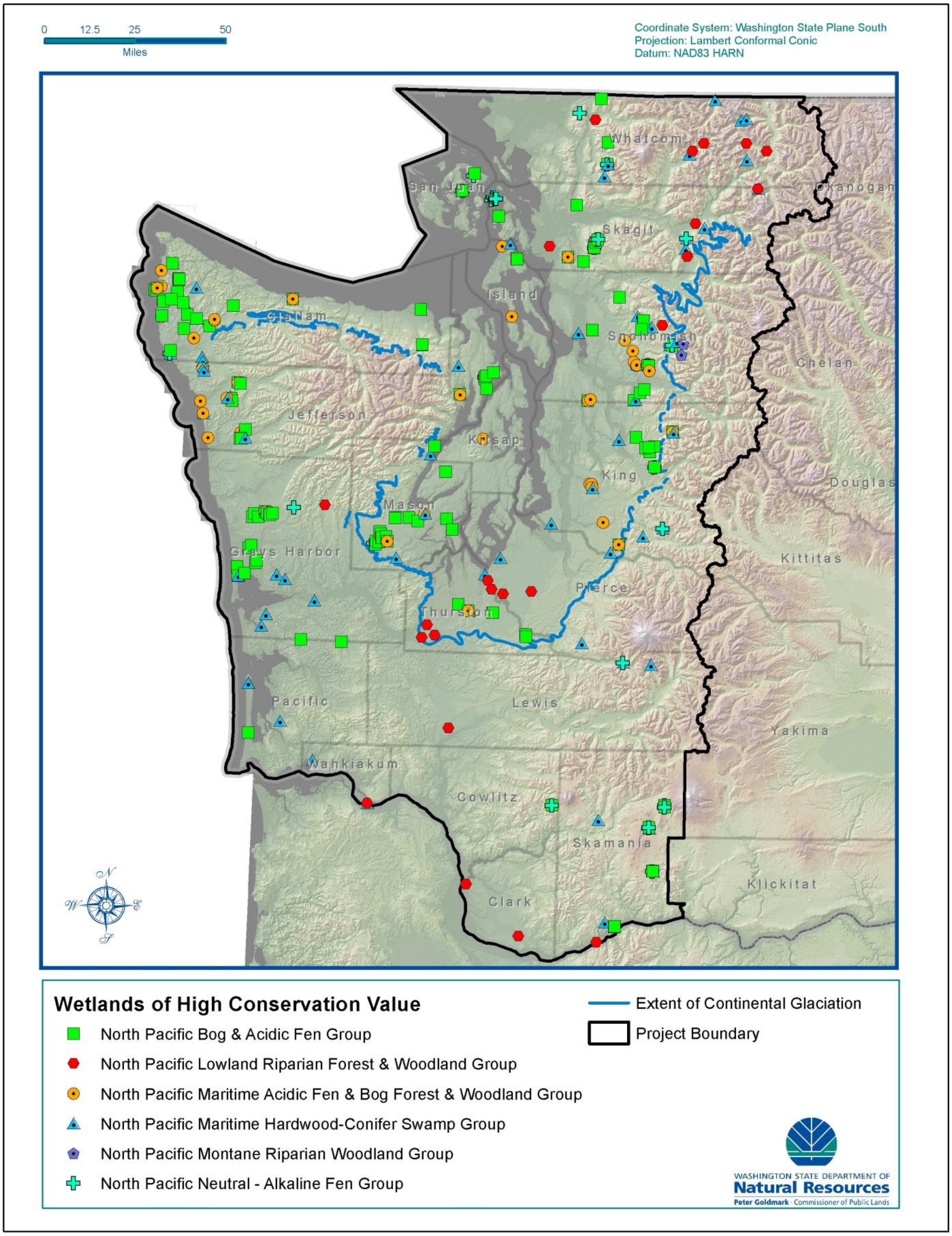

Figure 12. Plant Association-based Wetlands of High Conservation Value Grouped by USNVC Groups (North Pacific Groups)

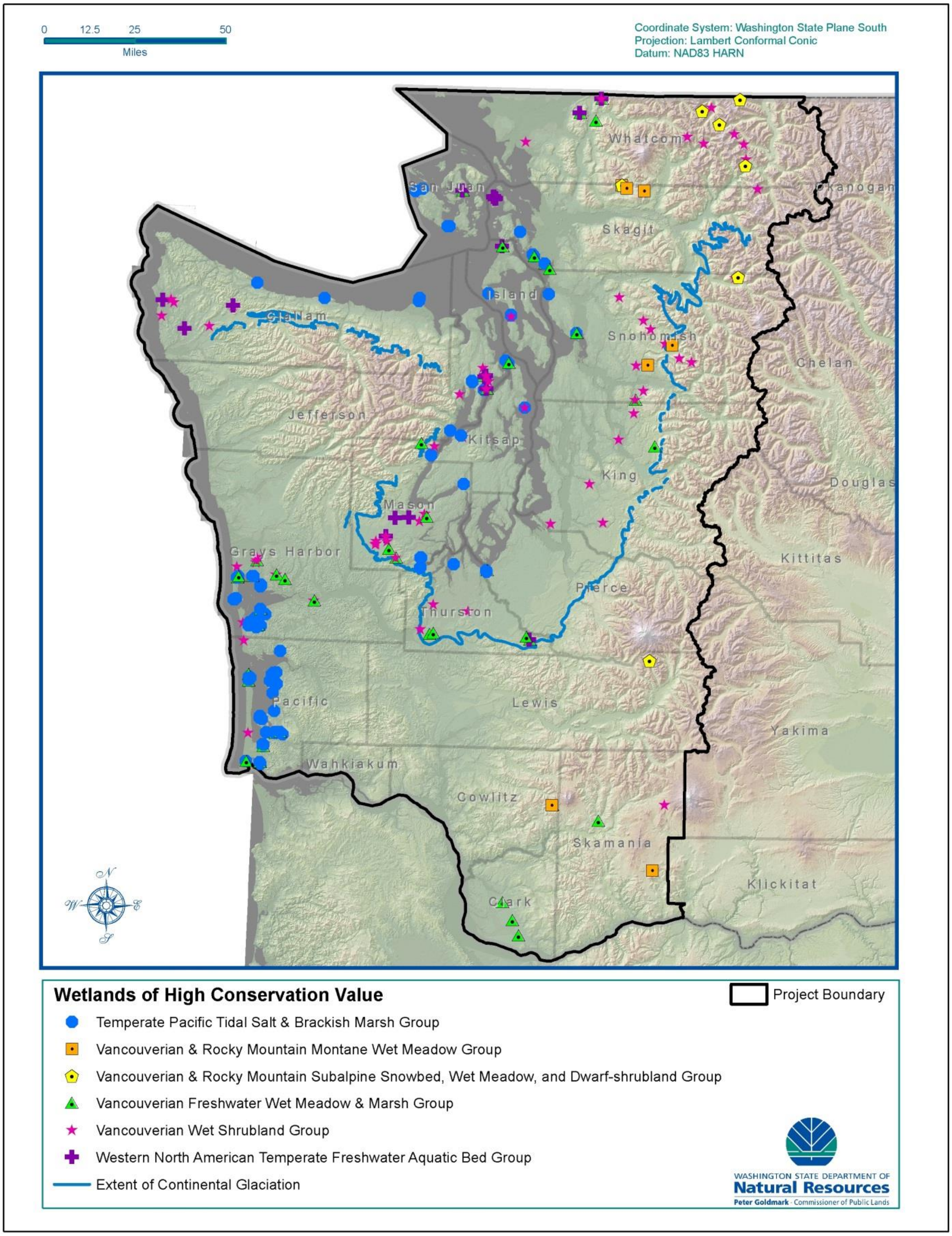

Figure 13. Plant Association-based Wetlands of High Conservation Value Grouped by USNVC Groups (Remaining Groups)

8.2.5 Inventory Needs

The distribution of known Plant Association-based WHCV across wetland ecological types (Appendix A) provides an overview of the level of inventory effort needed for each level of the classification hierarchy. Inventory priorities should be set on those wetland types with few to no WHCV associated with them. Conversely, wetland types with numerous WHCV associated with them are a lower inventory priority.

In an effort to standardize inventory prioritization, each level of the USNVC hierarchy from Group to Plant Association type were categorized as having High, Moderate, or Low inventory needs (Appendix A). At this time, this analysis is simply based on the number of known WHCV (or element occurrences). Future revisions of this analysis may consider level of past survey efforts to discern whether low WHCV numbers is a result of a lack of inventory versus lack of high-quality occurrences. This is more difficult to assess as inventories have often occurred opportunistically or specific targets were not stated. The inventory need categories are:

- High = ≤ 3 known WHCV documented in WNHP's Information System
- Moderate = 4-7 known WHCV documented in WNHP's Information System
- Low = ≥ 8 known WHCV documented in WNHP's Information System

The list can be further prioritized by focusing on those types with the lower (i.e., more rare) Global and State ranks first within each of the high, moderate, or low inventory need categories.

8.4 Conclusions

The concentration of Plant Association-based WHCV in the Puget Trough (specifically in the Puget Sound basin) is primarily due to unique ecological templates left by glaciation and because many wetland types in the basin have been dramatically impacted by human activity resulting in many of those wetland types becoming rare. The very wet and temperate climate of the outer coast and the corresponding biogeographic patterns result in an abundance of EOs in Northwest Coast ecoregion. The unique ecological template left by the Pleistocene Missoula floods in the Willamette Valley ecoregion allowed the development of rare wet prairies. Unfortunately very little of these prairies remain intact today due to conversion to agriculture and from being degraded by a variety of land uses. However, many of the degraded wet prairies still support rare wetland plants. A lack of inventory effort in the montane to alpine regions of western Washington precludes any conclusions regarding patterns of WHCV in those areas.

Many wetland types need additional inventory (Appendix A). It is not clear whether the lack of WHCV identified for these types is due to a lack of focused inventory efforts or lack of ecological quality necessary to meet WHCV criteria, or simply drastic loss from the landscape. Additional inventory effort will help clarify these questions.

The fact that the majority of the WHCV appear to remain embedded in relatively intact landscapes (as measured by the Level 1 EIA) relative to when they were originally documented by WNHP 20-30 years ago, is encouraging for their conservation. This may also suggest that management and conservation actions, whether due to regulatory or voluntary mechanisms are sufficient to maintain ecological integrity of these wetlands. However, more intensive and focused research of this question is needed before making any conclusive statements.

9 Current Protection Status of Plant Association-based Wetlands of High Conservation Value

9.1 Introduction

Wetland protection can be defined using many different criteria and for a variety of purposes. In this section, the protection status of WHCV is considered from two perspectives: (1) the number of WHCV that occur on lands devoted to protecting biodiversity and (2) the number of WHCV represented within the statewide system of natural areas. There is overlap between these two assessments but the latter is a more restrictive analysis.

9.2 Methods for Assessing Protection Status and Representation within Natural Areas

9.2.1 Assessing Overall Protection Status

The Protected Areas Database of the U.S. (PAD-US) is the official inventory of protected open space in the United States. PAD-US is a GIS database hosted by the USGS Gap Analysis Program (GAP) and can be downloaded from the USGS PAD-US web site (http://gapanalysis.usgs.gov/padus/). The spatial data in PAD-US includes public lands held in trust by national, state and some local governments and by some non-profit conservation organizations. Data sources include significant contributions and large aggregated datasets from the Bureau of Land Management (National Operations Center), the U.S. Forest Service (Automated Lands Program), and The Nature Conservancy. Many other federal, state, local, non-governmental organizations and land trusts provided highly valuable data that was more limited in scope. All lands in the database are assigned GAP conservation status codes to indicate the level of protection. The codes are:

- 1 - managed for biodiversity - disturbance events proceed or are mimicked
- 2 - managed for biodiversity – disturbance events suppressed
- 3 - managed for multiple uses – subject to extractive (e.g. mining or logging) or OHV use
- 4 - no known mandate for permanent protection

For this project, the codes were translated into three protection status categories:

- Protected – GAP codes 1 or 2 and any other information suggesting the WHCV feature occurs within a management unit meeting the "protection" definition described above.
- Public Land/Unknown Protection Status – GAP code 3 or other information suggesting the WHCV feature occurs on public lands but management objectives of the land are unknown.
- Not Protected – GAP code 4 or a WHCV feature which occurs on private land not identified as being managed for biodiversity. Also included here are lands not covered by PAD-US—these lands are assumed to be under private ownership with no protection status.

The protection status of a WHCV was assessed by intersecting the spatial location of WHCV with the PAD-US and incorporating any other information that was useful for assigning a protection status category to each WHCV. Using ArcGIS, WHCV were assigned the PAD-US codes they intersected with (per the cross-walk above). If no intersection occurred with the PAD-US database, and no other information was available to inform the current protection status, the WHCV was assigned a Not Protected status.

9.2.2 Assessing Representation within the Statewide Natural Areas System

The 1981 amendment of the Natural Area Preserves Act (RCW 79.70) mandated WNHP to develop a biennial plan to guide the implementation of the Act. The purpose of this plan (Natural Heritage Plan) is to identify which priority species and ecosystems should be considered in the selection of potential natural areas and to develop a set of criteria and a process by which natural areas are selected (WADNR 2007). The process for determining Natural Heritage Priorities differs for species and ecosystems. Species priorities are primarily based on the Global/State Conservation Status Ranks but other factors such as distribution patterns, demographic issues, and habitat quality are considered. Ecosystem priorities are based on Global/State Conservation Status Ranks, threats, and representation in the natural areas system (WADNR 2007). The ecosystem priorities are assigned one of the following categories:

- Priority 1 – these ecosystem elements have little to no representation on lands dedicated to biodiversity protection (see section 9.1), or little to no representation on other public lands, and appear to be in the greatest jeopardy of being destroyed or degraded. These ecosystems often have been greatly reduced in their extent and typically have very few known occurrences in their natural condition.
- Priority 2 – these ecosystem elements (1) are rare or highly threatened with some existing, but not adequate, representation on lands dededicated to biodiversity protection; or (2) have an intermediate degree of threat and rarity with little to no representation on lands dedicated to biodiversity protection.
- Priority 3 – these ecosystem elements are lower priority due to the fact that they are no in immediate jeopardy of being eliminated or degraded in Washington, but are not yet adequately represented on lands dedicated to biodiversity protection. These elements are typically not rare or threatened. They are often protected *de facto* on public lands (especially National Parks and Wilderness Areas) but are not represented well on lands dedicated to biodiversity protection.
- Protection Adequate – these ecosystem elements have adequate representation (generally at least three occurrences within an ecoregion) on lands dedicated to biodiversity protection.

The framework is applied to individual ecoregions in order to account for geographic variation of each ecological element. The current list of priorities (which does not include most wetland types discussed in this report) can be found here: http://www1.dnr.wa.gov/nhp/refdesk/plan/CommunityList.pdf

The statewide system of natural areas includes Washington Dept. of Natural Resources Natural Area Preserves & Natural Resource Conservation Areas, Washington Department of Fish & Wildlife and Washington State Parks and Recreation Commission Natural Area Preserves, Federal Research Natural Areas, and private preserves focused on biodiversity protection (e.g., land trusts, The Nature Conservancy, etc.). WHCV were intersected with spatial locations of management areas within the statewide system of Natural Areas to determine the level of representation of each wetland type.

9.3 Results

9.3.1 Protection Status of Plant Association-based Wetlands of High Conservation Value

Of the 718 Plant Association-based Wetlands of High Conservation Value, 31% are considered protected while the remaining 69% either have no protection (64%) or occur on public land (5%) with unknown or inadequate protection status (Appendix A; Figure 14). The protection status across USNVC Groups, Natural Community Types, and USNVC Associations is shown in Appendix A. This information can be used to identify which WHCV (at different classification scales) lack protection and thus direct conservation actions to sites supporting those wetland types. However, determining protection priorities of those WHCV is a complicated process that considers the conservation status rank (e.g., the relative risk of extinction/rarity; G/S rank), ecological integrity of individual occurrences, and current level of protection of each wetland type. Those data are included in Appendix D but WNHP has not systematically analyzed those pieces of data to identify a finer-level level of protection priorities. WNHP may conduct this analysis in the future but in the meantime WHCV currently lacking protection should be considered priorities for conservation action.

9.3.2 Natural Area Representation Needs

Of the 718 Plant Association-based Wetlands of High Conservation Value, 178 (25%) are represented within the statewide system of natural areas (Appendix D; Figure 15). The entire list of wetland types found in western Washington are listed in Appendix D to provide a comprehensive picture of which types are represented in the natural areas system. Patterns from this table can be gleaned from various hierarchical scales in the classification. For example, of the 272 unique Associations in western Washington, 34% (93) are within the natural areas system (Appendix D). However, since Associations can occur in more than one Natural Community Type, 23% (100) of the 427 unique combinations of Natural Community Type-Association are represented in the natural areas system (Appendix D). There are also patterns associated with the distribution of WHCV in the natural areas system. For example, the Northwest Coast ecoregion contains the highest number (77 or 43%; Figure 15) of WHCV represented in natural areas. The Puget Trough also contains a high number (47 or 26%; Figure 15). At the Group level, the majority of WHCV represented in natural areas in the North Pacific Bog & Fen and Temperate Pacific Salt & Brackish Marsh groups are found in the Northwest Coast ecoregion (Appendix D). Fifty four percent (13 of 24) of the North Pacific Maritime Hardwood-Conifer Swamp WHCV found in natural areas are in the North Cascades ecoregion (Appendix D). Sixty five percent (13 0f 20) of the North Pacific Neutral-Alkaline Fen WHCV found in natural areas are in the Puget Trough ecoregion, although all but one of those are serpentine fens found almost exclusively on Cypress Island (Appendix D). These types of patterns as well as consideration of threats and conservation status ranks of each elements will provide the foundation from which WNHP will ultimately assign Natural Heritage Plan Priorities (i.e. Priority 1, 2, 3, or Adequate) to each of the elements listed in Appendix D.

9.4 Conclusions

Only 31% of the 718 Plant Association-based WHCV are considered protected while 69% lack adequate protection. Although derived from a coarse analysis, these results suggest the vast majority of WHCV remain unprotected. This does not mean that those WHCV are in immediate danger of degradation or extirpation but it does highlight the level of conservation action needed to assist with their long-term viability. Only 25% of the WHCV are represented in the statewide system of natural areas. However, 34% (93) of the 272 Associations and 23% of the 427 unique Natural Community Type-Association combinations are represented in the statewide natural areas system. The protection status shown in Appendix D along with their conservation status ranks can help guide conservation actions toward those wetland types in most need of protection.

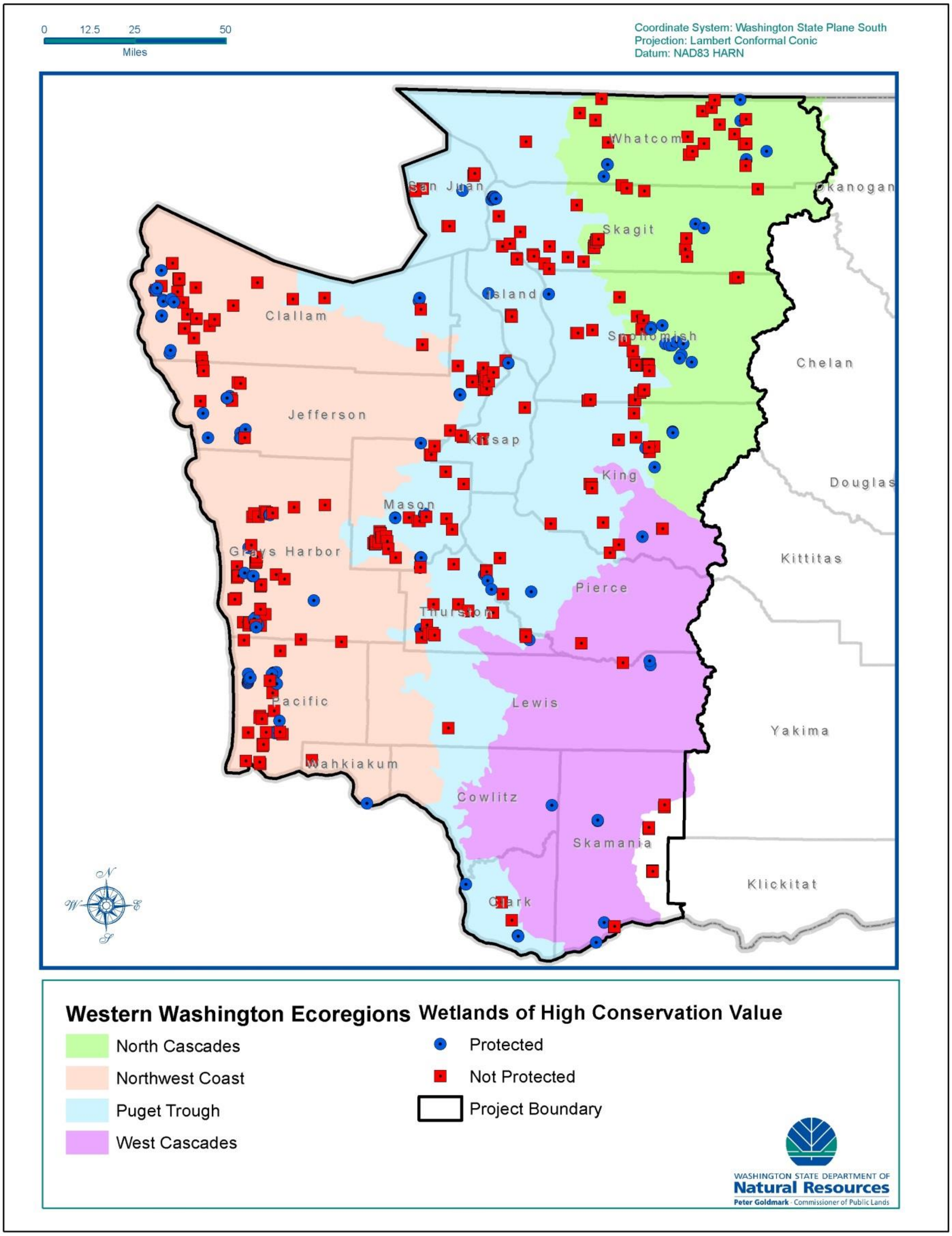

Figure 14. Protection Status of Plant Association-based Wetlands of High Conservation Value (Public Land/Unknown Protection Status and Not Protected Status are lumped here as Not Protected)

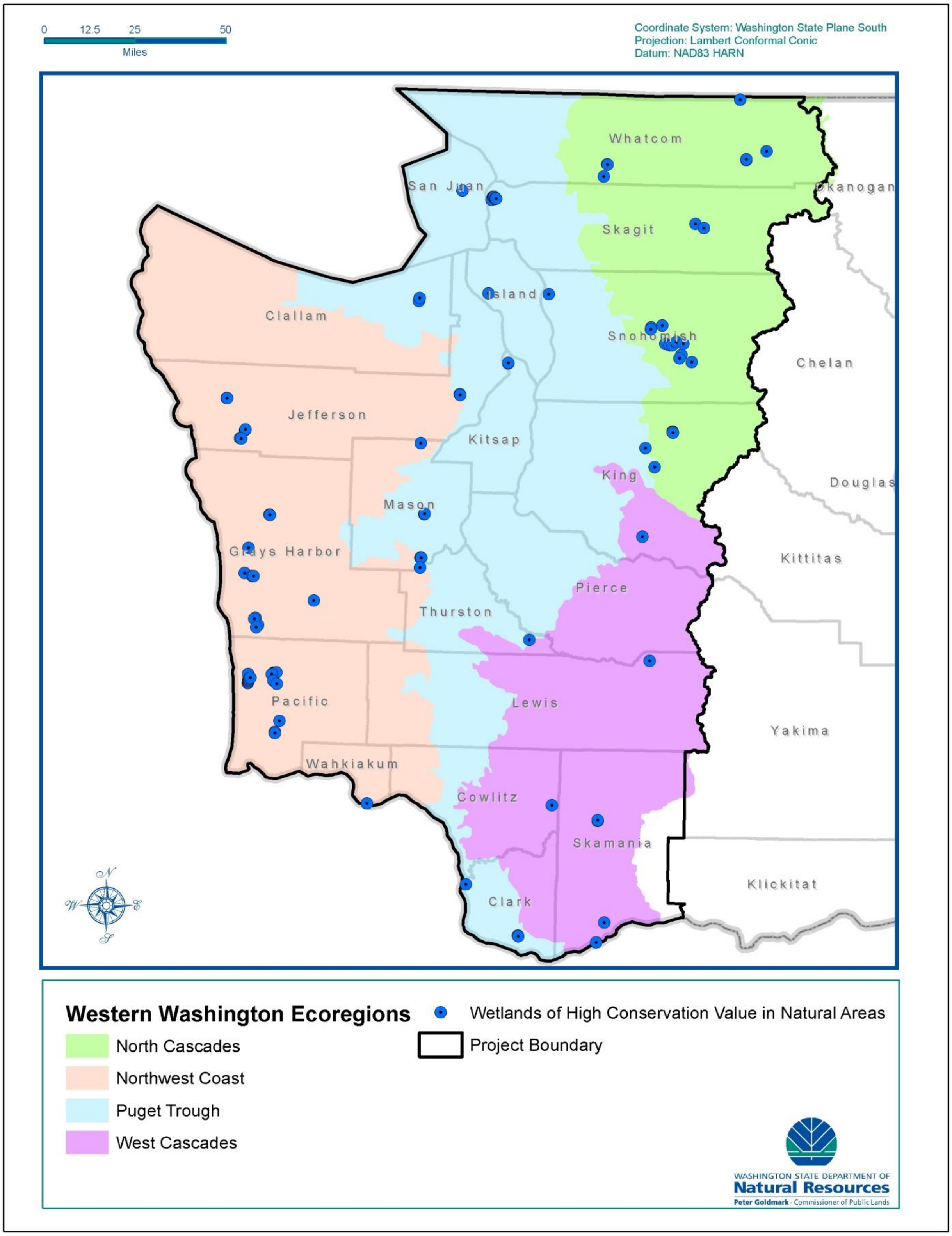

Figure 15. Plant Association-based Wetlands of High Conservation Value within natural areas

10 Locations of Potential New Plant Association-based Wetlands of High Conservation Value

10.1 Introduction

A Level 1 EIA (see Section 4.2.3) was used to identify wetlands which have the potential to meet the criteria for being a Wetland of High Conservation Value. The analysis is coarse but may help focus future field survey efforts toward those wetlands surrounded by relatively intact buffers and landscapes.

10.2 Methods

The Level 1 EIA used here is an overall index that aggregates four metrics characterizing ecological integrity of the buffer and surrounding landscape of a particular wetland. No metrics were used to assess Size or Condition of the wetland. Thus, the Level 1 EIA is a direct assessment of the buffer and landscape context and a surrogate measure (or predictor) of on-site condition of a given wetland. The ability of the Level 1 EIA to predict onsite ecological integrity is discussed in Section 11.3.4.

As noted in Section 4.2.3, WNHP modified an approach developed by NatureServe for automating the assessment of buffer and landscape context metrics using GIS (Lyons 2009). The method was applied to all Palustrine and Lacustrine wetlands contained on digital versions of National Wetland Inventory maps. The result is that each NWI polygon receives an overall Level 1 EIA score and rank (see section 4.2.3 and Appendix B for further details). Potential Wetlands of High Conservation Value were defined as an NWI polygon with a Level 1 EIA "A" rank (i.e. had a score ≥ 0.9).

10.3 Results

The results of the analysis are shown in Figure 16. Many of the Potential Plant Association-based Wetlands of High Conservation Value appear to occur along river and/or stream corridors, especially on the western portion of the Olympic peninsula and in upper elevations of the Olympic Mountains and Cascades (Figure 16). There are also numerous wetlands in the Puget Sound basin, especially on the Kitsap peninsula and near the foothills of the Cascades that had a high Level 1 EIA rank (Figure 16). Other areas of high potential include the flat lowlands of Lewis and Cowlitz counties (possibly wet prairies), and near the Columbia River in the Willamette Valley ecoregion (Figure 16).

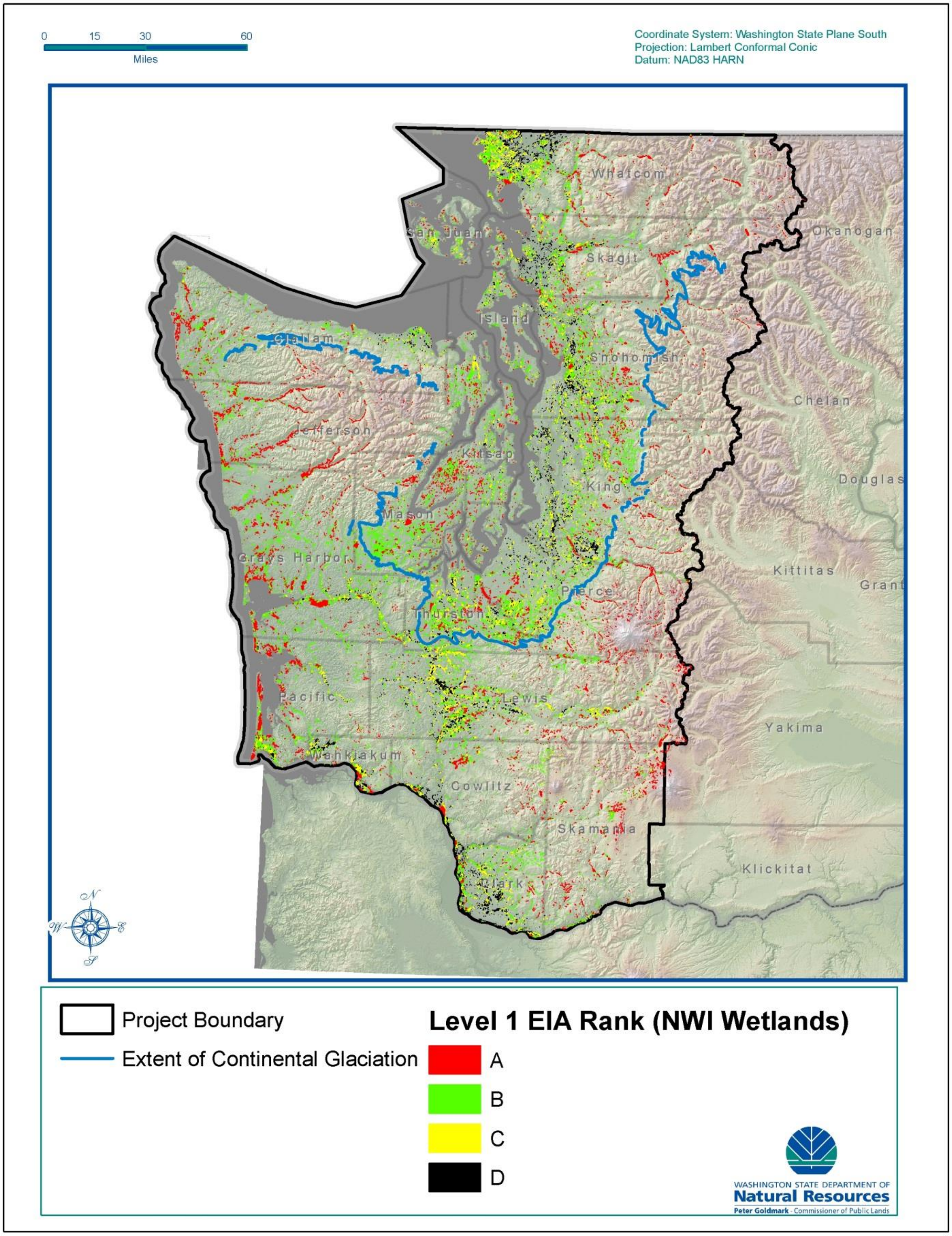

Figure 16. Potential Wetlands of High Conservation Value

10.4 Conclusions

The results of this GIS analysis suggest that there are numerous NWI wetland polygons that may meet the criteria of an Plant Association-based Wetland of High Conservation Value. However, the analysis is coarse and only based on adjacent land cover/land use as depicted in the underlying base map (i.e., Ecological Systems maps; see Section 4.2.3). The results do not mean these wetlands will qualify as WHCV only that the integrity of the immediate and surrounding landscape is of sufficient quality to suggest onsite ecological conditions may have high integrity. The analysis did not attempt to model what *type* of wetland the NWI polygon may represent, which is another criteria used to determine Plant Association-based Wetland of High Conservation Value status (see Section 3.6). Despite these shortcomings, this analysis may prove useful to prioritize future field surveys toward those sites more likely to meet WHCV criteria.

Finally, the Level 1 EIA assigned every NWI polygon an EIA rank (see accompanying geodatabase). This rank provides coarse information about the overall range of ecological conditions of NWI wetlands in a particular landscape. As such, the Level 1 EIA ranks can be used for a variety of landscape or watershed scale analyses including creating watershed wetland profiles (Johnson 2005), designing watershed wetland ambient monitoring protocols (Lemly et al. 2011), guiding site-level field surveys (Rocchio and Crawford 2009; Faber-Langendoen et al. 2012), and assist in identifying a reference network of wetlands (Faber-Langendoen et al. 2012).

11 Vegetation Composition, Ecological Integrity, Wetland Functions, and Stressors Associated with Plant Association-based Wetlands of High Conservation Value

11.1 Introduction

The number of wetlands prioritized for field surveys and the number of wetlands that were actually visited are summarized in Table 16 and shown in Figure 17. A total of 256 Plant Association-based Wetlands of High Conservation Value (at 109 unique sites) were visited, with 170 of those being known and 86 being newly documented Plant Association-based Wetlands of High Conservation Value occurrences (Table 16). Thus, 36% of the 718 WHCV (which includes newly documented sites) in western Washington were revisited and information updated in WNHP database. The primary reason not all the targeted wetlands were visited is due to time constraints. Because sites were distributed across ecoregions, they typically were not spatially aggregated thereby resulting in increased travel time between sites. Travel time coupled with time spent at an individual site (anywhere from a few hours to a full day) often resulted in only one or two sites being surveyed per day. Other factors such as being denied access by private landowners and occasionally being unable to physically access a wetland (e.g., water levels were too high in areas where boats were not feasible to use; impenetrable woody vegetation; treacherous areas of deep muck) also contributed to limiting the number of wetlands that WNHP was able to visit.

The sample site selection process often directed field work to a site where more than one WHCV occurred. In order to expedite field time and ensure that we were able to visit as many sites as possible, not all WHCV at a given site were assessed using the EIA methods. EIAs were used to update information on those WHCV selected for field sampling while general observations were made about the other WHCV that occurred at the same site. Of the 256 visited, 81% (207) were assessed using the Level 2 EIA while the remaining 19% (49) were updated based on field observations (Table 17).

Table 16. Summary of Field Sites Visited During Phase 1 and Phase 2. WHCV = Wetlands of High Conservation Value

	Phase 1	Phase 2	Totals
Known WHCV Targeted	100	134	**234**
Known Plant Association-based WHCV Visited/Updated	106	64	**170**
Potential WHCV Targeted	25	76	**101**
New Plant Association-based WHCV Documented	21	65	**86**
Total	**127**	**129**	**256**

Datasets associated with the vegetation composition, ecological integrity, wetland functions, and stressors were collected at most sites (Table 18). Vegetation plot data was collected to help with classification of western Washington wetland types and provide an overview of floristics within each wetland type. The resulting classification is presented in Appendix A and a forthcoming publication from WNHP will provide more detail about this classification scheme (Rocchio and

Crawford *In Progress*). Methods used to collect and analyze the data are reviewed in Section 5. An exploratory analysis of trends in ecological integrity, wetland functions, and stressors associated with the Wetlands of High Conservation Value visited are discussed in this Section.

Table 17. Number of Plant Association-based Wetlands of High Conservation Value Revisited

Project Phase	Unique Sites Visited	WHCV Assessed with Level 2 EIA	WHCV Assessed with Observation Data	Total WHCV Assessed
Phase 1 (2011)	51	86	41	127
Phase 2 (2012)	58	121	8	129
Totals	**109**	**207**	**49**	**256**

Table 18. Number of Datasets collected from Plant Association-based Wetlands of High Conservation Value

Project Phase	Level 2 EIA	Stressor Checklist	Wetland Rating System	Vegetation Plots
Phase 1 (2011)	86	86	85	170
Phase 2 (2012)	121	121	95	204
Total	**207**	**207**	**180**	**374**

11.2 Methods

11.2.1 Vegetation Composition

Vegetation releve plots (typically 100m^2 for herbaceous and shrubland types and 400m^2 for forested types) were established in most of the wetland sites visited. The releve plots were placed within homogenous vegetation types and ecotones were avoided when possible. GPS locations and water chemistry (when applicable) measures such as pH, electrical conductivity, and temperature were collected within the plot. See section 5.5.2 for more details on plot data collection.

Vegetation plot data was summarized for each of the USNVC Groups using the Western WA FQA calculator (http://www1.dnr.wa.gov/nhp/refdesk/communities/fqa.html).

11.2.2 Assessing Ecological Integrity

Most of the 718 Plant Association-based WHCV in WNHP’s BIOTICS database have an EO rank (i.e., ecological integrity rank) that were assigned using a guided best professional judgment

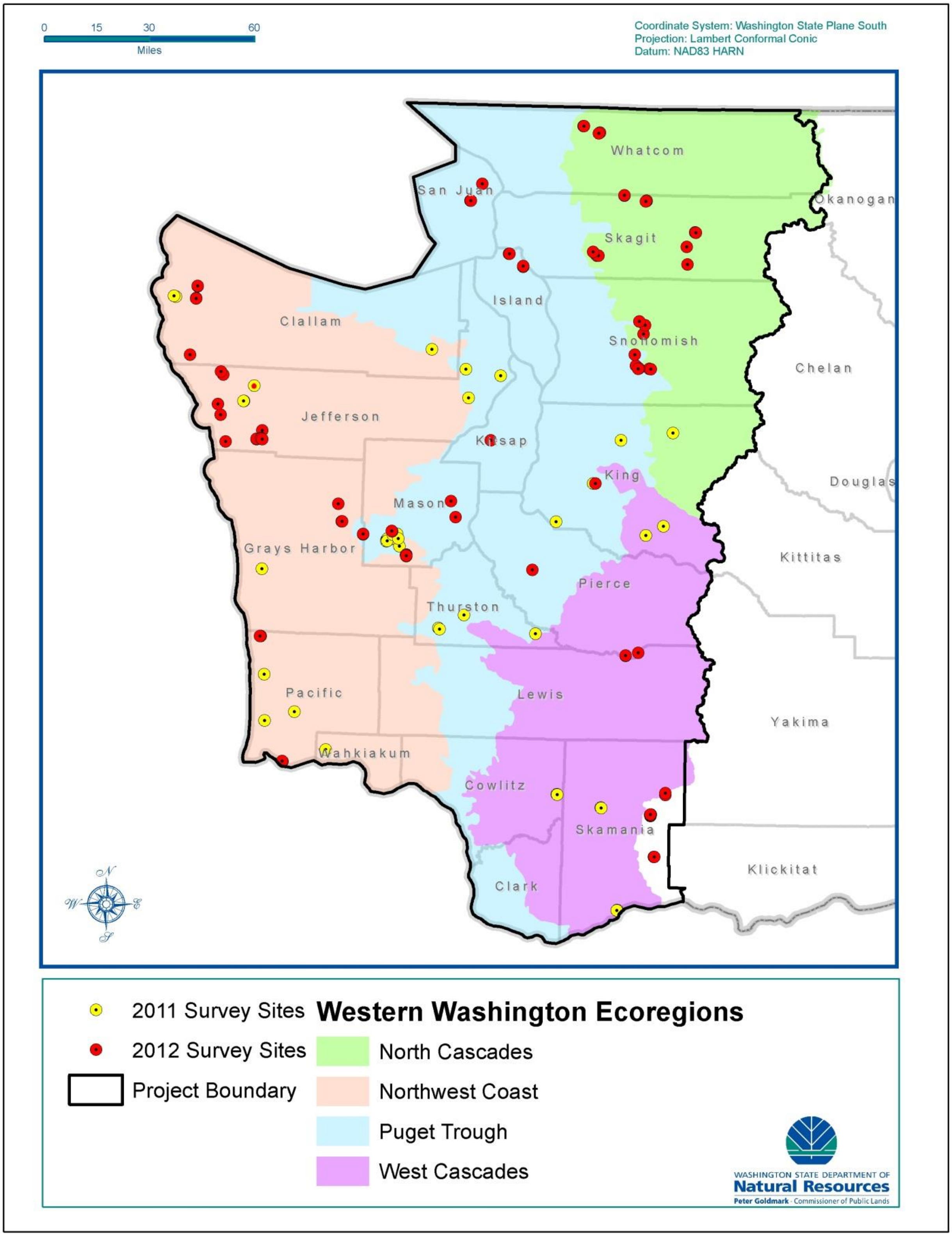

Figure 17. Location of Field Survey Sites (more than one Wetland of High Conservation Value occurs at some of the survey sites)

approach, where WNHP ecologists applied their field experience with site-level data either collected or located in published research. These ranks are referred to hereafter as “Existing EO Ranks”. Most of the existing EO ranks for western Washington wetlands are > 15 years old.

NatureServe formed the Ecological Integrity Assessment Workgroup in 2004 to develop a more systematic and transparent approach to assigning EO ranks. The result was the Ecological Integrity Assessment (EIA) method (see Section 4.2). Level 2 (rapid, field-based) EIA ranks were assigned to 207 Plant Association-based WHCV visited for this project. EIA results include an overall score/rank for ecological integrity and for individual metrics. The bounded area to which the Level 2 EIA was applied equaled the spatial boundary of the targeted WHCV. Thus, more than one Level 2 EIA rank could be assigned within a single site when numerous WHCV occur at one site.

Of the 207 WHCV assigned an EIA rank, 134 had existing EO Ranks. For these 134 sites, a comparison was made between existing EO ranks and Level 2 EIA ranks to discern whether ecological conditions have changed at an individual site since the original EO ranks were assigned.

For this analysis, each Plant Association-based WHCV was treated as a single data point. The comparison was as follows:

- If the existing rank and EIA rank were the same, that element was assigned as “no change”
- If the existing EO rank was lower than the EIA Rank (i.e., existing rank = B and EIA Rank = A), that element was assigned as “increase”.
- If the existing EO rank was higher than the EIA Rank (i.e., existing rank = A and EIA Rank = B), that element was assigned as “decrease”.
- If the existing EO rank was different than the EIA Rank, it was quantified based on the degree of difference in letter codes. Full rank changes (i.e. from A to B) were assigned +/- 1.0. Half rank changes (i.e., from AB to B) were assigned +/- 0.5.

11.2.3 Comparing Level 1 vs. Level 2 EIA Ranks

EIAs can be applied to multiple spatial scales and with a variety of data types using a three-level approach including Level 1 (remote sensing), Level 2 (rapid ground-based), and Level 3 (intensive ground-based) metrics (USEPA 2006). This three-level approach provides a hierarchical, spatially integrated framework for monitoring and assessment resulting in effective strategies and efficient use of resources (USEPA 2006). Having EIA Ranks from multiple levels (e.g., Level 1 and Level 2), allows calibration and validation of the more coarse level. For example, Level 2 EIA ranks are assumed to be more accurate than Level 1 EIA Ranks due to the fact that the former is ground-based and the latter is depends on remote sensing datasets.

The 207 Plant Association-based WHCV with Level 2 EIA ranks were also assigned a Level 1 EIA rank allowing for a correlation analysis. This analysis provides insights regarding the ability of the Level 1 to predict Level 2 EIA ranks. Using a sensitivity analysis, the results can be used to recalibrate the Level 1 to more accurately predict on-site ecological integrity. A sensitivity analysis was not conducted for this project but will be performed as WNHP collects additional data points to allow for a greater sample size across the entire stressor gradient.

11.2.4 Assessing Wetland Functions

The Western Washington Wetland Rating System (Rating System) was used to rapidly assess potential performance of wetland functions (see Hruby 2004b for full methods). The Rating System was applied to the spatial boundaries of HGM classes rather than limiting it to WHCV. Thus, EIA data and Rating System data do not necessarily reflect the same spatial locations on the ground. Generally, the area to which the Rating System was applied was greater than the area occupied by one WHCV. Consequently, if there were more than one WHCV at a particular site they often shared the same Rating System scores.

11.2.5 Assessing Stressors

Stressors were documented at each site using NatureServe's Stressor checklist methods (Master et al. 2009; Appendix C). At each site a predefined list of stressors was used to document the presence, scope, and severity of stressors associated with four categories: (1) Landscape Stressors; (2) Vegetation Stressors; (3) Soil Stressors; and (4) Hydrology Stressors. For each category, the scope and severity of each stressor was then combined to determine an impact of that category using logic matrices (Table 7; Master et al. 2009). Similarly, an overall impact rating was determined by aggregating the impact rating of the four categories and using a logic matrix to determine an overall impact rating for the site. The Stressor Impact Ratings were converted to a numeric score in order to allow for correlation analysis with EIA and Wetland Rating System data (Table 7). See Section 5.5.5 for additional details about collecting stressor data.

11.2.6 Analysis of Relationships

A Pearson correlation analysis and scatterplots were used to discern any trends between ecological integrity, wetland functions, and stressors. The analysis was conducted using PCORD Version 6.0 and Microsoft Excel. The specific comparisons made were:

- Level 1 vs. Level 2 EIA rank
- Level 2 EIA rank vs. Wetland Rating System score
- Level 2 EIA rank vs. Stressor score
- Wetland Rating System score vs. Stressor score.

11.3 Results

11.3.1 Wetland Types Sampled

The Groups and Natural Community Types represented by the 256 WHCV visited are shown in Table 22. The majority of wetlands sampled were peatlands (North Pacific Bog & and Fen Group (33%), North Pacific Neutral-Alkaline Fen Group (18%), and North Pacific Acidic Fen & Bog Woodland Group (14%; Table 22). North Pacific Maritime Hardwood-Conifer Swamp Group (11%) and Vancouverian Wet Shrubland Group (9%) were the next two highest Groups sampled. Except for the North Pacific Bog & Fen Group, these proportions are similar to the proportion of WHCV represented by these Groups (Table 14).

11.3.2 Vegetation Composition of Wetlands Sampled

A total of 374 vegetation plots were sampled during this study. The number of plots sampled per USNVC Groups varied (Table 19). The North Pacific Bog & Acidic Fen Group (131 plots) had over twice as many plots as the next highest Group (North Pacific Maritime Hardwood-Conifer

Swamp Group with 49 plots). The North Pacific Lowland Riparian Forest & Woodland Group, Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group, and Western North American Temperate Freshwater Aquatic Bed Group were undersampled relative to other Groups (Table 19).

North Pacific Bog & Acidic Fen Group, North Pacific Maritime Hardwood-Conifer Swamp Group, and Vancouverian Freshwater Wet Meadow & Marsh Group had the highest vascular plant species richness across all plot relative to other Groups (Table 19). Although North Pacific Bog & Fen Group had the second highest total richness it had one of the lowest average species richness on a per plot basis (Table 19). These numbers reflect field observations suggesting that individual bogs and poor fens are typically low in diversity due to the very acidic and nutrient poor conditions that characterize these wetlands (Rydin and Jeglum 2013). However, because there is wide variation in the types of plant associations that occur in the North Pacific Bog & Fen Group (see Table 11) the total richness of plants across the Group is high. This same pattern is observed with the Vancouverian Freshwater Wet Meadow & Marsh Group which has the highest total species richness and highest number of plant associations (Table 11) but also one of the lowest average species richness per plot (Table 19). Vancouverian Freshwater Wet Meadow & Marsh sites are often dominated by a few competitive and dominant species which may explain the relatively low average richness per plot. However, there is a significant diversity of vegetation types that, cumulatively, result in high total species richness for the Group. The Western North American Temperate Freshwater Aquatic Bed Group had the lowest species richness (13 species documented across plots) as well as the lowest richness per plot (Table 19). These aquatic communities are typically monotypic and have low diversity. It is likely submergent species were missed during data collection as observations were often limited by water depth and muck. On a per plot basis, the North Pacific Lowland Riparian Forest & Woodland Group and North Pacific Maritime Hardwood-Conifer Swamp Group had the highest totals (Table 19). These are typically nutrient rich sites with high structural and microtopographic diversity providing habitat for a variety of plant species. The North Pacific Maritime Hardwood-Conifer Swamp Group also had the third highest total richness (Table 19). The low total richness for the North Pacific Lowland Riparian Forest & Woodland Group may be due to the relatively low number of plots that were sampled (Table 19).

A summary of additional vegetation attributes within each USNVC Group is provided in Table 20 and Table 21. The first eight attributes listed in those tables are derived from coefficient of conservatism values (see Rocchio and Crawford 2013).

Table 19. Species Richness of USNVC Groups Sampled

USNVC Group	Total # of Plots Sampled	Avg. Species Richness / Plot	Total Species Richness Across Plots
North Pacific Bog & Acidic Fen Group	131	9.0	176
North Pacific Lowland Riparian Forest & Woodland Group	7	16.1	58
North Pacific Maritime Acidic Fen & Bog Forest & Woodland Group	43	10.5	95
North Pacific Maritime Hardwood-Conifer Swamp Group	49	14.3	165
North Pacific Neutral - Alkaline Fen Group	47	11.4	126
Vancouverian & Rocky Mountain Montane Wet Meadow Group	10	7.8	55
Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group	2	13	25
Vancouverian Freshwater Wet Meadow & Marsh Group	39	10.6	180
Vancouverian Wet Shrubland Group	40	9.4	118
Western North American Temperate Freshwater Aquatic Bed Group	6	4.0	13

Table 20. Summary of Vegetation Composition for USNVC Groups (North Pacific Groups) Sampled. For explanation of vegetation attributes see Table 6 in Rocchio and Crawford 2013

Vegetation Attribute	North Pacific Bog & Acidic Fen Group			North Pacific Lowland Riparian Forest & Woodland Group			North Pacific Maritime Acidic Fen & Bog Forest & Woodland Group			North Pacific Maritime Hardwood-Conifer Swamp Group			North Pacific Neutral - Alkaline Fen Group		
	131 plots			7 plots			43 plots			49 plots			47 plots		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Mean C (native species)	7.7	2.9	5.3	3.4	2.1	2.8	7.0	3.0	4.7	5.0	2.4	3.6	7.0	3.4	5.0
Mean C (all species)	7.7	2.7	5.2	3.0	1.9	2.6	7.0	3.0	4.7	5.0	2.0	3.5	7.0	2.0	5.0
Mean C (native trees)	6.0	2.0	3.2	3.2	1.5	2.2	4.0	1.5	3.3	4.6	0.5	2.9	5.0	1.5	3.1
Mean C (native shrubs)	7.0	3.0	5.2	3.6	3.0	3.2	7.0	3.5	5.1	5.7	3.0	3.9	7.0	3.0	5.6

Vegetation Attribute	North Pacific Bog & Acidic Fen Group			North Pacific Lowland Riparian Forest & Woodland Group			North Pacific Maritime Acidic Fen & Bog Forest & Woodland Group			North Pacific Maritime Hardwood-Conifer Swamp Group			North Pacific Neutral - Alkaline Fen Group		
	131 plots			7 plots			43 plots			49 plots			47 plots		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Mean C (native herbaceous)	8.0	1.0	5.5	4.0	2.5	3.3	8.0	1.0	4.8	5.3	2.0	3.8	7.0	3.4	5.0
FQAI (native species)	26.2	5.7	14.9	14.6	6.0	10.2	24.9	7.5	14.1	25.5	5.4	12.9	29.0	7.0	16.1
FQAI (all species)	26.8	5.7	15.1	14.5	6.3	10.4	25.5	7.5	14.4	26.0	4.9	13.1	30.1	5.7	16.3
Adjusted FQAI	76.7	28.2	51.7	29.8	18.1	25.2	70.0	30.0	45.8	49.1	21.8	34.1	70.0	32.2	48.9
% intolerant (C value >= 7)	80%	0%	24%	0%	0%	0%	50%	0%	15%	20%	0%	4%	53%	0%	14%
% tolerant (C value =< 3)	71%	0%	18%	93%	53%	72%	58%	0%	22%	100%	15%	48%	67%	0%	19%
Species Richness (all)	23.0	2.0	9.0	24.0	11.0	16.1	23.0	3.0	10.5	27.0	6.0	14.3	27.0	3.0	11.4
Species Richness (native)	21.0	2.0	8.6	18.0	8.0	13.3	22.0	3.0	9.9	26.0	5.0	13.0	25.0	3.0	10.9
% Non-native	0.3	0.0	0.0	0.3	0.0	0.2	0.2	0.0	0.0	0.4	0.0	0.1	0.5	0.0	0.0
Wet Indicator (all)	0.7	-5.0	-3.8	2.3	-0.3	1.0	1.5	-5.0	-1.5	1.4	-2.9	-0.9	-1.4	-5.0	-3.8
Wet Indicator (native)	0.7	-5.0	-3.8	2.3	-0.3	1.0	1.5	-5.0	-1.5	1.4	-3.2	-0.9	-2.3	-5.0	-3.9
% hydrophyte	100%	0%	70%	27%	0%	9%	70%	0%	37%	83%	0%	34%	100%	0%	73%
% native perennial	100%	67%	94%	100%	73%	82%	100%	76%	95%	100%	58%	89%	100%	50%	89%
% native annual	8%	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	0%	0%	0%
% annual	17%	0%	0%	11%	0%	2%	0%	0%	0%	10%	0%	1%	0%	0%	0%
% perennial	100%	75%	98%	100%	89%	97%	100%	88%	99%	100%	86%	97%	100%	70%	93%
# species with moderate fidelity to prairies	2.0	0.0	0.3	4.0	0.0	0.9	1.0	0.0	0.1	2.0	0.0	0.2	4.0	0.0	0.8
# species with high fidelity to prairies	1.0	0.0	0.0	2.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.1
% native forbs	71%	0%	25%	36%	0%	17%	43%	0%	14%	70%	0%	24%	63%	0%	32%
% native graminoids	80%	0%	31%	16%	0%	8%	50%	0%	15%	32%	0%	11%	80%	13%	39%

Table 21. Vegetation Composition Summary for USNVC Groups (Other Groups) For explanation of vegetation attributes see Table 6 in Rocchio and Crawford (2013)

Vegetation Attribute	Vancouverian & Rocky Mountain Montane Wet Meadow Group			Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group			Vancouverian Freshwater Wet Meadow & Marsh Group			Vancouverian Wet Shrubland Group			Western North American Temperate Freshwater Aquatic Bed Group		
	10 plots			2 plots			38 plots			40 plots			5 plots		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
Mean C (native species)	5.5	4.5	5.1	5.9	5.4	5.6	5.5	2.0	3.6	7.0	2.0	3.6	7.0	3.0	5.0
Mean C (all species)	5.5	4.5	5.1	5.9	5.4	5.6	4.8	1.1	2.7	7.0	2.0	3.4	7.0	2.4	4.9
Mean C (native trees)	6.0	6.0	6.0	n/a	n/a	n/a	4.0	1.5	2.5	4.0	1.5	2.7	n/a	n/a	n/a
Mean C (native shrubs)	7.0	5.0	6.1	6.5	5.0	5.8	5.0	3.0	3.3	7.0	3.0	3.7	7.0	7.0	7.0
Mean C (native herbaceous)	5.5	4.3	5.0	6.0	5.2	5.6	5.5	1.5	3.9	7.0	1.5	3.9	7.0	3.0	5.0
FQAI (native species)	20.3	7.8	13.3	21.6	16.6	19.1	16.2	4.0	9.6	18.8	3.5	9.8	14.0	5.7	9.5
FQAI (all species)	20.3	8.1	13.7	22.3	17.6	19.9	16.0	2.7	8.6	18.8	3.5	9.8	14.0	5.7	9.5
Adjusted FQAI	54.3	44.9	49.2	55.4	52.4	53.9	47.5	14.9	30.4	70.0	18.9	33.8	70.0	24.5	48.9
% intolerant (C value >= 7)	33%	0%	20%	24%	22%	23%	14%	0%	2%	20%	0%	2%	50%	0%	15%
% tolerant (C value =< 3)	33%	0%	14%	6%	0%	3%	89%	0%	54%	100%	0%	53%	67%	0%	18%
Species Richness (all)	14.0	3.0	7.8	17.0	9.0	13.0	23.0	3.0	10.6	19.0	2.0	9.4	6.0	2.0	4.0
Species Richness (native)	14.0	2.0	7.5	16.0	8.0	12.0	17.0	0.0	7.4	18.0	2.0	8.2	4.0	2.0	3.6
% Non-native	0.3	0.0	0.1	0.1	0.1	0.1	1.0	0.0	0.3	0.5	0.0	0.1	0.3	0.0	0.1
Wet Indicator (all)	-1.5	-5.0	-3.5	-2.4	-3.6	-3.0	1.7	-4.7	-2.2	-0.7	-5.0	-2.8	-4.0	-5.0	-4.7
Wet Indicator (native)	-1.5	-5.0	-3.5	-2.4	-3.6	-3.0	3.0	-5.0	-2.5	0.0	-5.0	-2.8	-4.0	-5.0	-4.8
% hydrophyte	100%	33%	72%	78%	59%	68%	100%	0%	53%	100%	0%	57%	100%	0%	77%
% native perennial	100%	67%	95%	94%	89%	92%	100%	0%	62%	100%	33%	84%	100%	50%	90%
% native annual	0%	0%	0%	0%	0%	0%	63%	0%	4%	6%	0%	0%	17%	0%	3%
% annual	0%	0%	0%	0%	0%	0%	63%	0%	8%	20%	0%	2%	20%	0%	4%
% perennial	100%	100%	100%	100%	100%	100%	100%	33%	88%	100%	60%	93%	100%	80%	96%
# species with moderate fidelity to prairies	1.0	0.0	0.3	0.0	0.0	0.0	6.0	0.0	1.3	2.0	0.0	0.5	0.0	0.0	0.0

Vegetation Attribute	Vancouverian & Rocky Mountain Montane Wet Meadow Group			Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group			Vancouverian Freshwater Wet Meadow & Marsh Group			Vancouverian Wet Shrubland Group			Western North American Temperate Freshwater Aquatic Bed Group		
	10 plots			2 plots			38 plots			40 plots			5 plots		
	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean
# species with high fidelity to prairies	1.0	0.0	0.2	1.0	1.0	1.0	7.0	0.0	0.9	1.0	0.0	0.0	0.0	0.0	0.0
% native forbs	60%	0%	34%	56%	41%	48%	50%	0%	24%	67%	0%	19%	67%	0%	43%
% native graminoids	100%	21%	52%	41%	22%	32%	75%	0%	27%	50%	0%	18%	50%	0%	40%

11.3.3 Temporal Changes in Ecological Integrity of Plant Association-based Wetlands of High Conservation Value.

Of the 134 WHCV that were compared, 15% (40) showed no change in their rank (i.e. Level 2 EIA ranks were the same as existing EO ranks), 26% (66) showed an increase in their rank (i.e., Level 2 EIA ranks were higher than existing EO ranks), 11% (28) had a decrease in their EO rank (i.e., Level 2 EIA ranks were lower than existing EO ranks) (Figure 18). The most common type of changes were an increase of half rank (25; e.g., an increase from AB to A), whole rank (20; and increase from B to A), and decrease in half rank (19; e.g., drop from B to BC; Figure 18).

King County had the highest number of Plant Association-based WHCV that decreased in rank (Table 23), however King County also had the largest number of WHCV sampled compared to other counties (Table 23). It would seem logical that WHCV located within King County, one of the most urbanized counties in the State, would experience degradation in the past 15-25 years. However, because the existing EO ranks do not have accompanying individual metric scores as the Level 2 EIA ranks do, it is difficult to quickly discern whether specific ecological variables have changed. Additional research is required to make conclusions regarding explanatory causes of rank changes. Possibilities include (1) true ecological change due to stressors, succession, etc; (2) variation in methods associated with assigning the existing EO ranks versus the EIA ranks; or (3) variation in observer interpretation and subsequent application of rank assignments.

Due to the disproportionate sample size across USNVC Groups it is difficult to discern any patterns regarding degradation across Groups (Figure 18). However, based on what was sampled, most Groups showed an increase in EO ranks. Possible explanations of these changes include differences in methods or the possibility that land use change around the WHCV has changed in the intervening years that improved the overall EO rank. For example, if the surrounding landscape was logged when the existing EO rank was assigned 20+ years ago, that site would have received a low score for Landscape Context; however, if the same landscape had not been logged since, then today that site might get a higher score for Landscape Context resulting in a higher EIA rank today.

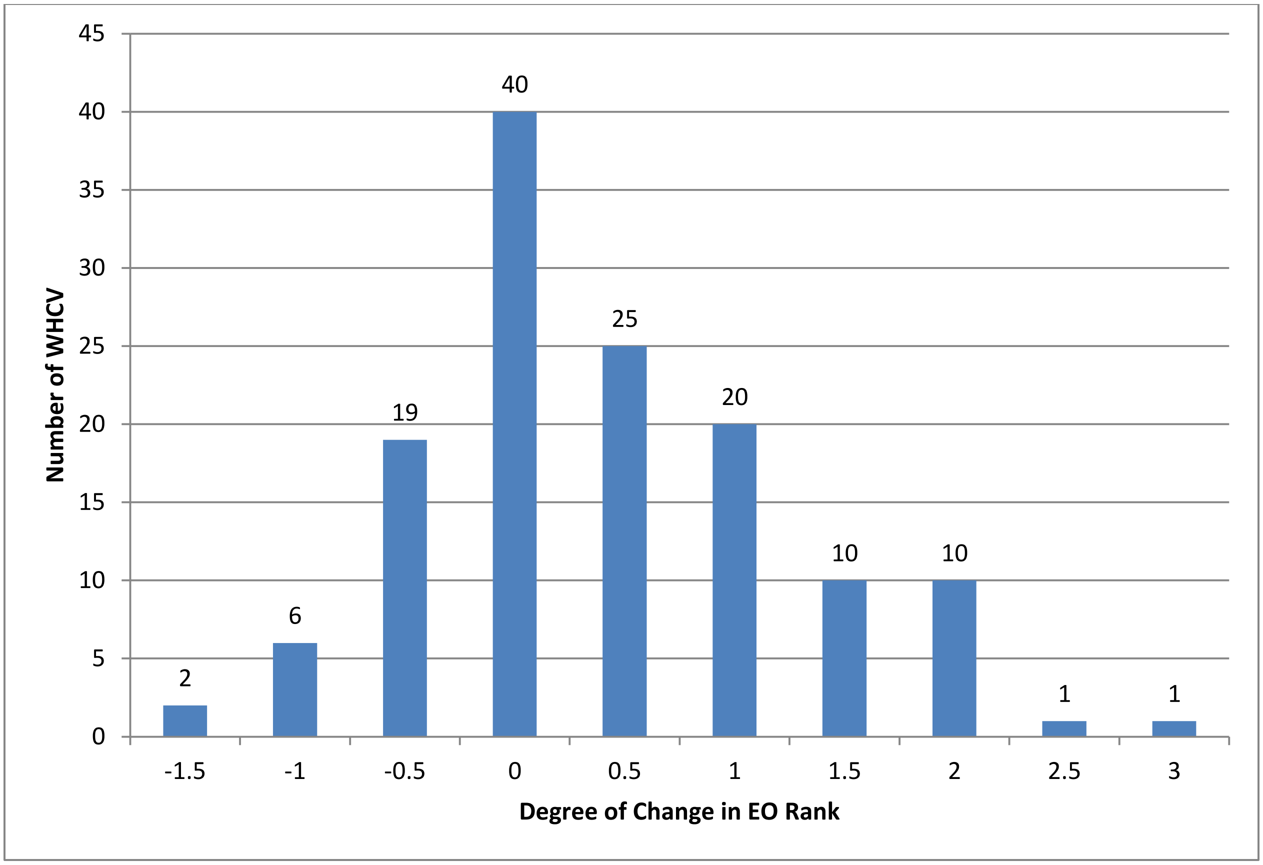

Figure 18. Temporal Change in Ecological Integrity of Plant Association-based WHCV.

11.3.4 Predicting Onsite Ecological Integrity Using a Level 1 EIA Analysis

The correlation between the Level 1 and Level 2 EIA ranks is shown in Figure 19. The relationship shows an expected but noisy trend (r = 0.36). Generally, as Level 1 scores decrease so do Level 2 scores, although there is significant noise throughout the scatterplot especially with a series of Vancouverian Freshwater Marsh & Wet Meadow sites (Figure 19). All four of these sites are Willamette Valley Wet Prairies which, despite representing the highest quality examples of this wetland type in Washington, have all been degraded by agriculture, hydrological alteration, and nonnative and invasive species. The surrounding landscape in these sites consists of other wetland types, agriculture, and other open space which is why they have relatively high Level 1 EIA scores (Figure 19). Removing these four sites slightly improves the correlation (r=0.43). Thus, the ability of the Level 1 EIA to predict onsite condition (as measured by the Level 2 EIA) is not very high. This may suggest that the land use weights or weighting protocol used in the Level 1 EIA need to be modified to better match the Level 2 EIA results. For example, down weighting certain land uses may result in overall lower Level 1 scores and thus improve the ability of the Level 1 to predict onsite conditions. Or, additional inputs into the Level 1 EIA could be used to better predict onsite conditions. Such decisions need to be determined via a sensitivity analysis and, of course, only if they make ecological sense.

Table 22. Temporal Change in Ecological Integrity of Plant Association-based WHCV by Wetland Type.

Wetland Type	Comparison of Existing EO Rank vs. EIA Rank				
	No change	Decrease	Increase	Not Included in Analysis*	Total
North Pacific Bog & Acidic Fen Group	**13**	**13**	**24**	**35**	**85 (33%)**
North Pacific Montane Poor Basin Fen			1	3	4
North Pacific Montane Poor Sloping Fen	1		1	3	5
North Pacific Montane Poor Water Track & Quaking Mat			1	1	2
North Pacific Lowland Poor Sloping Fen	3	2	6	2	13
North Pacific Lowland Bog & Poor Basin Fen	8	10	12	23	53
North Pacific Domed Bog			1		1
North Pacific Lowland Poor Water Track & Floating Bog Mat	1	1	2	3	7
North Pacific Lowland Riparian Forest & Woodland Group	**1**	**1**		**3**	**5 (2%)**
North Pacific Lowland Floodplain Forest	1	1		3	5
North Pacific Maritime Poor Fen & Bog Forest & Woodland Group	**6**	**5**	**10**	**16**	**37 (14%)**
North Pacific Lowland Wooded Poor Sloping Fen		1	5	5	11
North Pacific Lowland Bog Woodland	6	4	5	9	24
North Pacific Domed Bog Woodland				2	2
North Pacific Maritime Hardwood-Conifer Swamp Group	**2**	**4**	**6**	**15**	**27 (11%)**
North Pacific Freshwater Tidal Surge Plain Forested Swamp		2			2
North Pacific Interdunal Conifer Swamp				1	1
North Pacific Lowland Flat & Depressional Forested Swamp			3	5	8
North Pacific Lowland Forested Seepage Swamp	2	2	2	5	11
North Pacific Montane Flat & Depressional Swamp			1		1
North Pacific Montane Forested Seepage Swamp				2	2
North Pacific Montane Wooded Moderately Rich Sloping Fen				2	2
North Pacific Neutral - Alkaline Fen Group	**7**	**4**	**13**	**23**	**47 (18%)**
North Pacific Serpentine Fen	3		5	4	12

Wetland Type	Comparison of Existing EO Rank vs. EIA Rank				
	No change	Decrease	Increase	Not Included in Analysis*	Total
North Pacific Lowland Moderately Rich Basin Fen		4	3	1	8
North Pacific Lowland Moderately Rich Sloping Fen	1		1	2	4
North Pacific Lowland Moderately Rich Water Track & Quaking Mat				2	2
North Pacific Montane Moderately Rich Basin Fen	2		3	1	6
North Pacific Montane Moderately Rich Sloping Fen	1		1	11	13
North Pacific Montane Moderately Rich Tall Shrub Fen				1	1
North Pacific Montane Moderately Rich Water Track & Quaking Mat				1	1
Vancouverian & Rocky Mountain Montane Wet Meadow Group	**1**		**5**	**3**	**9 (4%)**
Vancouverian & Rocky Mountain Montane Streamside Marsh & Wet Meadow	1				1
Vancouverian & Rocky Mountain Montane Riverine Impounded Marsh & Wet Meadow			3		3
Vancouverian & Rocky Mountain Montane Depressional Marsh & Wet Meadow			1	3	4
Vancouverian & Rocky Mountain Montane Seep & Spring			1		1
Vancouverian Freshwater Wet Meadow & Marsh Group	**3**		**4**	**10**	**17 (7%)**
Vancouverian Freshwater Tidal Surge Plain Marsh	2				2
Vancouverian Interdunal Deflation Plain				1	1
Vancouverian Interdunal Marsh & Sedge Meadow				1	1
Vancouverian Lowland Depressional Marsh			3	3	6
Vancouverian Lowland Riverine Impounded Marsh				1	1
Vancouverian Lowland Lacustrine-Fringe Marsh			1		1
Puget Lowland Wet Prairie				2	2
Willamette Valley Wet Prairie	1			2	3
Vancouverian Wet Shrubland Group	**6**	**1**	**3**	**14**	**24 (9%)**
Vancouverian Interdunal Shrub Swamp				2	2
Vancouverian Lagg Shrub Swamp		1		9	10
Vancouverian Lowland Depressional Shrub Swamp			2	1	3

Wetland Type	Comparison of Existing EO Rank vs. EIA Rank				
	No change	Decrease	Increase	Not Included in Analysis*	Total
Vancouverian Lowland Lacustrine-Fringe Shrub Swamp	2		1		3
Vancouverian Lowland Riverine Impounded Shrub Swamp	4			1	5
Vancouverian Montane Shrub Seepage Swamp				1	1
Western North American Temperate Freshwater Aquatic Bed Group	**1**		**1**	**3**	**5 (2%)**
Western North American Temperate Lowland Peatland Pool	1		1	3	5
Total	**40 (15%)**	**28 (11%)**	**66 (26%)**	**122 (48%)**	**256**

*The values in this column reflect the number of WHCV that did not have initial EO ranks either because they were new WHCV identified during the course of this project or they simply lacked an initial EO Rank. Thus they were not included in this analysis.

Table 23 Temporal Change of Ecological Integrity of Plant Association-based WHCV by Counties

County	No Change	Decrease	Increase	Not Included in Analysis*	Total
Clallam			10	8	**18**
Clark	1			2	**3**
Cowlitz			6	3	**9**
Grays Harbor	7	2	5	2	**16**
Island	2		2		**4**
Jefferson	1		7	6	**14**
King	10	11	4	13	**38**
Kitsap			1		**1**
Mason	5	6	10	22	**43**
Pacific			2	5	**7**
Pierce			1	2	**3**
San Juan		3		4	**7**
Skagit	5	3	16	13	**37**
Skamania				19	**19**
Snohomish	2		1	17	**20**
Thurston	2	2		2	**6**
Wahkiakum		1			**1**
Whatcom	5		1	4	**10**
(blank)					
Total	**40**	**28**	**66**	**122**	**256**

* The values in this column reflect the number of WHCV that did not have initial EO ranks either because they were new WHCV identified during the course of this project or they simply lacked an initial EO Rank. Thus they were not included in this analysis.

On the other hand, onsite stressors may account for the observed variability, as those impacts are not accounted for in a Level 1 EIA but are specifically addressed in a Level 2 EIA. This explanation seems to be the case for the four wet prairie sites. Additionally, this hypothesis is supported when Level 1 EIA scores are compared independently to Level 2 Landscape Context and Condition scores (Figure 20 and Figure 21). There is a stronger correlation (r = 0.48) between Level 1 EIA and Level 2 Landscape Context scores (Figure 20) than between Level 1 EIA and Level 2 Conditions scores (Figure 21). Thus, the higher variability associated with the Condition scores is suggestive that onsite stressors may be the more likely cause of the relatively noisy relationship between Level 1 and Level 2 EIA scores. Unfortunately, remote sensing data capable of measuring onsite stressors is lacking.

Results from this analysis suggest the Level 1 EIA used for this project may not yet be a reliable predictor of where high-quality wetlands occur on the landscape. However, the lack of data from highly degraded sites for both Level 1 and Level 2 limits definitive conclusions.

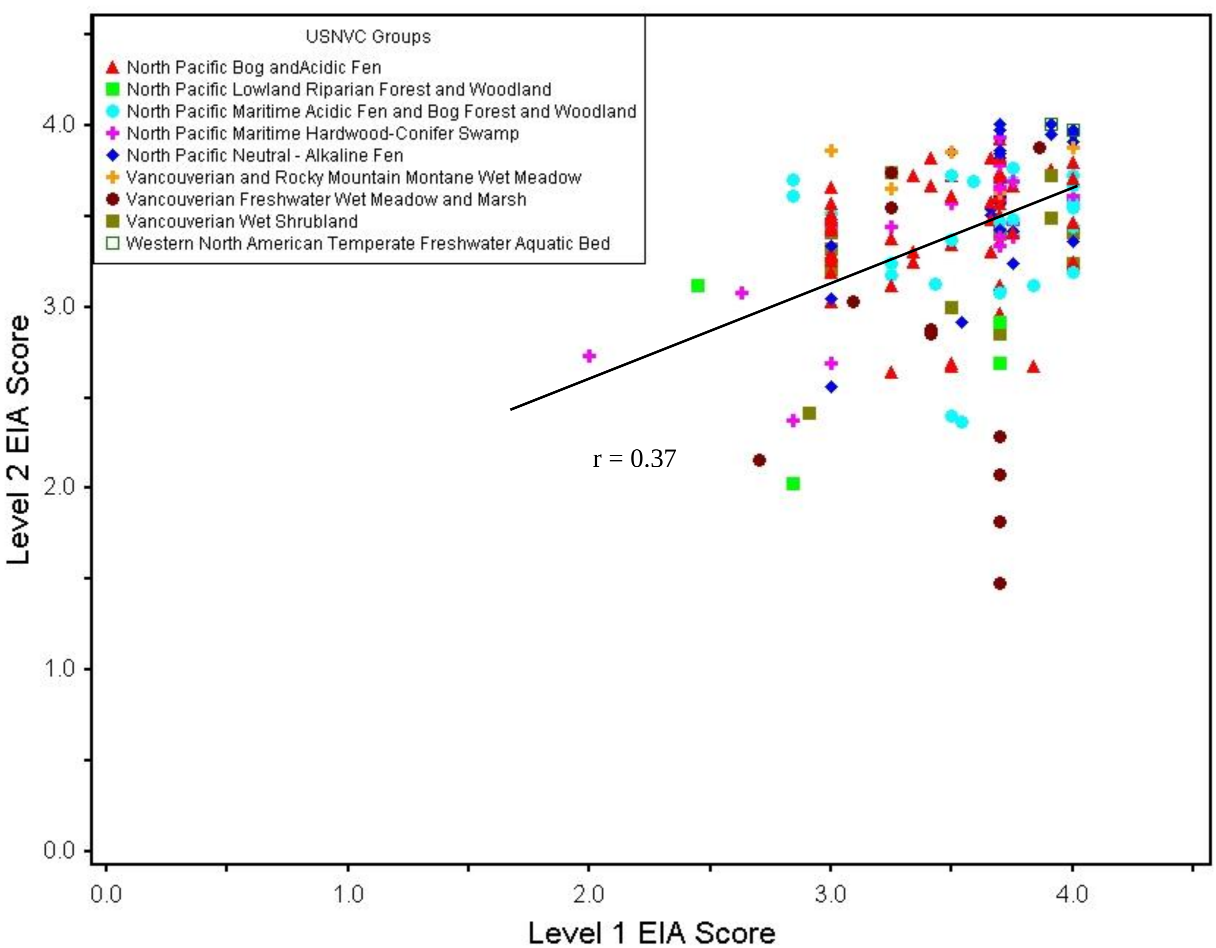

Figure 19. Correlation between Level 1 and Level 2 EIA Scores (higher scores = higher ecological integrity)

11.3.5 Relationship between Ecological Integrity Assessment and Wetland Rating System Scores

There was little correlation between Level 1 (r = -0.13) or Level 2 (r=-0.15) EIA scores with the Wetland Rating System score (Figure 22 and Figure 23, respectively). The lack of correlation may reflect the lack of samples points from wetlands that are in very poor ecological condition. On the other hand, the Wetland Rating System gives more points to wetlands that occur in landscape where anthropogenic activities increase the likelihood that a wetland has the opportunity to perform (i.e., "improve") water quality and hydrologic functions. For example, a wetland which occurs within an urbanized landscape has a higher potential to improve water quality than a wetland which occurs in a landscape with a relatively natural land cover , and would receive a higher Wetland Rating System score as a result. In contrast, the metrics measured for a Level 2 EIA generally score higher in a landscape with higher natural land cover.

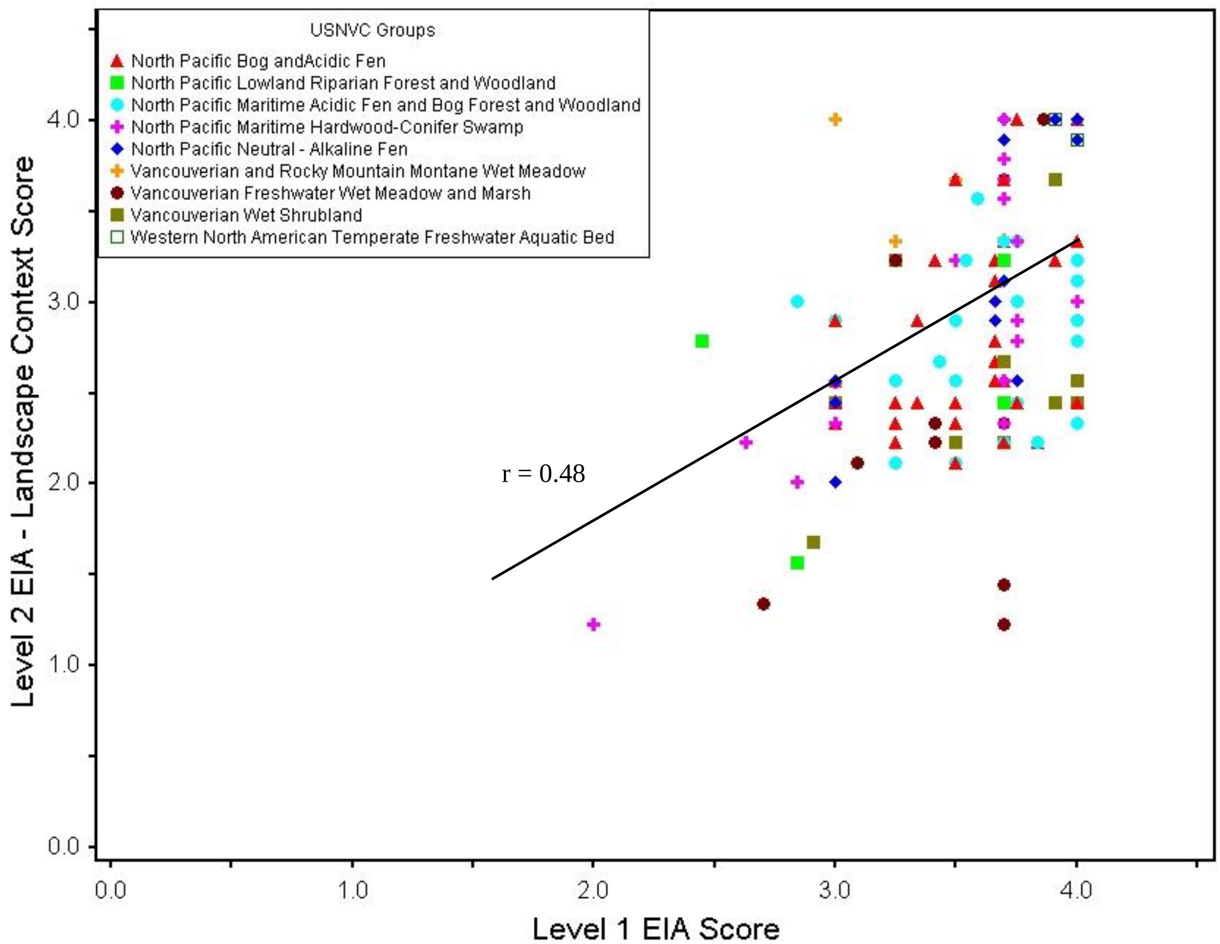

Figure 20. Correlation between Level 1 EIA and Level 2 EIA - Landscape Context Scores

However, there is a correlation between the Habitat Function score (the Wetland Rating System is comprised of a Water Quality, Hydrologic, and Water Quality Function Score) and the Level 1 and Level 2 EIA scores (Figure 24; Figure 25). Habitat Function and Level 1 EIA scores have a positive correlation (r = 0.35) but there is still an abundance of noise associated with high Level 1 scores (Figure 24). The relationship is somewhat stronger between Level 2 EIA and Habitat Function scores (r = 0.41). This correlation is not surprising given that many of the same characteristics (e.g., plant structure and composition, landscape connectivity and buffer condition) are assessed by both the Level 2 EIA and Wetland Rating System and provides some support to the notion that ecological integrity can be a surrogate measure of habitat quality, at least by the measures used in these two methods.

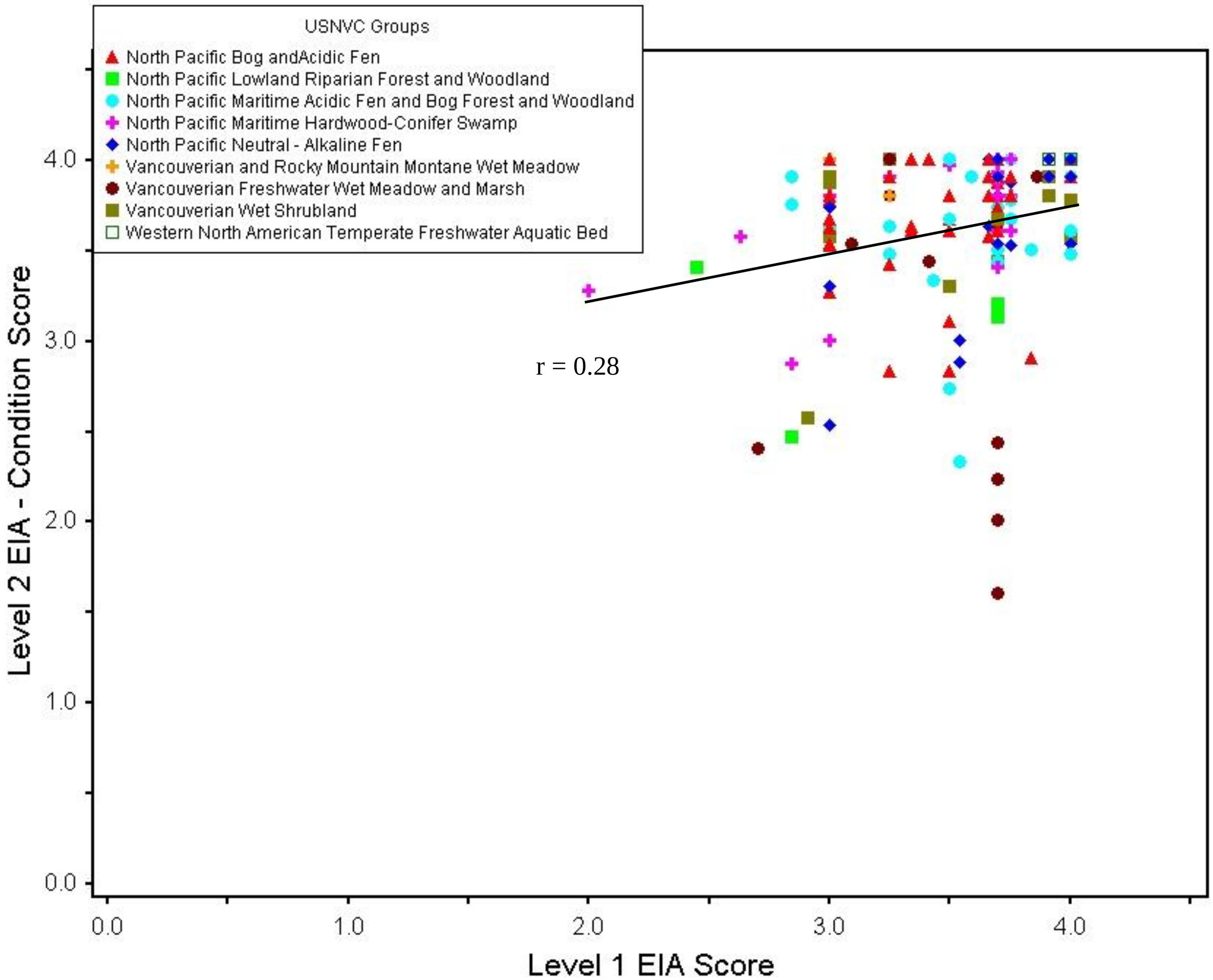

Figure 21. Correlation between Level 1 EIA and Level 2 EIA - Condition Scores

11.3.6 Relationship between Stressor, Ecological Integrity, and Wetland Rating System Scores

A strong negative correlation (r = - 0.68) exists between Level 2 EIA and Overall Stressor scores (Figure 26) suggesting the Level 2 EIA is documenting changes in ecological condition associated with anthropogenic stressors. Although more data points are needed from highly impacted wetlands, this analysis suggests the Level 2 EIAs developed for western Washington wetlands (WNHP 2010) are performing as intended.

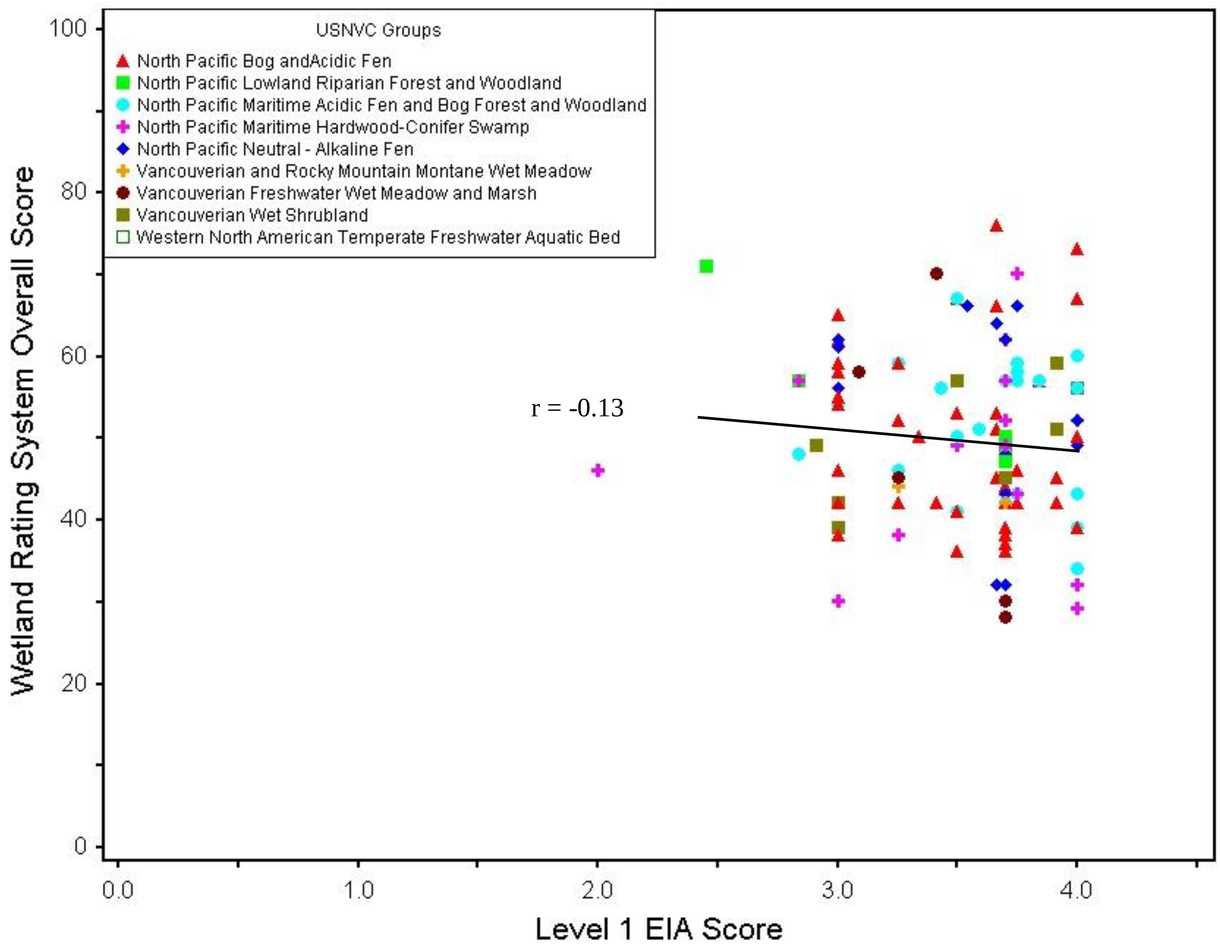

Figure 22. Correlation between Level 1 EIA and Wetland Rating System Score (higher scores = higher ecological integrity and increased potential of performing wetland functions)

Future analysis could focus on the relationship between individual metric scores and the Overall Stressor scores to determine which metrics are performing adequately and what, if any calibration measures are needed to improve metric performance.

A weaker but positive correlation exists between Wetland Rating System and Overall Stressor Scores (Figure 27). As noted previously, the Wetland Rating System gives more points to wetlands that occur in landscape where anthropogenic activities increase the likelihood that a wetland has the opportunity to perform (i.e., “improve”) water quality and hydrologic functions. This explains why there is a positive rather than a negative correlation between the Wetland Rating System and Overall Stressor scores (Figure 27). As with most of the analyses discussed in this section, the lack of samples from highly impacted wetlands limits conclusive statements about the trends observed.

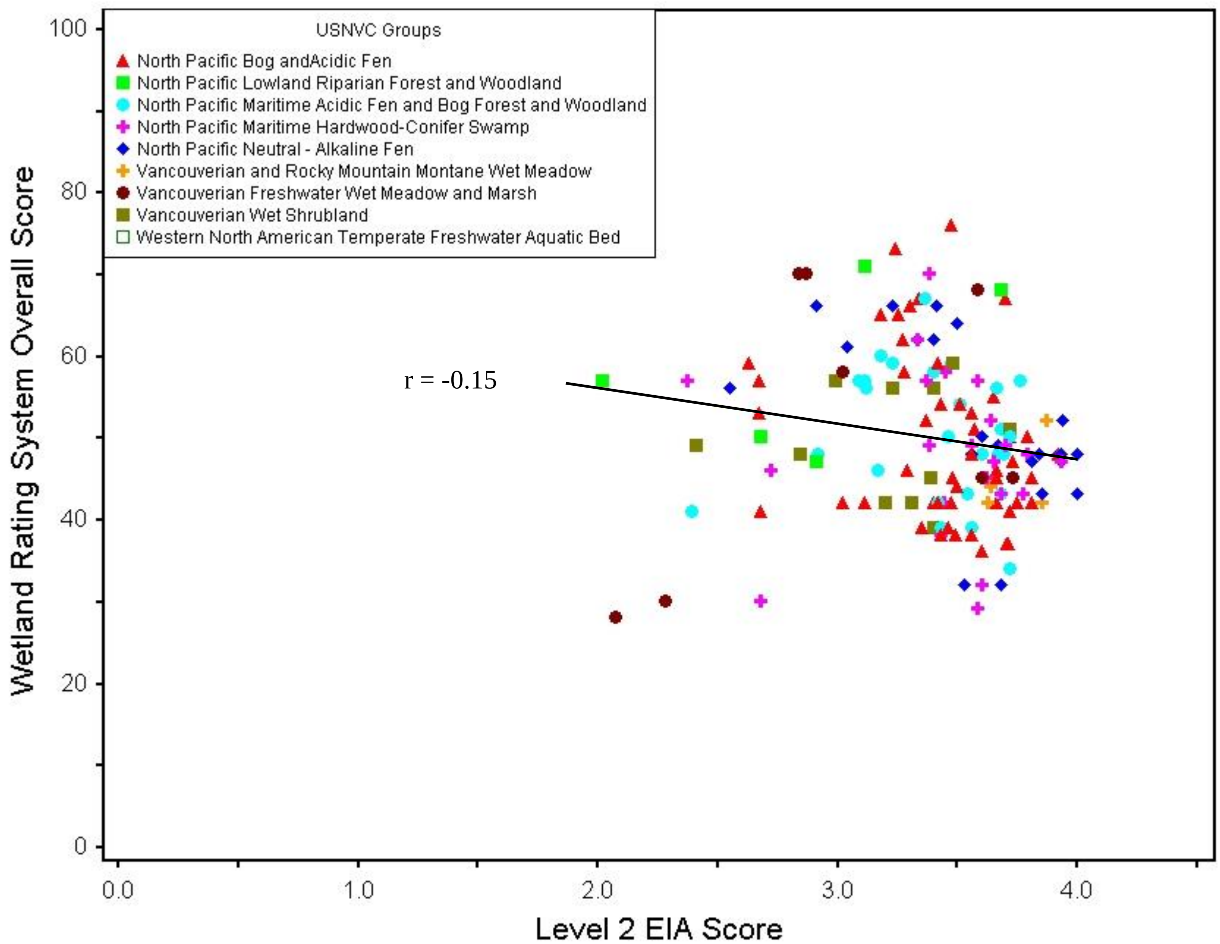

Figure 23. Correlation between Level 2 EIA and Wetland Rating System Score (higher scores = higher ecological integrity and increased potential of performing wetland functions)

11.4 Conclusions

Based on data collected from the 134 WHCV with existing EO ranks, the majority (26%) were found to have increased in ecological integrity since they were initially assessed (15-25 years ago). However, the degree of change was predominantly minor, with the majority of sites experiencing up to one whole rank change (e.g., B to A, etc.). Whether these changes are the result of observer errors when assigning EO ranks, differences in methods, or due to real ecological changes cannot be determined without additional analysis.

The majority of decreases occurred in the most urbanized landscape of western Washington (i.e., King County) however this area also had the most samples relative to other regions. Due to the disproportionate sample size across USNVC Groups it is difficult to find patterns of ecological change with any given Group.

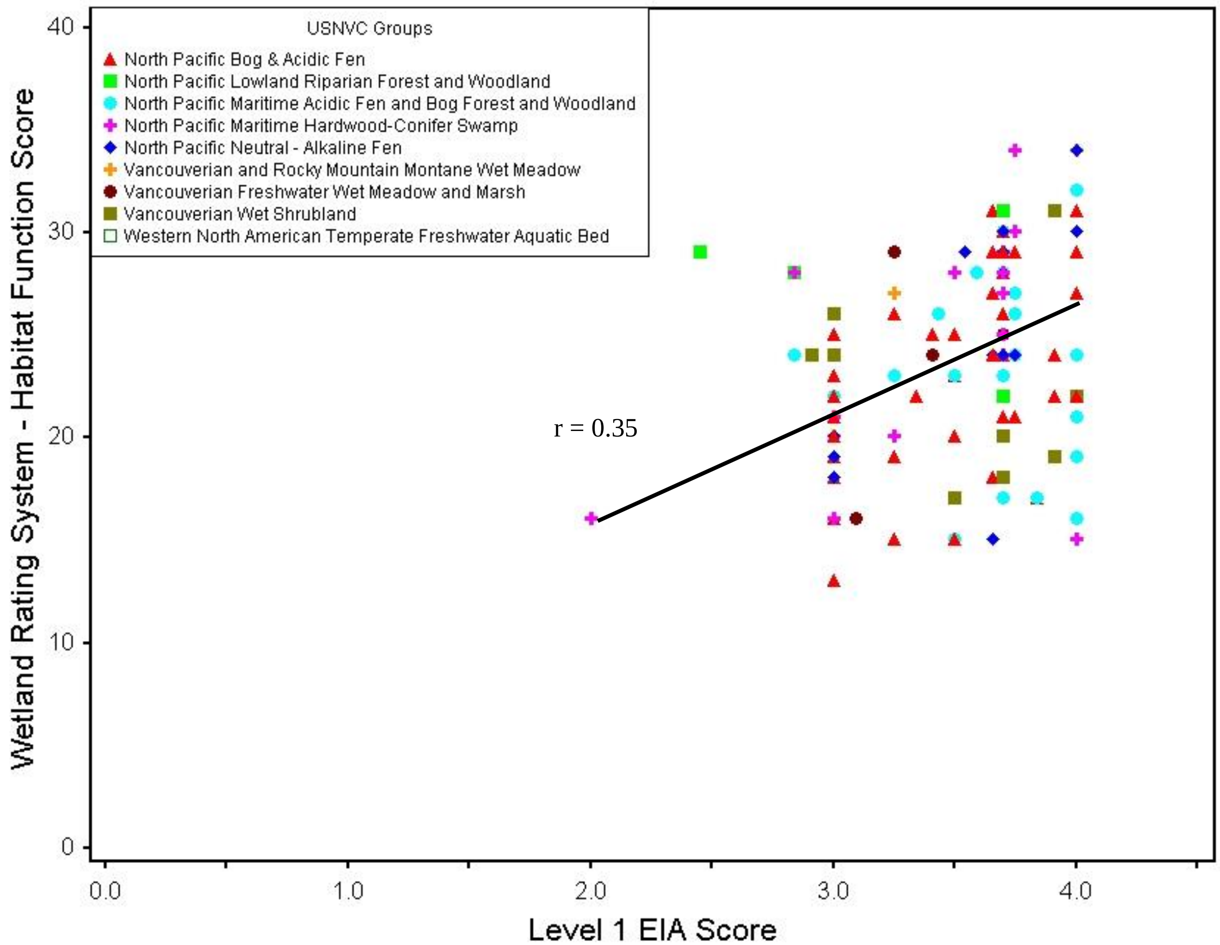

Figure 24. Correlation between Level 1 EIA Score and Habitat Function Score

Field data collected for this project suggest that the Level 1 EIA may not yet be a reliable predictor of where high-quality wetlands occur on the landscape. Analysis of Level 2 metrics suggests that onsite stressors are a likely cause of the relatively noisy relationship between Level 1 and Level 2 EIA scores. Additional testing and calibration of the Level 1 EIA is needed.

Neither the Level 1 nor Level 2 EIA scores showed a correlation with the Wetland Rating System scores but did show a positive correlation with Habitat Function scores due to the similarity of ecological attributes used in each method. This suggests that measures of ecological integrity may be a good surrogate measure of habitat quality, as measured by these methods.

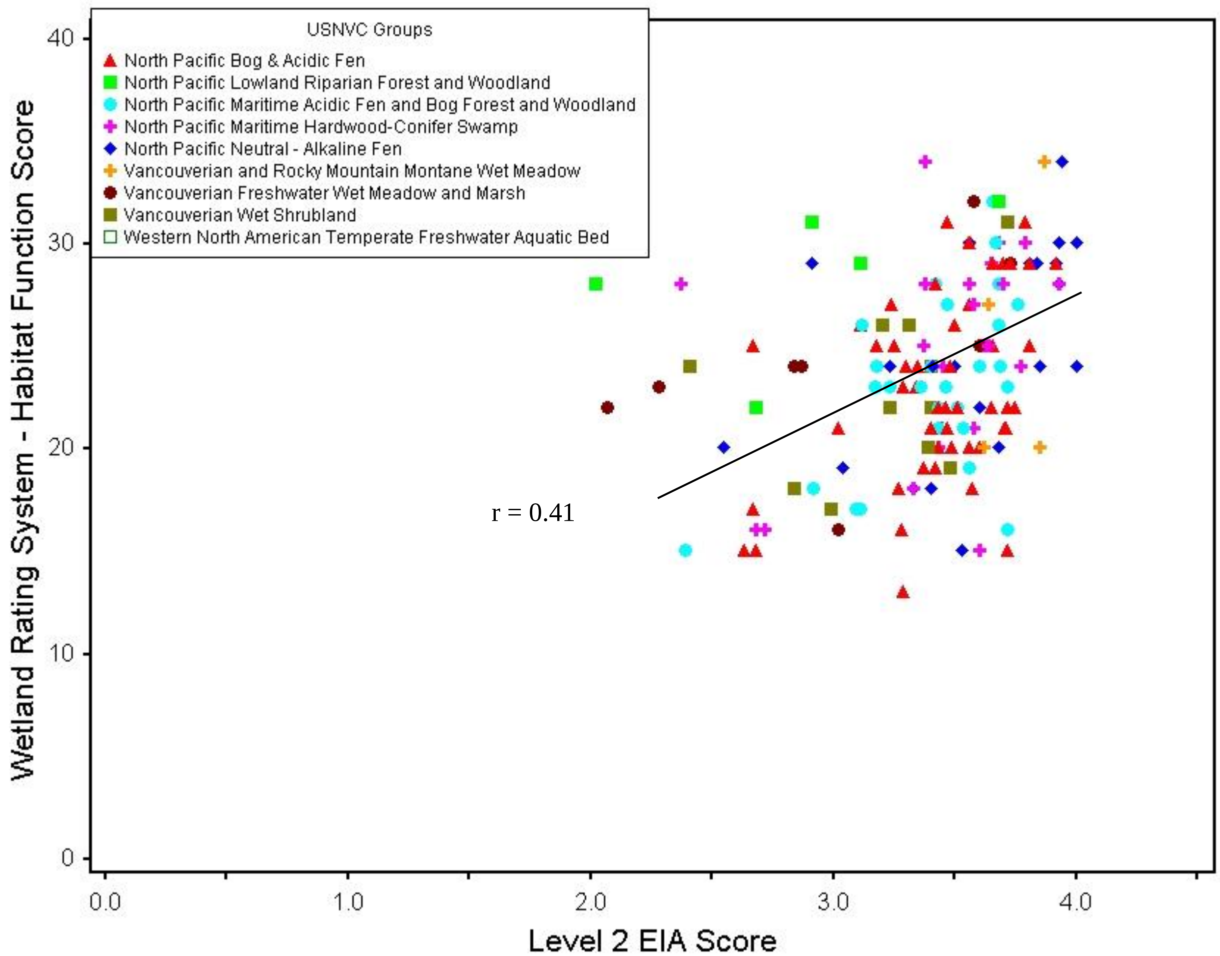

Figure 25. Correlation between Level 2 EIA Score and Habitat Function Score

The strong correlation between Level 2 EIA and Overall Stressors scores indicates that the Level 2 EIAs developed for western Washington wetlands are adequately documenting changes of ecological condition associated with human stressors (http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html).

Finally, the lack of samples from highly impacted sites (sites with poor ecological integrity and/or very high overall stressor scores) precludes conclusive statements about the relationships explored in this Section. Future research should target sampling across the entire gradient of ecological conditions in order to explore the full relationships among these variables.

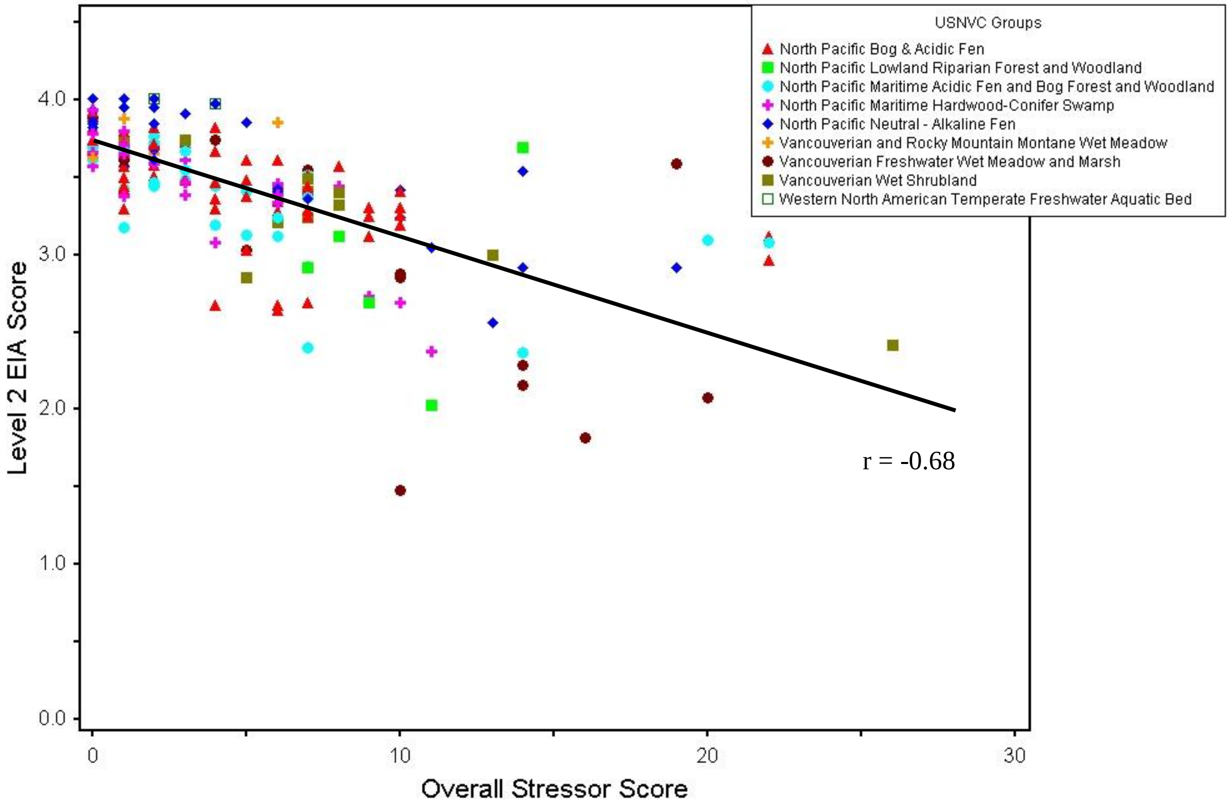

Figure 26. Correlation between Level 2 EIA and Overall Stressor Scores

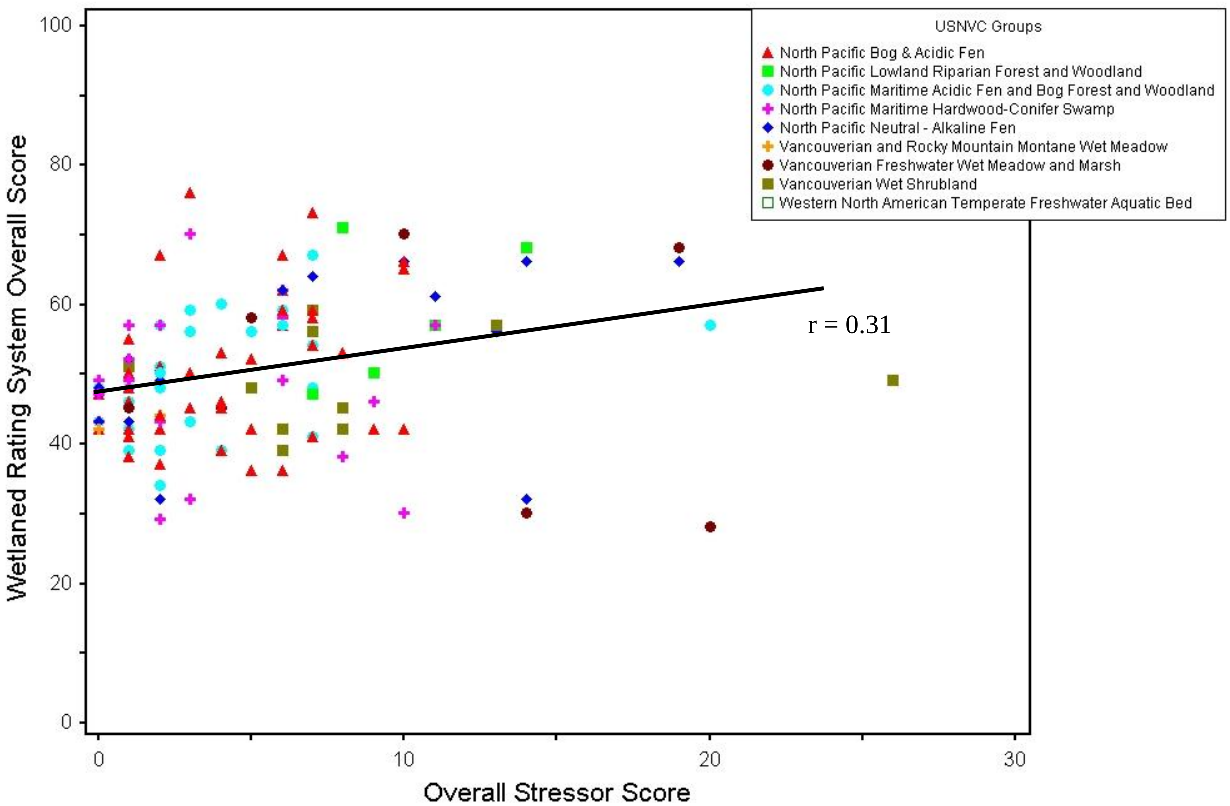

Figure 27. Correlation between Wetland Rating System and Overall Stressor Scores

12 Synthesis of Wetland Conservation Profile

12.1 Summary of Wetland Profile

A summary of factors related to the conservation of western Washington wetlands is provided in Appendix D (an accompanying Microsoft Excel file). That file summarizes much of the information discussed in Sections 6-9 and also includes a list of reference sites (see below).

12.1.1 Ecological Patterns Associated with Wetlands of High Conservation Value

The diversity of ecological templates and biotic diversity associated with western Washington wetlands is not well characterized by established and commonly used classification schemes. When fine-scale ecological drivers and vegetation composition are collectively considered, the diversity of wetlands is more apparent. The *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* resulted in an improved understanding of the diversity of ecological templates associated with vegetation patterns in western Washington wetlands. The classification includes 15 Groups, 87 Natural Community types, and 272 unique Plant Associations. There are 427 unique Natural Community Type-Association combinations (plant associations can occur in more than one Natural Community Types).

The patterns associated with conservation significance, inventory needs, protection status, and how those patterns vary by ecoregion combine to comprise the 'Western Washington Wetland Conservation Profile' (see Appendix D – an accompanying Excel workbook). Such information can be used to guide conservation actions within each ecoregion to ensure each type is adequately considered in regulatory, management, and conservation actions. WNHP will also utilize this information to set Natural Heritage Plan priorities, which are used for targeting sites for inclusion in the statewide natural areas system.

Additional inventory work is needed for numerous Natural Community and Plant Association types. Only 31% of all known wetland & riparian features are considered to have some level of protection. Of the 718 Plant Association-based WHCV, 25% are represented in the statewide system of natural areas. Of those, 34% (93) of the 272 Associations, and 23% of the 427 unique Natural Community Type-Association combinations are represented. While encouraging numbers, much more conservation work needs to occur to adequately protect western Washington wetland biodiversity and represent that diversity in a system of natural areas.

12.1.2 Ecoregional Patterns Associated with Wetlands of High Conservation Value

The Northwest Coast ecoregion receives large amounts of rain and has a relatively mild climate resulting in unique coastal Natural Community and Plant Association types. The Northwest Coast has <u>the only known domed bog in the western United States</u>, a high concentration of poor sloping fens and some of the last remaining old growth cedar/spruce swamps in Washington. Vegetation patterns in these wetlands are unique relative to other parts of western Washington due to the presence of numerous wetland species which are limited to the coastal zone. The domed bog is of very high significance and WNHP is currently exploring options for ensuring the long-term viability of this unique ecosystem. Most riparian areas have been impacted by logging but a few old growth remnants exist. Those remnants without current protection should be targeted for conservation. The Northwest Coast also supports the highest number of salt/brackish marsh wetlands of high conservation value. About 1/3 of these have some level of protection.

In the Puget Trough ecoregion past glaciation has left a high concentration of bogs, poor basin fens and remnant wet prairies (which occur on glacial outwash). Many of the ecoregion's peatlands have been destroyed or degraded in the urbanized areas of King, Pierce, and Snohomish counties but there are numerous bogs/basin fens in less urbanized areas of the Puget Sound region which remain somewhat intact. Riparian areas are another conservation priority in this region due to their degradation from a high density of development and agriculture. Salt/brackish marshes are also abundant along the shores of Puget Sound. Other wetland types are numerous in this ecoregion including shrub swamps and marshes but most are degraded from human land uses. The southern portion of this ecoregion has received much less inventory/ classification attention mostly due to the extensive agriculture and timber extraction that occurred in the region. However, one of western Washington's most endangered wetland types—wet prairies—is primarily found in Clark, Cowlitz, and Lewis counties (they are also found in very few locations Thurston and Pierce counties in the southern Puget Sound region).

Wetlands and riparian areas along the Columbia River extend through multiple ecoregions (from West Cascades through the southern extent of the Puget Trough and finally into the Northwest Coast ecoregion). There are numerous marsh/wet meadows, forested swamps and riparian forest types that are primarily found along or within the Columbia River floodplain. Due to the amount of hydrological management of the Columbia River, all of these wetlands have experienced hydrological alteration. In addition, many of the wetlands in the floodplain have been destroyed, converted, and/or degraded due to agriculture and development. Nonetheless, many of these wetlands remain conservation targets due to their unique ecological templates and resulting floristics.

Tidally-influenced, freshwater wetlands occur along the lower reaches of rivers, streams, and sloughs within the Northwest Coast ecoregion and near the mouths of major rivers in the Puget Trough ecoregion. Many of the Associations found in these wetlands are restricted to the tidally-influenced yet freshwater environment.

The montane regions of western Washington have not received as much classification and inventory attention as other ecoregions. As such, our knowledge of wetland conservation priorities in these areas lags behind our knowledge of other areas. Based on what we do know, the area around the southwestern base of Mount Adams supports what may be the highest concentration of peatlands in the montane regions of western Washington. The peatlands in this area are larger than commonly observed elsewhere in the West Cascades, North Cascades, or Olympic Mountains and support a flora that is reflective of both western and eastern Washington (this area is a known transition zone between Vancouverian and Rocky Mountain flora).

12.2 Contributions to Advancing Wetland Conservation

Documenting the specific locations of wetland conservation priorities (i.e. Wetlands of High Conservation Value) is one of the most important outcomes of this project. The presence of Wetlands of High Conservation Value are used in the Wetland Rating System as one qualification for designating a site as a Category 1 wetland. Category 1 wetlands are typically given the most stringent protection and buffer regulations by municipalities that use the Rating System.

This project has also produced multiple products that contribute to wetland conservation (Table 24). Incorporating a revised classification of wetland types within the U.S. National Vegetation Classification provides a systematic accounting of the ecological and vegetation diversity associated with western Washington wetlands and riparian areas. The classification provides a means for tracking the distribution of ecological patterns across the landscape. A subsequent assessment of the conservation significance of each of the classification units, ongoing inventory for determining the location of those wetlands, and an assessment of current protection status/needs has produced a dataset which can lead to more effective conservation actions, provide restoration benchmarks, and assist in regulatory decisions.

Some additional information collected at the wetlands visited during this project includes ecological integrity, stressor checklists and wetland function ratings. This information allowed a cursory analysis of the relationships between these variables. Some of these variables are correlated (stressor and ecological integrity) while others are not (ecological integrity and wetland function rating). It is important that users of these data understand the assumptions underlying each of these wetland assessment approaches and how their results provide unique and often contradictory information about wetland "quality".

All of the information presented in this report will assist WNHP in achieving its programmatic objectives of setting conservation priorities. This information is also used by many land trusts, conservation organizations and local, state, and federal agencies for conservation planning. Specifically, this information will feed into the process of establishing Natural Heritage Plan priorities. Natural Heritage Plan priorities are a key component of evaluating sites for Washington Wildlife and Recreation Program (WWRP) funding. As such, project results will influence where the State of Washington spends millions of dollars to voluntarily protect irreplaceable wetland habitat.

12.2 Network of Reference Standard Wetlands

A *reference network* is a group of wetlands which reflect the range of variability associated with specific wetland types in a given geographic region. *Reference standard wetlands* are a subset of those wetlands that reflect the range of conditions that are used as a benchmark for comparison to other wetlands for a specific objective, such as evaluating wetland functions or ecological integrity. Thus, the group of wetlands representing the reference standard condition varies according to the stated objective.

Table 24. Conservation Outcomes of this Project.

Product	Conservation Outcomes
Revised classification of western Washington native vegetation (Appendix A; forthcoming publication on WNHP website): Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington	Provides a systematic mechanism to account for the diversity of ecological templates associated with wetland biodiversity. This information can then be applied toward guiding conservation actions, informing restoration benchmarks (when coupled with EIA), and assisting with regulatory decisions
Updated conservation status ranks	A systematic assessment of biodiversity values (based on distribution, trends, threats, and rarity) which can then be applied toward prioritizing conservation actions.
Floristic Quality Assessment for Washington (Rocchio 2013; http://www1.dnr.wa.gov/nhp/refdesk/communities/fqa.html)	A standardized method for assessing the integrity of vegetation communities associated with both wetland and upland ecosystems. Results have multiple applications including monitoring, establishing restoration or even mitigation benchmarks, informing management actions and prioritizing conservation actions
Coarse assessment of ecological integrity of every NWI polygon (i.e., Level 1 EIA GIS file submitted with report)	Provides an assessment of ecological integrity of every mapped wetland (NWI) in western Washington. May be useful for watershed-scale planning and analysis. Further calibration of the results is needed.
Updated information about ecological integrity, stressors, and wetland functions for 256 Wetlands of High Conservation Value (36% of total WHCV in western Washington).	Ensures WHCV data is up to date. Data concerning trends may help understand or at least pinpoint additional research questions regarding the complex interactions and relationships between anthropogenic stressors, wetland functions, and ecological integrity. Data collected suggest that wetland with high ecological integrity do not always have the highest potential for performing certain functions. Conversely, wetlands with high potential of function performance do not always have high ecological integrity.
Summary of protection achievements and needs for WHCV within each ecoregion	Provide a scorecard for conservation success and needs. Such information can pinpoint exactly what types of wetlands within each ecoregion should be high priority targets for protection.
Inventory needs for wetland Natural Community and Plant Association types	Data about many Natural Community and Plant Association types are lacking. This information can help focus future field inventory work on those types of wetlands in most need of such attention.
Revised process for accounting for wetlands meeting WHCV criteria not in WNHP's database	WNHP has not inventoried every western WA wetland. Thus, it is likely wetlands may be encountered by other scientists that may meet the WHCV criteria. In the past, these wetlands were not able to be counted as a WHCV. WNHP and WA Dept. of Ecology have agreed that if a rare plant species, rare plant association, or high-quality common plant association is encountered but is not currently documented in the WNHP's database, relevant information can be submitted to WNHP for consideration to be included in the database. Thus, new WHCV can now be "proposed" to WNHP by submitting required information about wetland type and condition.
Network of Reference Standard Sites	A total of 152 unique reference standard sites were identified for 193 unique combinations of Natural Community Types & Plant Associations. The list is a first iteration based on known WHCV and field experience of the authors. As new inventory data becomes available the list may change. Reference standard sites have not been identified for all wetland types. Future work by WNHP will seek to identify reference standard sites for these types.

The following sections describe the use of WHCV data managed by WNHP to develop a network of *reference standard* sites that possess ecological and vegetation conditions that best represent the historical or natural range of variation (e.g., have experience the least degradation by human stressors) of western Washington wetlands and riparian areas.

12.2.1 Plant Association-based Wetlands of High Conservation Value as Reference Standard Wetlands

The concept of minimally disturbed condition (MDC), or the ecological condition of sites in the absence of significant human disturbance, is one approach for defining reference standard wetlands (Stoddard et al. 2006). Stoddard et al. (2006) consider the MDC to be the "best approximation or estimate of biotic integrity." Recognizing that most sites have likely been exposed to some minimal human stressor (e.g. atmospheric contaminants, climate change, etc.), the definition incorporates the disclaimer of "significant" human disturbances. MDC sites represent one end of a continuum ranging from sites with minimal or no exposure to human-induced disturbance (i.e. reference standard sites) to those in a highly degraded condition due to such impacts (Bailey et al. 2004; Stoddard et al. 2006). The natural variation of the MDC provides a baseline from which biotic or abiotic variables can be assessed to determine whether ecological integrity has been compromised at a site. In other words, it becomes easier to separate the signal (response to human disturbance) from noise (natural variability) when sampling wetlands across a human disturbance gradient. It follows that, if ecological response to stressors can be identified then better informed restoration, management, and protection projects can be implemented.

The EIA method is essentially based on the MDC concept. EIA is used to identify high-quality or minimally disturbed examples of wetlands to help identify WHCV. Thus, many of the Plant Association-based Wetlands of High Conservation Value discussed in this report can serve as reference standard wetlands for objectives based on comparison to wetlands with minimal or no human disturbance. Such objectives might include identifying restoration potential and benchmarks, mitigation performance standards (Faber-Langendoen et al. 2006; 2008), conservation priorities, or to assess ecological response to human-induced disturbance.

The highest EIA ranks of WHCV were used to identify reference standard sites for a given wetland type. For many wetlands, these are WHCV with an EIA rank of excellent integrity (e.g., "A" rank). However, because of varying degrees of loss and degradation on the landscape not all wetlands have remaining examples close to historical conditions (e.g., wet prairies). For those wetland types, the highest ranked examples would qualify as reference standard sites for that wetland type. For example, the highest quality example of wet prairie remaining in western Washington has an EIA Rank of "C" (fair integrity). Thus, although the site is significantly degraded relative to historical conditions because it is the best remaining example of wet prairie it would be identified as a reference standard wetland. Presence within a Natural Area Preserve or other similarly protected area was also considered since these sites are likely to persist in the long-term.

Appendix D (accompanying Excel workbook) has a list of reference standard sites derived from the 718 Plant Association-based WHCV. A total of 152 reference standard sites were identified for 100 of the 427 (23%) unique combinations of Natural Community Types-Associations.

Reference Standard Sites were located in all western Washington counties (Figure 28; Figure 29; Figure 30; Figure 31; Figure 32).

A couple of caveats should be considered when using this list:

- The list was generated for the Natural Community Type-Association combination. The list might vary for a different portion of the classification. For example, a list of reference standard sites just for Associations may have a different list of sites.

- The list should not be interpreted as exhaustive or complete. It is a first iteration based on known WHCV and field experience of the authors. As new inventory data becomes available the list may change.

- Reference standard sites have not been identified for all wetland types. Future work will seek to identify reference standard sites for these types.

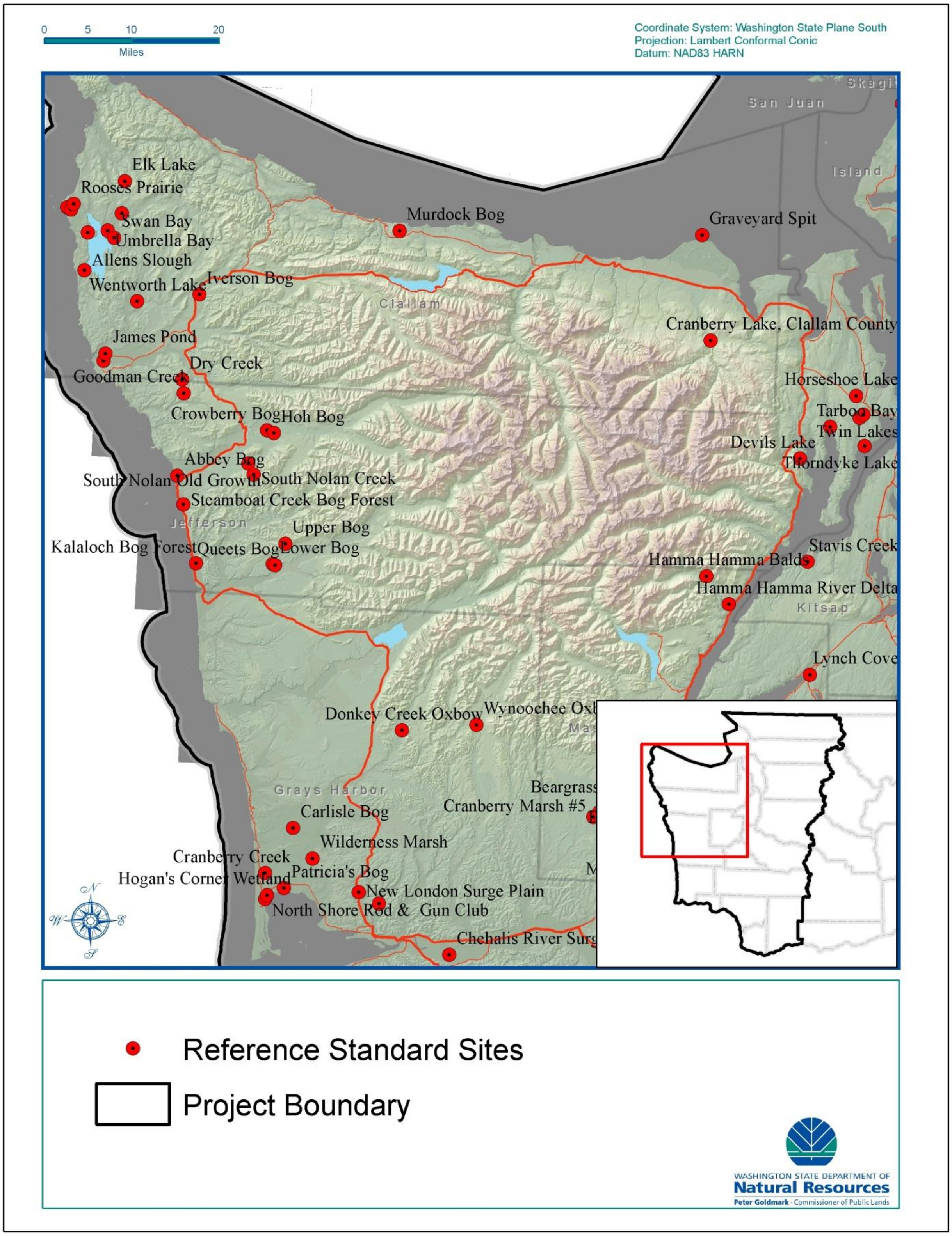

Figure 28. Reference Standard Sites (northwest)

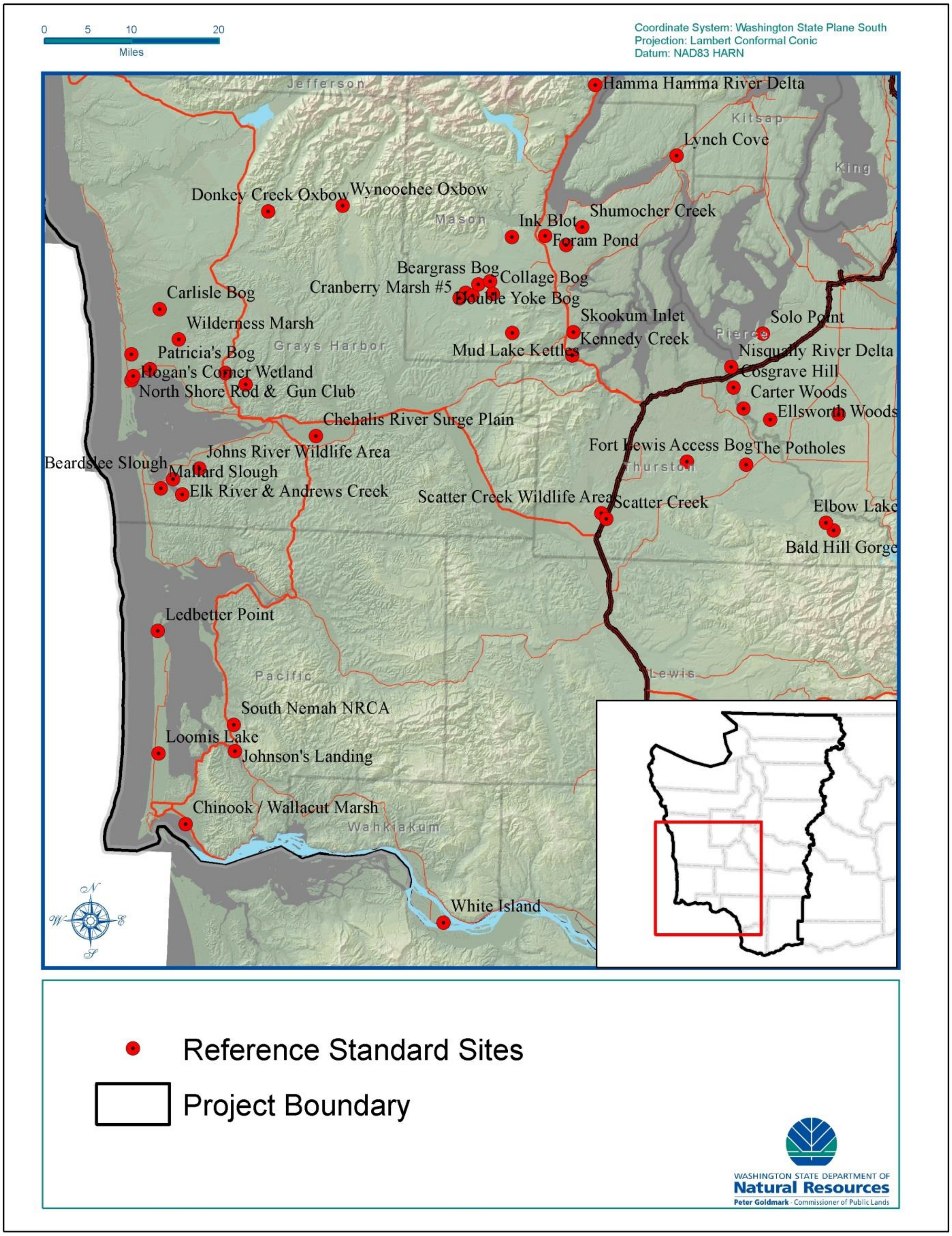

Figure 29. Reference Standard Sites (southwest)

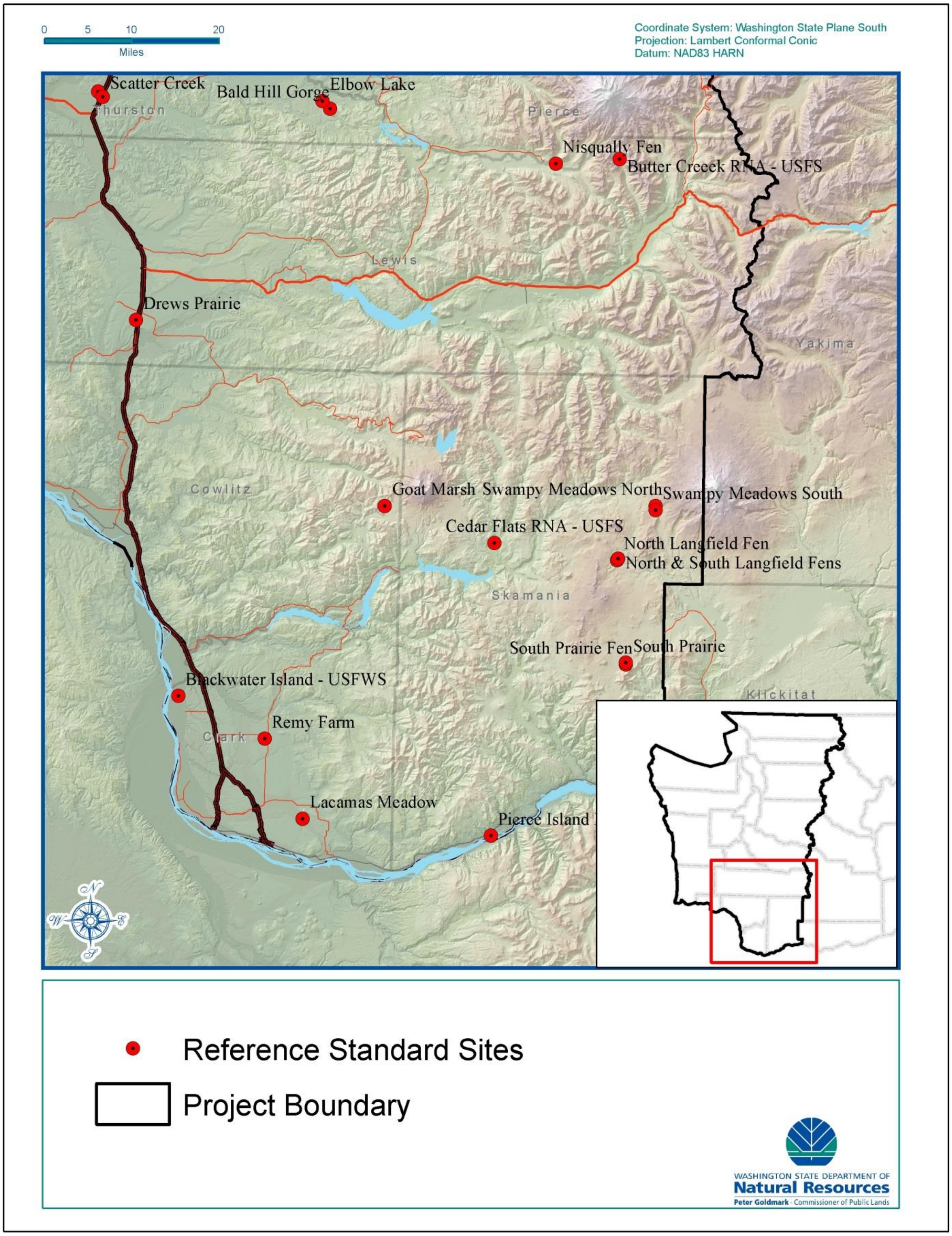

Figure 30. Reference Standard Sites (southeast)

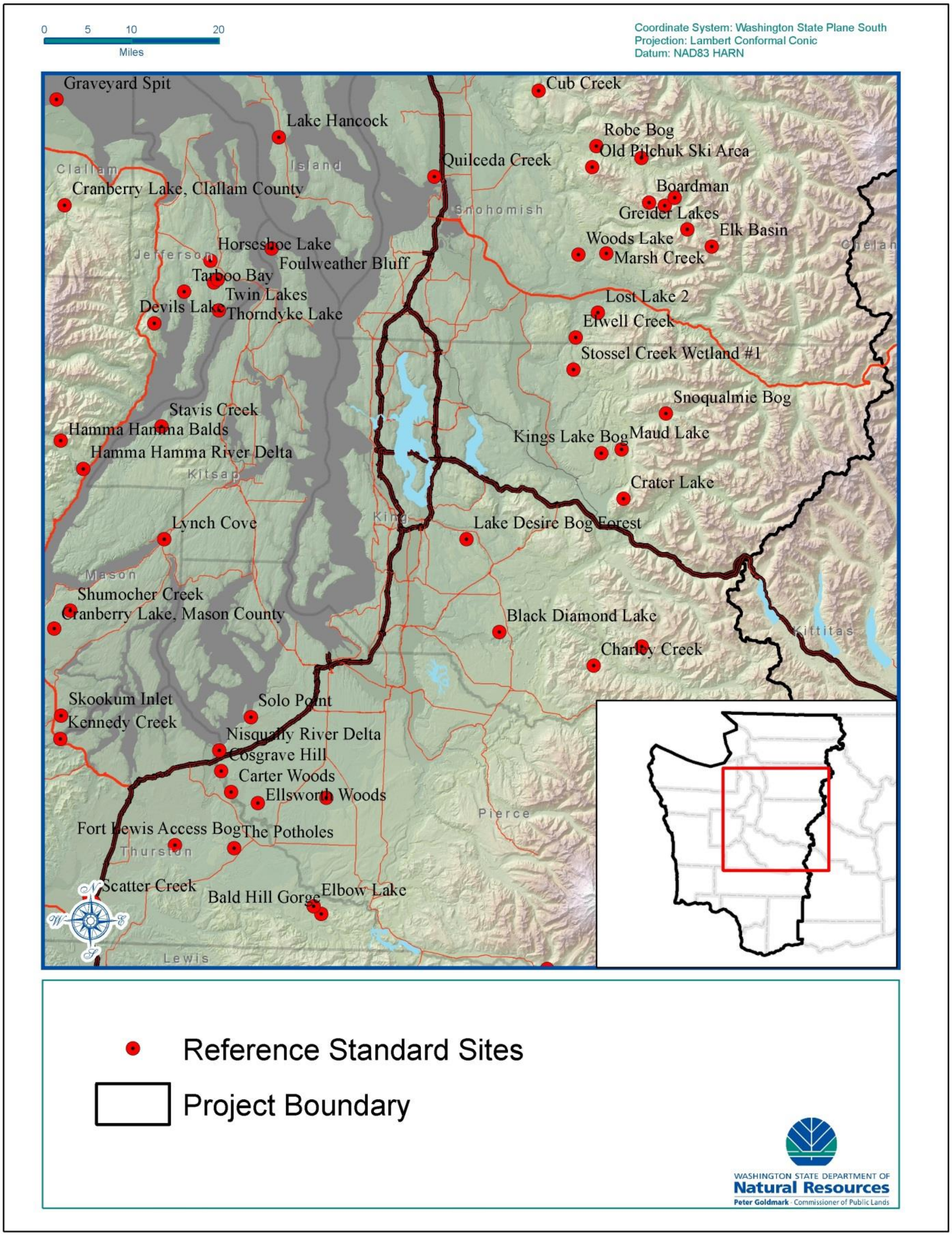

Figure 31. Reference Standard Sites (central)

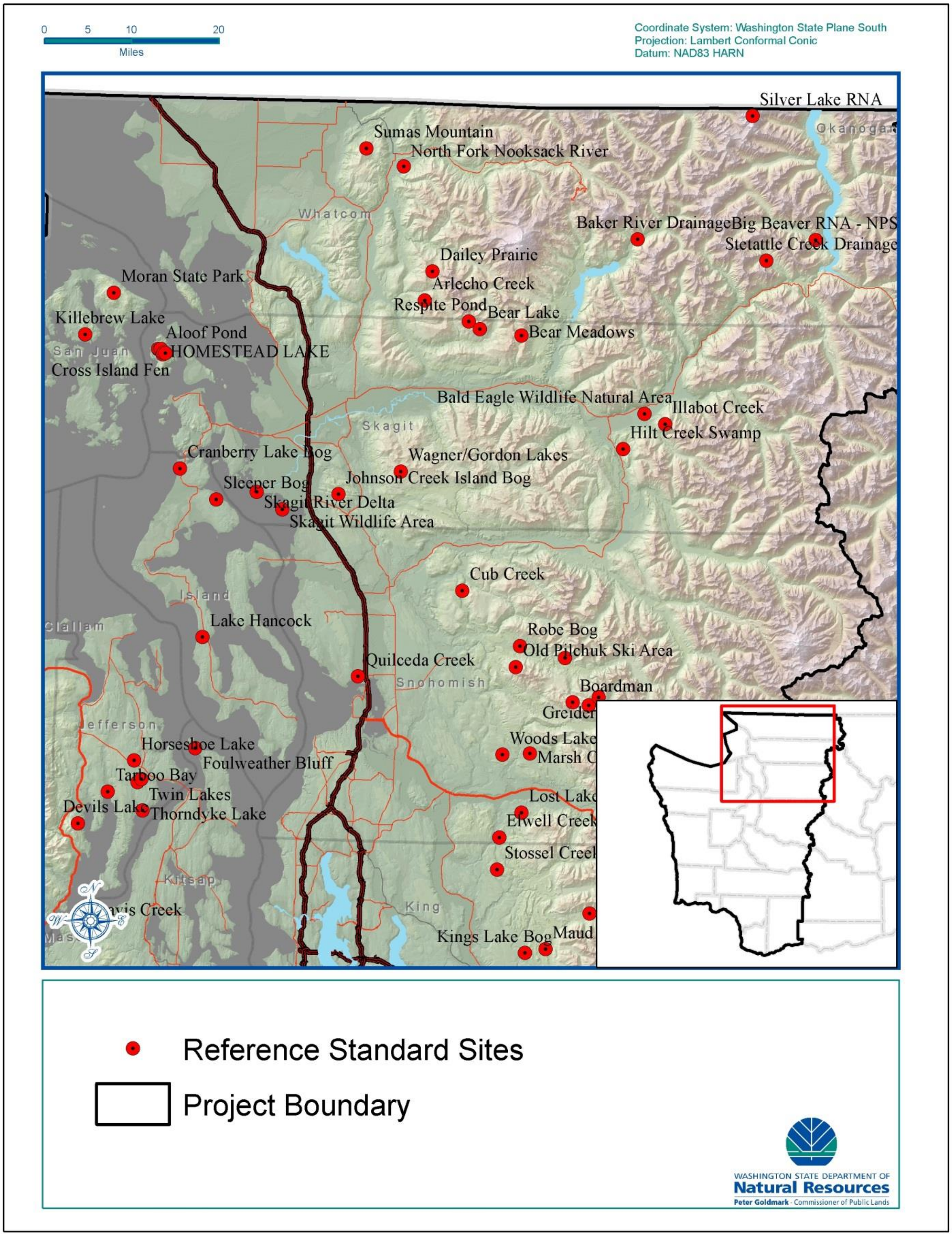

Figure 32. Reference Standard Sites (northeast)

12.3 Limitations of Data

The information presented in this report is based on data collected over a 30-year time frame and represents 718 Plant Association-based WHCV at 300 unique sites that span the entirety of western Washington (Figure 8). This is a substantial body of work but data gaps still exist.

WNHP has not visited each wetland in western Washington thus additional sites which may meet WHCV criteria may occur on the landscape. As seen in Figure 8, most inventory work has been conducted in the lowlands of western Washington. This is primarily because the lowlands are where the greatest threats and urgency are for conservation. However, addressing gaps in knowledge of wetland types and conservation significance at higher elevations is recommended in order to fully understand the biodiversity values of western Washington wetlands. In addition, some ecosystem types have received more inventory attention than others. Appendix A lists priorities for future inventory. This list should be considered along with the conservation status rank of each type to priorities future surveys.

In the context of the Wetland Rating System, WNHP collaborated with Washington Department of Ecology to establish a protocol that will allow consultants and other ecologically trained individuals to propose a site as a WHCV to WNHP. WNHP will review submitted data then work with those individuals to determine whether sites meet the WHCV criteria. This new process is described in the updated Wetland Rating System manuals accessible on Washington Department of Ecology's website. This process has the potential to increase the knowledge of wetland type distributions, conservation significance, and site priorities.

12.4 Next Steps

This report summarizes work completed in fulfillment of two EPA Region 10 Wetland Program Development Grants (CD-00J263010 and CD-00J49101). WNHP is currently working completing a wetland conservation profile for eastern Washington (EPA WPDG CD-00J64201) which will have a similar format as presented in this document. That project is expected to be completed by December, 2015. Another EPA WPDG (CD-00J78501) is in progress and is focused on completing a statewide reference standard wetland network, developing a publicly accessible web-based map viewer (to share locations of WHCV and reference standard wetlands), creating a web site with information about Washington's wetland biodiversity, and to develop and offer training for wetland professionals interested in learning how to apply the *Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington* and Ecological Integrity Assessment method.

12.5 Data Transfer and Outreach

The products listed in Section 1.3 will soon be available from WNHP's website (http://www1.dnr.wa.gov/nhp/refdesk/communities.html).

WNHP presented preliminary results of this project at the Biodiversity Without Boundaries Conference hosted by NatureServe in Portland, OR in April 2012. WNHP presented the classification to the Pacific Northwest Wetlands Climate Change Symposium held in Seattle, WA on November 8, 2012. WNHP also presented preliminary results to U.S. EPA Region 10 and the Washington Department of Ecology staff. WNHP will explore opportunities to present project results at relevant local and/or national professional conferences. WNHP will also seek to publish the classification results in a peer-reviewed publication.

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Appendix A: Ecological Classification of Native Wetland & Riparian Vegetation of Western Washington (September 2014 Version)

Classification Level
USNVC Formation Class
USNVC Formation Subclass
USNVC Formation
USNVC Division
USNVC Macrogroup
USNVC Group
Natural Community Type (WA specific)
USNVC Plant Association

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
1 Forest to Open Woodland Class					
1.B Temperate & Boreal Forest Subclass					
1.B.3 Temperate Flooded & Swamp Forest Formation					
1.B.3.Ng Vancouverian Flooded & Swamp Forest Division					
Vancouverian Flooded & Swamp Forest Macrogroup					
North Pacific Lowland Riparian Forest & Woodland Group					
Lower Columbia River Overflow Plains Forest					
Fraxinus latifolia - (Populus balsamifera ssp. trichocarpa) / Cornus sericea Forest	G4	S2	1	High	1
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Acer circinatum Forest	G3	SNR	0	High	
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Carex deweyana - Urtica dioica ssp. gracilis Forest	G1	S1S2	0	High	
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Corylus cornuta - Physocarpus capitatus Forest	G3	S1?	0	High	
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Rubus spectabilis Forest	G2	SNR	0	High	
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Symphoricarpos albus Forest	G4	S2?	0	High	
Salix lucida ssp. lasiandra / Salix fluviatilis Woodland	G3Q	S2	1	High	1
Salix lucida ssp. lasiandra / Urtica dioica ssp. gracilis Forest	G2	S1S2	0	High	
North Pacific Lowland Confined Riparian Forest					
Acer macrophyllum / Oxalis oregana Forest	G3G4	S3S4	0	High	
Alnus rubra / Acer circinatum / Claytonia sibirica Forest	G4G5	S4	0	High	
Alnus rubra / Oplopanax horridus - Rubus spectabilis Forest	G4G5	S4	0	High	
Alnus rubra / Petasites frigidus Forest	G4	S4?	1	High	1
Alnus rubra / Rubus parviflorus Forest	G4	S4?	0	High	
Alnus rubra / Rubus spectabilis Forest	G4G5	S4S5	1	High	
North Pacific Lowland Floodplain Forest					
Acer macrophyllum / Polystichum munitum - Tolmiea menziesii Forest	G3G4	S3S4	0	High	
Acer macrophyllum / Rubus spectabilis Forest	G4	S3S4	1	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Acer macrophyllum / Symphoricarpos albus / Urtica dioica ssp. gracilis Forest	G3	SNR	0	High	
Acer macrophyllum / Urtica dioica ssp. gracilis Forest	G3	SNR	0	High	
Alnus rubra / Acer circinatum / Claytonia sibirica Forest	G4G5	S4	0	High	
Alnus rubra / Elymus glaucus Forest	G4	S3S4	0	High	
Alnus rubra / Oplopanax horridus - Rubus spectabilis Forest	G4G5	S4	0	High	
Alnus rubra / Petasites frigidus Forest	G4	S4?	0	High	
Alnus rubra / Rubus parviflorus Forest	G4	S4?	0	High	
Alnus rubra / Rubus spectabilis Forest	G4G5	S4S5	3	High	1
Alnus rubra / Stachys chamissonis var. cooleyae - Tolmiea menziesii Forest	G4	S3S4	0	High	
Fraxinus latifolia - (Populus balsamifera ssp. trichocarpa) / Cornus sericea Forest	G4	S2	0	High	
Fraxinus latifolia - Populus balsamifera ssp. trichocarpa / Carex deweyana - Urtica dioica ssp. gracilis Forest	G1	S1S2	1	High	
Fraxinus latifolia / Symphoricarpos albus Forest	G4	S2?	2	High	
Populus balsamifera ssp. trichocarpa - Acer macrophyllum / Equisetum hyemale Forest	G3	S2?	3	High	3
Populus balsamifera ssp. trichocarpa - Acer macrophyllum / Symphoricarpos albus Forest	G3	S2S3	3	High	2
Populus balsamifera ssp. trichocarpa - Alnus rubra / Carex obnupta Forest	GNR	S2Q	0	High	
Populus balsamifera ssp. trichocarpa - Alnus rubra / Rubus spectabilis Forest	G2G3	S2?	6	Moderate	1
Populus balsamifera ssp. trichocarpa - Alnus rubra / Symphoricarpos albus Forest	G3	S2?	0	High	
Populus balsamifera ssp. trichocarpa - Picea sitchensis - (Acer macrophyllum) / Oxalis oregana Forest	G2G3	S2	0	High	
Quercus garryana - (Fraxinus latifolia) / Symphoricarpos albus Forest	G2	S2	5	Moderate	2
North Pacific Maritime Hardwood-Conifer Swamp Group					
North Pacific Freshwater Tidal Surge Plain Forested Swamp					
Alnus rubra / Rubus spectabilis / Carex obnupta - Lysichiton americanus Woodland	G3G4	S3S4	2	High	1
Picea sitchensis / Cornus sericea / Lysichiton americanus Forest	G2	S1	5	Moderate	1
Picea sitchensis / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G2G3	S2	4	Moderate	1
Populus balsamifera ssp. trichocarpa / Cornus sericea / Impatiens capensis Forest	G1	S1	2	High	2

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
North Pacific Interdunal Conifer Swamp					
Pinus contorta var. contorta / Carex obnupta Forest	G3	SNR	1	High	1
North Pacific Lowland Flat & Depressional Forested Swamp					
Alnus rubra / Athyrium filix-femina - Lysichiton americanus Forest	G3G4	S3	3	High	1
Alnus rubra / Glyceria striata Woodland	GNR	S2S4Q	0	High	
Alnus rubra / Rubus spectabilis / Carex obnupta - Lysichiton americanus Woodland	G3G4	S3S4	3	High	1
Fraxinus latifolia / Carex obnupta Forest	G4	S2?	0	High	
Fraxinus latifolia / Spiraea douglasii Forest	G3	S2?	1	High	
Picea sitchensis - Alnus rubra / Lysichiton americanus - Chrysosplenium glechomifolium Forest	GNR	SNR	1	High	
Picea sitchensis / Cornus sericea / Lysichiton americanus Forest	G2	S1	0	High	
Picea sitchensis / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G2G3	S2	2	High	1
Tsuga heterophylla - (Thuja plicata - Alnus rubra) / Lysichiton americanus - Athyrium filix-femina Forest	G3?	S2S3	6	Moderate	1
Tsuga heterophylla - Thuja plicata / Gaultheria shallon / Lysichiton americanus Forest	GNR	S2	3	High	1
North Pacific Lowland Forested Seepage Swamp					
Alnus rubra / Athyrium filix-femina - Lysichiton americanus Forest	G3G4	S3	0	High	
Alnus rubra / Rubus spectabilis / Carex obnupta - Lysichiton americanus Woodland	G3G4	S3S4	0	High	
Alnus rubra / Rubus spectabilis / Chrysosplenium glechomifolium Forest	G3G4	S3S4	0	High	
Picea sitchensis - (Alnus rubra) / Rubus spectabilis / Polystichum munitum Forest	G3?	S3	0	High	
Picea sitchensis - Alnus rubra / Lysichiton americanus - Chrysosplenium glechomifolium Forest	GNR	SNR	0	High	
Picea sitchensis - Tsuga heterophylla - (Alnus rubra) / Oplopanax horridus / Polystichum munitum Forest	G2G3	S2S3	0	High	
Picea sitchensis / Rubus spectabilis / Carex obnupta - Lysichiton americanus Forest	G2G3	S2	1	High	
Populus tremuloides / Carex obnupta Forest	G2	S1?	0	High	
Tsuga heterophylla - (Pseudotsuga menziesii - Thuja plicata) / Polystichum munitum - Athyrium filix-femina Forest	G4G5	S4	8	Low	5
Tsuga heterophylla - (Thuja plicata - Alnus rubra) / Lysichiton americanus - Athyrium filix-femina Forest	G3?	S2S3	11	Low	2

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Tsuga heterophylla - Pseudotsuga menziesii - (Thuja plicata) / Oplopanax horridus / Polystichum munitum Forest	G3	S2S3	0	High	
Tsuga heterophylla - Thuja plicata / Gaultheria shallon / Lysichiton americanus Forest	GNR	S2	11	Low	4
North Pacific Montane Flat & Depressional Swamp					
Tsuga heterophylla - (Thuja plicata - Alnus rubra) / Lysichiton americanus - Athyrium filix-femina Forest	G3?	S2S3	0	High	
North Pacific Montane Forested Seepage Swamp					
Abies amabilis - Tsuga heterophylla / Oplopanax horridus Forest	G5	S5	8	Low	6
Alnus rubra / Athyrium filix-femina - Lysichiton americanus Forest	G3G4	S3	2	High	
Tsuga heterophylla - (Thuja plicata - Alnus rubra) / Lysichiton americanus - Athyrium filix-femina Forest	G3?	S2S3	0	High	
Tsuga heterophylla - Abies amabilis / Vaccinium alaskaense / Lysichiton americanus Forest	G3	S3	1	High	1
Tsuga mertensiana - Abies amabilis / Caltha leptosepala ssp. howellii Forest	G3	S3	2	High	2
North Pacific Montane Wooded Moderately Rich Fen					
Pinus contorta var. contorta - Thuja plicata / Alnus incana / Carex (aquatilis var. dives, echinata ssp. echinata) Woodland	GNR	SNR	1	High	
North Pacific Maritime Poor Fen & Bog Forest & Woodland Group					
North Pacific Domed Bog Woodland					
Pinus contorta var. contorta - Tsuga heterophylla / Gaultheria shallon / Sphagnum spp. Woodland	GNR	SNR	1	High	
Pinus contorta var. contorta / Ledum groenlandicum / Xerophyllum tenax / Sphagnum spp. Woodland	GNR	SNR	1	High	
North Pacific Lowland Bog Woodland					
Pinus contorta var. contorta - Betula papyrifera / Ledum groenlandicum Woodland [Provisional]	GNR	SNR	0	High	
Pinus contorta var. contorta - Thuja plicata / Myrica gale / Sphagnum spp. Woodland	G3G4	S1	0	High	
Pinus contorta var. contorta - Tsuga heterophylla / Gaultheria shallon / Sphagnum spp. Woodland	GNR	SNR	4	Moderate	2
Pinus contorta var. contorta / Ledum groenlandicum / Sphagnum spp. Woodland	G3	S2	12	Low	1
Pinus monticola / Ledum groenlandicum / Sphagnum spp. Woodland	G1	S1	0	High	
Thuja plicata - Tsuga heterophylla / Lysichiton americanus / Sphagnum spp. Woodland	G3G4	S1	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Tsuga heterophylla - (Thuja plicata) / Ledum groenlandicum / Sphagnum spp. Woodland	G3	S2	19	Low	2
Tsuga heterophylla - (Thuja plicata) / Sphagnum spp. Forest	G1	S1	3	High	
North Pacific Lowland Wooded Poor Sloping Fen					
Pinus contorta var. contorta - Thuja plicata / Myrica gale / Sphagnum spp. Woodland	G3G4	S1	5	Moderate	3
Pinus contorta var. contorta / Ledum glandulosum / Sphagnum spp. Woodland	G1	SNR	0	High	
Thuja plicata - Tsuga heterophylla / Lysichiton americanus / Sphagnum spp. Woodland	G3G4	S1	7	Moderate	4
Tsuga heterophylla - (Thuja plicata) / Ledum groenlandicum / Carex (obnupta, utriculata) / Sphagnum spp. Woodland	GNR	SNR	9	Low	3
Tsuga heterophylla - (Thuja plicata) / Ledum groenlandicum / Sphagnum spp. Woodland	G3	S2	2	High	1
North Pacific Montane Wooded Poor Basin Fen					
Association(s) Not Yet Identified			0	High	
North Pacific Montane Wooded Poor Sloping Fen					
Association(s) Not Yet Identified			0	High	
North Pacific Montane Riparian Woodland Group					
North Pacific Montane Confined Riparian Forest					
Alnus rubra / Vaccinium ovalifolium / Trautvetteria caroliniensis Shrubland	GNR	S3S4	0	High	
Thuja plicata / Rubus spectabilis / Oxalis oregana Forest	G3	S2	0	High	
North Pacific Montane Floodplain Forest					
Abies amabilis / Rubus spectabilis - Vaccinium alaskaense Forest [Provisional]	G2G4Q	S2S4Q	0	High	
Abies lasiocarpa / Rubus spectabilis Forest [Provisional]	G2G4Q	S2S4Q	0	High	
Alnus rubra / Vaccinium ovalifolium / Trautvetteria caroliniensis Shrubland	GNR	S3S4	0	High	
Thuja plicata / Athyrium filix-femina - Stachys chamissonis var. cooleyae Forest	GNR	SNR	0	High	
Thuja plicata / Rubus spectabilis / Oxalis oregana Forest	G3	S2	0	High	
2 Shrubland & Grassland Class					
2.B Temperate & Boreal Grassland & Shrubland Subclass					

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
2.B.5 Temperate & Boreal Bog & Fen Formation					
2.B.5.Na North American Bog & Fen Division					
North Pacific Bog & Fen Macrogroup					
North Pacific Bog & Acidic Fen Group					
North Pacific Domed Bog					
Kalmia microphylla - Vaccinium oxycoccos / Xerophyllum tenax / Sphagnum spp. Dwarf-shrubland	GNR	SNR	2	High	
North Pacific Lowland Bog & Poor Basin Fen					
Carex cusickii - (Carex aquatilis var. dives) / Sphagnum spp. Herbaceous Vegetation	G2	S1	9	Low	1
Carex echinata ssp. echinata Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex exsiccata Acidic Fen Herbaceous Vegetation [Provisional]	G2G3	S2S3	6	Moderate	2
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	G4?	S3?	0	High	
Dulichium arundinaceum Acidic Fen Herbaceous Vegetation [Provisional]	G3	S2S3	6	Moderate	1
Juncus balticus - Comarum palustre / Sphagnum spp. Herbaceous Vegetation [Provisional]	GNR	SNR	2	High	
Kalmia microphylla - Ledum groenlandicum / Xerophyllum tenax Shrubland	G1	S1	4	Moderate	1
Ledum groenlandicum - Kalmia microphylla / Sphagnum spp. Shrubland	G4	S3	14	Low	2
Ledum groenlandicum - Myrica gale / Sphagnum spp. Shrubland	G2	S1	3	High	
Ledum groenlandicum / Carex utriculata / Sphagnum spp. Shrubland	GNR	SNR	3	High	1
Ledum groenlandicum / Typha latifolia / Sphagnum spp. Shrubland [Provisional]	GNR	S1?	1	High	
Myrica gale - Spiraea douglasii / Sphagnum spp. Shrubland	G2?	S1	0	High	
Myrica gale / Carex (aquatilis var. dives, utriculata) Shrubland	G3	S2	0	High	
Spiraea douglasii / Carex aquatilis var. dives Shrubland	G4	S2	6	Moderate	1
Spiraea douglasii / Sphagnum spp. Shrubland	G3	S1	7	Moderate	2
North Pacific Lowland Poor Sloping Fen					
Carex (livida, utriculata) / Sphagnum spp. Herbaceous Vegetation	G1G2	S1	7	Moderate	3
Carex echinata ssp. echinata Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	G4?	S3?	1	High	1

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Carex utriculata - Carex aquatilis var. dives - Sanguisorba officinalis / Sphagnum spp. Herbaceous Vegetation	G3?	S2	7	Moderate	5
Kalmia microphylla - Ledum groenlandicum - Gaultheria shallon - Pteridium aquilinum / Sphagnum spp. Shrubland	GNR	SNR	0	High	
Kalmia microphylla - Ledum groenlandicum / Carex utriculata / Sphagnum spp. Shrubland	GNR	SNR	1	High	1
Kalmia microphylla - Vaccinium oxycoccos / Carex (livida, obnupta) / Sphagnum spp. Dwarf-shrubland	GNR	SNR	3	High	2
Ledum groenlandicum - Myrica gale / Sphagnum spp. Shrubland	G2	S1	4	Moderate	2
Myrica gale / Carex (aquatilis var. dives, utriculata) Shrubland	G3	S2	8	Low	3
Myrica gale / Sanguisorba officinalis / Sphagnum spp. Shrubland	G1?	S1?	8	Low	4
Spiraea douglasii / Carex aquatilis var. dives Shrubland	G4	S2	1	High	1
North Pacific Lowland Poor Water Track & Floating Bog Mat					
Carex cusickii - (Carex aquatilis var. dives) / Sphagnum spp. Herbaceous Vegetation	G2	S1	0	High	
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	G4?	S3?	0	High	
Eriophorum chamissonis / Sphagnum spp. Herbaceous Vegetation	G4	S1	3	High	
Juncus supiniformis - (Carex livida, Rhynchospora alba) Herbaceous Vegetation	GNR	SNR	0	High	
Kalmia microphylla - Vaccinium oxycoccos / Sphagnum spp. Dwarf-shrubland	GNR	SNR	11	Low	1
Rhynchospora alba - (Vaccinium oxycoccos) / Sphagnum spp. Herbaceous Vegetation	G3	S2	19	Low	5
North Pacific Montane Poor Basin Fen					
Carex exsiccata Acidic Fen Herbaceous Vegetation [Provisional]	G2G3	S2S3	1	High	1
Kalmia microphylla / Carex nigricans Dwarf-shrubland	G3G4	S3	0	High	
Kalmia microphylla / Carex spp. - Caltha leptosepala ssp. howellii / Sphagnum spp. Dwarf-shrubland	GNR	SNR	1	High	
Vaccinium uliginosum / (Carex aquatilis var. dives) Dwarf-shrubland	G4	SNR	0	High	
North Pacific Montane Poor Sloping Fen					
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	G4?	S3?	0	High	
Carex luzulina Herbaceous Vegetation	G3	SNR	0	High	
Kalmia microphylla / Carex nigricans Dwarf-shrubland	G3G4	S3	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Kalmia microphylla / Carex spp. - Caltha leptosepala ssp. howellii / Sphagnum spp. Dwarf-shrubland	GNR	SNR	3	High	1
Vaccinium uliginosum / (Carex aquatilis var. dives) Dwarf-shrubland	G4	SNR	4	Moderate	
North Pacific Montane Poor Water Track & Floating Bog Mat					
Carex lasiocarpa / (Sphagnum spp.) Herbaceous Vegetation [Provisional]	G4?	S3?	0	High	
Carex limosa Herbaceous Vegetation	G2	S2?	1	High	
Eriophorum angustifolium ssp. subarcticum var. majus / Sphagnum spp. Herbaceous Vegetation	G4?	S2S3	0	High	
Kalmia microphylla - Vaccinium oxycoccos / Sphagnum spp. Dwarf-shrubland	GNR	SNR	2	High	
North Pacific Neutral - Alkaline Fen Group					
North Pacific Calcareous Fen					
Association(s) Not Yet Identified			0	High	
North Pacific Lowland Moderately Rich Basin Fen					
Carex aquatilis var. dives - Carex utriculata Herbaceous Vegetation	G3G4	S2	5	Moderate	
Carex aquatilis var. dives Herbaceous Vegetation	G4	S3S4	1	High	1
Ledum groenlandicum / Carex cusickii Shrubland [Provisional]	GNR	SNR	1	High	1
North Pacific Lowland Moderately Rich Sloping Fen					
Carex aquatilis var. dives - Carex utriculata Herbaceous Vegetation	G3G4	S2	7	Moderate	2
Carex aquatilis var. dives Herbaceous Vegetation	G4	S3S4	0	High	
Carex echinata ssp. echinata Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex lasiocarpa Herbaceous Vegetation	G4?	S3?	1	High	
Dulichium arundinaceum Circumneutral Fen Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Equisetum arvense Fen Herbaceous Vegetation [Provisional]	G5	S5	0	High	
North Pacific Lowland Moderately Rich Water Track & Quaking Mat					
Carex cusickii - (Menyanthes trifoliata) Herbaceous Vegetation	G2G3	S2	7	Moderate	
North Pacific Montane Moderately Rich Basin Fen					
Betula nana / Carex aquatilis var. dives Shrubland	GNR	SNR	0	High	
Carex aquatilis var. dives - (Eleocharis quinqueflora) Herbaceous Vegetation	GNR	SNR	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Carex aquatilis var. dives Herbaceous Vegetation	G4	S3S4	2	High	1
Carex lenticularis Fen Herbaceous vegetation [Provisional]	G3?	S2S3	0	High	
Carex scopulorum - Eleocharis quinqueflora Herbaceous Vegetation [Provisional]	G4	S3S4	0	High	
Carex utriculata Herbaceous vegetation	G5	S5	1	High	1
North Pacific Montane Moderately Rich Sloping Fen					
Betula nana / Carex aquatilis var. dives Shrubland	GNR	SNR	1	High	
Carex (aquatilis var. dives, nigricans, utriculata) - Caltha leptosepala ssp. howellii Herbaceous Vegetation [Provisional]	G2G3Q	S2S3	10	Low	2
Carex aquatilis var. dives - (Eleocharis quinqueflora) Herbaceous Vegetation	GNR	SNR	3	High	1
Carex aquatilis var. dives - Carex utriculata Herbaceous Vegetation	G3G4	S2	0	High	
Carex aquatilis var. dives Herbaceous Vegetation	G4	S3S4	0	High	
Carex scopulorum - Eleocharis quinqueflora Herbaceous Vegetation [Provisional]	G4	S3S4	0	High	
Eleocharis quinqueflora Herbaceous Vegetation	G4	S2?	1	High	
Equisetum arvense Fen Herbaceous Vegetation [Provisional]	G5	S5	0	High	
Trichophorum caespitosum - (Hypericum anagalloides) Herbaceous Vegetation	GNR	SNR	1	High	
Vaccinium uliginosum / Dodecatheon jeffreyi - Caltha leptosepala ssp. howellii Dwarf-shrubland	G3	SNR	0	High	
North Pacific Montane Moderately Rich Water Track & Quaking Mat					
Carex lasiocarpa Herbaceous Vegetation	G4?	S3?	0	High	
Eleocharis quinqueflora Herbaceous Vegetation	G4	S2?	0	High	
North Pacific Montane Shrub Carr					
Alnus incana / Carex (aquatilis, deweyana, lenticularis, luzulina, pellita) Shrubland	G3	S1	1	High	
Alnus incana / Lysichiton americanus Shrubland	G3	S2?	0	High	
Salix commutata Shrubland	GNR	SNR	0	High	
North Pacific Serpentine Fen					
Carex interior - Hypericum anagalloides Herbaceous Vegetation	G2?Q	S2?	1	High	
Carex obnupta - (Carex cusickii) Herbaceous Vegetation	G4	S4	4	Moderate	4
Eriophorum chamissonis - Carex interior Herbaceous Vegetation	GNR	SNR	2	High	1

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Juncus balticus - Festuca rubra - Carex cusickii Herbaceous Vegetation [Provisional]	GNR	SNR	4	Moderate	4
Ledum groenlandicum / Carex (cusickii, interior, utriculata) - Festuca rubra Shrubland [Provisional]	GNR	SNR	3	High	2
Spiraea douglasii / Carex obnupta Shrubland [Provisional]	GNR	SNR	1	High	1
2.B.6 Temperate & Boreal Freshwater Marsh, Wet Meadow & Shrubland Formation					
2.B.6.Nb Western North American Freshwater Shrubland, Wet Meadow & Marsh Division					
Western North American Montane & Subalpine Wet Shrubland & Wet Meadow Macrogroup					
Vancouverian & Rocky Mountain Montane Wet Meadow Group					
Vancouverian & Rocky Mountain Montane Depressional Marsh & Wet Meadow					
Calamagrostis canadensis Western Herbaceous Vegetation	G4	S3S4	2	High	1
Caltha leptosepala ssp. howellii Herbaceous Vegetation	G4	S4	0	High	
Carex lenticularis Herbaceous vegetation	G3?	S2S3	1	High	
Deschampsia cespitosa Herbaceous Vegetation	G4	S2?	1	High	1
Lysichiton americanus Herbaceous Vegetation	G4?	S3S4	1	High	
Saussurea americana - Heracleum maximum Herbaceous Vegetation	G3G4	S3S4	0	High	
Senecio triangularis Herbaceous Vegetation	G5?	SNR	0	High	
Vancouverian & Rocky Mountain Montane Lacustrine-Fringe Marsh & Wet Meadow					
Association(s) Not Yet Identified			0	High	
Vancouverian & Rocky Mountain Montane Riverine Impounded Marsh & Wet Meadow					
Carex exsiccata Montane Herbaceous Vegetation [Provisional]	G2G3	S2S3	1	High	
Carex lenticularis Herbaceous vegetation	G3?	S2S3	4	Moderate	2
Carex utriculata Marsh Herbaceous Vegetation [Provisional]	G5	S5	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Vancouverian & Rocky Mountain Montane Seep & Spring					
Caltha leptosepala ssp. howellii Herbaceous Vegetation	G4	S4	4	Moderate	2
Vancouverian & Rocky Mountain Montane Streamside Marsh & Wet Meadow					
Carex lenticularis Herbaceous vegetation	G3?	S2S3	0	High	
Corydalis scouleri Herbaceous Vegetation	G3?Q	S3?	0	High	
Mimulus guttatus Herbaceous Vegetation	G4	S4	0	High	
Saxifraga odontoloma - Senecio triangularis Herbaceous Vegetation	G3G4	S3	0	High	
Senecio triangularis Herbaceous Vegetation	G5?	SNR	0	High	
Trautvetteria caroliniensis - (Senecio triangularis) Herbaceous Vegetation	GNR	SNR	0	High	
Vancouverian & Rocky Mountain Subalpine Snowbed, Wet Meadow, and Dwarf-shrubland Group					
Vancouverian & Rocky Mountain Alpine-Subalpine Geothermal Seep & Spring					
Association(s) Not Yet Identified			0	High	
Vancouverian & Rocky Mountain Alpine-Subalpine Seep & Spring					
Carex nigricans - (Petasites frigidus var. frigidus) / Philonotis fontana Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex nigricans Herbaceous Vegetation	G4	S4	7	Moderate	2
Carex scopulorum Herbaceous Vegetation	G4	S3S4	0	High	
Kalmia microphylla / Carex nigricans Dwarf-shrubland	G3G4	S3	0	High	
Marchantia polymorpha - Philonotis fontana Bryophyte Vegetation	G3	SNR	0	High	
Polytrichum commune Bryophyte Vegetation	G4	SNR	0	High	
Vancouverian & Rocky Mountain Montane Snowmelt Flat & Depression					
Kalmia microphylla / Carex nigricans Dwarf-shrubland	G3G4	S3	0	High	
Western North American Temperate Lowland Wet Shrubland, Wet Meadow & Marsh Macrogroup					
Temperate Pacific Freshwater Wet Mudflat Group					

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Temperate Pacific Freshwater Tidal Surge Plain Mud Flat					
Eleocharis obtusa Herbaceous Vegetation [Provisional]	G4	SNR	0	High	
Eleocharis ovata - Ludwigia palustris Herbaceous Vegetation	G2	SNR	0	High	
Temperate Pacific Lowland Freshwater Wet Mudflat					
Eleocharis obtusa Herbaceous Vegetation [Provisional]	G4	SNR	0	High	
Eleocharis ovata - Ludwigia palustris Herbaceous Vegetation	G2	SNR	0	High	
Eragrostis hypnoides - Gnaphalium palustre Herbaceous Vegetation [Provisional]	G2	SNR	0	High	
Vancouverian & Rocky Mountain Montane Wet Meadow Group					
Vancouverian & Rocky Mountain Montane Depressional Marsh & Wet Meadow					
Carex pellita Herbaceous Vegetation	G3	S1	1	High	1
Vancouverian Freshwater Wet Meadow & Marsh Group					
Puget Lowland Wet Prairie					
Camassia quamash - Triteleia hyacinthina Herbaceous Vegetation	GNR	S1S2	0	High	
Camassia quamash Wet Prairie Herbaceous Vegetation	G3	S1S2?	0	High	
Carex unilateralis - Hordeum brachyantherum Herbaceous Vegetation	G2	SH	1	High	
Deschampsia cespitosa - Danthonia californica Herbaceous Vegetation	G2	S1	1	High	
Eleocharis palustris - Carex unilateralis Herbaceous Vegetation	G2	SNR	0	High	
Vancouverian Freshwater Tidal Surge Plain Marsh					
Athyrium filix-femina Coastal Herbaceous Vegetation	G4?	S2	3	High	1
Bidens cernua Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Bidens frondosa Herbaceous Vegetation	G4	SNR	0	High	
Caltha palustris - Lysichiton americanus Herbaceous Vegetation	G3	S2	0	High	
Carex interrupta Herbaceous Vegetation	G3G4	S3?	0	High	
Carex lyngbyei Herbaceous Vegetation	G4	S2	15	Low	4
Carex obnupta Herbaceous Vegetation	G4	S4	0	High	
Eleocharis palustris Herbaceous Vegetation	G5	S3?	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Equisetum fluviatile Herbaceous Vegetation	G4	S3?	0	High	
Lilaeopsis occidentalis Herbaceous Vegetation [Provisional]	G3	S2	0	High	
Ludwigia palustris - Polygonum hydropiperoides Herbaceous Vegetation	G2	S1S2	0	High	
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5	S3S4	1	High	1
Sparganium angustifolium Herbaceous Vegetation	G4	S3S4	0	High	
Sparganium eurycarpum Herbaceous Vegetation	G4	S2S3	0	High	
Vancouverian Interdunal Deflation Plain					
Juncus falcatus - Juncus (lesueurii, nevadensis) Herbaceous Vegetation	G3	S1?	1	High	1
Vancouverian Interdunal Marsh & Sedge Meadow					
Carex obnupta - Argentina egedii ssp. egedii Herbaceous Vegetation	G4	S2?	1	High	1
Vancouverian Lagg Marsh					
Carex exsiccata Herbaceous Vegetation	G2G3	S2S3	0	High	
Carex obnupta Herbaceous Vegetation	G4	S4	0	High	
Dulichium arundinaceum Herbaceous Vegetation	G3	S2S3	0	High	
Sparganium angustifolium Herbaceous Vegetation	G4	S3S4	0	High	
Typha latifolia Western Herbaceous Vegetation	G5	S5	1	High	
Vancouverian Lowland Depressional Marsh					
Bidens cernua Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Carex exsiccata Herbaceous Vegetation	G2G3	S2S3	2	High	
Carex obnupta - (Carex aquatilis var. dives, utriculata) Herbaceous Vegetation	G4	S4	2	High	2
Dulichium arundinaceum Herbaceous Vegetation	G3	S2S3	4	Moderate	2
Eleocharis palustris - Ludwigia palustris Herbaceous Vegetation	G2	SNR	0	High	
Eleocharis palustris Herbaceous Vegetation	G5	S3?	2	High	1
Hippuris vulgaris Herbaceous Vegetation	G5	S2	1	High	
Juncus articulatus Herbaceous Vegetation	GNR	SNR	0	High	
Juncus balticus Pacific Coast Herbaceous Vegetation	G5	S3S4	1	High	
Juncus bufonius Herbaceous Vegetation	G5	S5	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Juncus effusus var. brunneus Pacific Coast Herbaceous Vegetation	G5	S5	0	High	
Ludwigia palustris - Polygonum hydropiperoides Herbaceous Vegetation	G2	S1S2	0	High	
Oenanthe sarmentosa Herbaceous Vegetation	G4	S3S4	0	High	
Paspalum distichum Herbaceous Vegetation	G3	S2	0	High	
Sagittaria latifolia Herbaceous Vegetation	G2	S1	0	High	
Schoenoplectus acutus Herbaceous Vegetation	G5	S4	3	High	1
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5	S3S4	0	High	
Scirpus atrocinctus Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Scirpus microcarpus Herbaceous Vegetation	G4	S3S4	0	High	
Typha latifolia Western Herbaceous Vegetation	G5	S5	1	High	1
Vancouverian Lowland Geothermal Seep & Spring					
Eleocharis rostellata Herbaceous Vegetation	G3	S1	0	High	
Vancouverian Lowland Lacustrine-Fringe Marsh					
Bidens cernua Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Carex aquatilis var. dives - Comarum palustre Herbaceous Vegetation	G2	S2	4	Moderate	1
Carex obnupta Herbaceous Vegetation	G4	S4	0	High	
Dulichium arundinaceum Herbaceous Vegetation	G3	S2S3	0	High	
Equisetum fluviatile Herbaceous Vegetation	G4	S3?	0	High	
Hippuris vulgaris Herbaceous Vegetation	G5	S2	1	High	1
Ludwigia palustris - Polygonum hydropiperoides Herbaceous Vegetation	G2	S1S2	0	High	
Ranunculus flammula - Carex obnupta - Juncus nevadensis Herbaceous Vegetation	G1	S1	0	High	
Sagittaria latifolia Herbaceous Vegetation	G2	S1	0	High	
Schoenoplectus acutus Herbaceous Vegetation	G5	S4	0	High	
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5	S3S4	0	High	
Sparganium angustifolium Herbaceous Vegetation	G4	S3S4	0	High	
Sparganium eurycarpum Herbaceous Vegetation	G4	S2S3	0	High	
Typha latifolia Western Herbaceous Vegetation	G5	S5	2	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Vancouverian Lowland Riverine Impounded Marsh					
Bidens cernua Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Carex obnupta Herbaceous Vegetation	G4	S4	0	High	
Eleocharis palustris Herbaceous Vegetation	G5	S3?	0	High	
Equisetum arvense Herbaceous Vegetation	G5	S5	0	High	
Equisetum telmateia Herbaceous Vegetation	GNR	SNR	0	High	
Euthamia occidentalis Herbaceous Vegetation	G3	S3	0	High	
Glyceria striata Herbaceous Vegetation	G3	S2	1	High	
Hippuris vulgaris Herbaceous Vegetation	G5	S2	0	High	
Ludwigia palustris - Polygonum hydropiperoides Herbaceous Vegetation	G2	S1S2	0	High	
Sagittaria latifolia Herbaceous Vegetation	G2	S1	0	High	
Schoenoplectus acutus Herbaceous Vegetation	G5	S4	0	High	
Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation	G5	S3S4	0	High	
Scirpus microcarpus Herbaceous Vegetation	G4	S3S4	0	High	
Sparganium angustifolium Herbaceous Vegetation	G4	S3S4	0	High	
Sparganium eurycarpum Herbaceous Vegetation	G4	S2S3	0	High	
Typha latifolia Western Herbaceous Vegetation	G5	S5	2	High	1
Vancouverian Lowland Seep & Spring					
Equisetum telmateia Herbaceous Vegetation	GNR	SNR	0	High	
Juncus balticus Pacific Coast Herbaceous Vegetation	G5	S3S4	0	High	
Juncus effusus var. brunneus Pacific Coast Herbaceous Vegetation	G5	S5	0	High	
Mimulus guttatus - Bryum miniatum Herbaceous Vegetation	G4	S3S4	1	High	1
Mimulus guttatus Seep Herbaceous Vegetation [Provisional]	G4	S4	0	High	
Scirpus microcarpus Herbaceous Vegetation	G4	S3S4	0	High	
Vancouverian Lowland Serpentine Seep & Spring					
Association(s) Not Yet Identified			0	High	
Vancouverian Lowland Streamside Marsh					

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Adiantum pedatum Herbaceous Vegetation [Provisional]	G4G5	S4	0	High	
Bidens cernua Herbaceous Vegetation [Provisional]	G3	S2S3	0	High	
Bidens frondosa Herbaceous Vegetation	G4	SNR	0	High	
Carex interrupta Herbaceous Vegetation	G3G4	S3?	0	High	
Deschampsia cespitosa - Artemisia lindleyana Herbaceous Vegetation	G1	S1	0	High	
Equisetum arvense Herbaceous Vegetation	G5	S5	0	High	
Equisetum telmateia Herbaceous Vegetation	GNR	SNR	0	High	
Juncus bufonius Herbaceous Vegetation	G5	S5	0	High	
Paspalum distichum Herbaceous Vegetation	G3	S2	0	High	
Petasites frigidus Herbaceous Vegetation	G5	S5	0	High	
Scirpus microcarpus Herbaceous Vegetation	G4	S3S4	0	High	
Stachys ciliata Herbaceous Vegetation	G4	S4	0	High	
Typha latifolia Western Herbaceous Vegetation	G5	S5	1	High	
Willamette Valley Wet Prairie					
Camassia quamash - Triteleia hyacinthina Herbaceous Vegetation	GNR	S1S2	0	High	
Camassia quamash Wet Prairie Herbaceous Vegetation	G3	S1S2?	0	High	
Carex aperta Herbaceous Vegetation	G1?	S1	0	High	
Carex densa - Deschampsia cespitosa Herbaceous Vegetation [Provisional]	G2	S1	0	High	
Carex densa - Eleocharis palustris Herbaceous Vegetation [Provisional]	G4	SNR	0	High	
Carex deweyana ssp. leptopoda Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex feta Herbaceous Vegetation [Provisional]	GNR	SNR	0	High	
Carex pachystachya Herbaceous Vegetation	GNR	SNR	0	High	
Carex pellita Wet Prairie Herbaceous Vegetation	GNR	S1	0	High	
Carex unilateralis - Hordeum brachyantherum Herbaceous Vegetation	G2	SH	0	High	
Deschampsia cespitosa - Danthonia californica Herbaceous Vegetation	G2	S1	3	High	1
Eleocharis palustris - Carex unilateralis Herbaceous Vegetation	G2	SNR	0	High	
Isoetes nuttallii Herbaceous Vegetation	G3	SNR	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Paspalum distichum Herbaceous Vegetation	G3	S2	0	High	
Rosa nutkana / Deschampsia cespitosa Shrubland [Provisional]	G2	SNR	0	High	
Triteleia hyacinthina Herbaceous Vegetation	GNR	S2	0	High	
Vancouverian Wet Shrubland Group					
Lower Columbia River Overflow Plains Shrubland					
Salix hookeriana - (Salix sitchensis) Shrubland	G2	S2	0	High	
Vancouverian Interdunal Shrub Swamp					
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3	S2	2	High	
Salix hookeriana - Spiraea douglasii Shrubland	GNR	SNR	1	High	
Salix hookeriana / Carex obnupta - (Argentina egedii ssp. egedii) Shrubland	G4	S1?	3	High	1
Spiraea douglasii Shrubland	G5	S5	0	High	
Vancouverian Lagg Shrub Swamp					
Alnus (incana, viridis ssp. sinuata) / Lysichiton americanus - Oenanthe sarmentosa Shrubland	G1	S1	1	High	
Cornus sericea - Salix spp. - Spiraea douglasii Shrubland	GNR	SNR	1	High	
Malus fusca Shrubland	G3	S2S3	7	Moderate	1
Salix spp. - Spiraea douglasii / Carex (aquatilis var. dives, obnupta, utriculata) Shrubland	G3G4	S2S3	4	Moderate	
Spiraea douglasii Shrubland	G5	S5	3	High	1
Vancouverian Lowland Confined Riparian Shrubland					
Oplopanax horridus Shrubland	G4	S4	0	High	
Vancouverian Lowland Depressional Shrub Swamp					
Cornus sericea - Salix spp. - Spiraea douglasii Shrubland	GNR	SNR	1	High	
Malus fusca Shrubland	G3	S2S3	1	High	
Myrica gale / Lysichiton americanus Shrubland	G1	S1	3	High	1
Physocarpus capitatus Shrubland	GNR	SNR	0	High	
Salix (hookeriana, lucida ssp. lasiandra, sitchensis) Shrubland [Provisional]	G3Q	S3	4	Moderate	
Salix geyeriana - Salix hookeriana Shrubland	G1	S1	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Salix hookeriana - (Salix sitchensis) Shrubland	G2	S2	0	High	
Salix sitchensis Shrubland	G4	S3?	0	High	
Salix spp. - Spiraea douglasii / Carex (aquatilis var. dives, obnupta, utriculata) Shrubland	G3G4	S2S3	0	High	
Spiraea douglasii Shrubland	G5	S5	6	Moderate	
Vancouverian Lowland Floodplain Shrubland					
Physocarpus capitatus Shrubland	GNR	SNR	0	High	
Salix sitchensis / Equisetum arvense - Petasites frigidus Shrubland	G4?	S4?	0	High	
Vancouverian Lowland Lacustrine-Fringe Shrub Swamp					
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3	S2	0	High	
Malus fusca / Boykinia major / Carex obnupta Shrubland	GNR	SNR	0	High	
Malus fusca Shrubland	G3	S2S3	4	Moderate	2
Myrica gale / Boykinia intermedia - Carex obnupta Shrubland	G1	S1	2	High	1
Myrica gale / Boykinia intermedia - Deschampsia cespitosa Shrubland	G1	S1	1	High	1
Salix hookeriana - Spiraea douglasii Shrubland	GNR	SNR	0	High	
Spiraea douglasii Shrubland	G5	S5	4	Moderate	1
Vancouverian Lowland Riverine Impounded Shrub Swamp					
Alnus (incana, viridis ssp. sinuata) / Lysichiton americanus - Oenanthe sarmentosa Shrubland	G1	S1	1	High	1
Cornus sericea - Salix spp. - Spiraea douglasii Shrubland	GNR	SNR	3	High	
Salix (hookeriana, lucida ssp. lasiandra, sitchensis) Shrubland [Provisional]	G3Q	S3	2	High	
Salix sitchensis Shrubland	G4	S3?	0	High	
Salix spp. - Spiraea douglasii / Carex (aquatilis var. dives, obnupta, utriculata) Shrubland	G3G4	S2S3	8	Low	1
Spiraea douglasii Shrubland	G5	S5	6	Moderate	1
Vancouverian Lowland Shrub Seepage Swamp					
Myrica gale / Lysichiton americanus Shrubland	G1	S1	0	High	
Oplopanax horridus Shrubland	G4	S4	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Physocarpus capitatus Shrubland	GNR	SNR	0	High	
Rubus spectabilis Wet Shrubland	G4	SNR	0	High	
Vancouverian Montane Confined Riparian Shrubland					
Acer circinatum - Alnus incana Shrubland	G4G5	S4S5	0	High	
Acer circinatum / Athyrium filix-femina - Tolmiea menziesii Shrubland	G5	S4	0	High	
Acer circinatum / Oplopanax horridus - Rubus spectabilis Shrubland	G4	S4	1	High	1
Acer circinatum Shrubland	G4	S4	0	High	
Alnus incana / Calamagrostis canadensis Shrubland	G3Q	S2	0	High	
Alnus viridis ssp. sinuata / Acer circinatum Shrubland	GNR	S4S5	5	Moderate	4
Alnus viridis ssp. sinuata / Oplopanax horridus Shrubland	G4G5	S4	0	High	
Alnus viridis ssp. sinuata / Rubus spectabilis / Athyrium filix-femina Shrubland	GNR	S4	0	High	
Alnus viridis ssp. sinuata Shrubland [Placeholder]	GNR	S4S5	7	Moderate	1
Cupressus nootkatensis / Oplopanax horridus - (Alnus viridis ssp. sinuata) Forest	G3	S3?	0	High	
Vancouverian Montane Depressional Shrub Swamp					
Salix sitchensis Shrubland	G4	S3?	0	High	
Vancouverian Montane Floodplain Shrubland					
Alnus incana / Calamagrostis canadensis Shrubland	G3Q	S2	0	High	
Cornus sericea Pacific Coast Shrubland [Provisional]	GNR	SNR	0	High	
Ribes bracteosum - Rubus spectabilis Shrubland	G5	S5	0	High	
Vancouverian Montane Lacustrine-Fringe Shrub Swamp					
Association(s) Not Yet Identified			0	High	
Vancouverian Montane Riverine Impounded Shrub Swamp					
Alnus incana / Calamagrostis canadensis Shrubland	G3Q	S2	1	High	
Salix sitchensis Shrubland	G4	S3?	0	High	
Vancouverian Montane Shrub Seepage Swamp					
Acer circinatum - Alnus incana Shrubland	G4G5	S4S5	0	High	
Alnus viridis ssp. sinuata / Oplopanax horridus Shrubland	G4G5	S4	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Alnus viridis ssp. sinuata / Rubus spectabilis / Athyrium filix-femina Shrubland	GNR	S4	0	High	
Alnus viridis ssp. sinuata Shrubland [Placeholder]	GNR	S4S5	0	High	
Cornus sericea Pacific Coast Shrubland [Provisional]	GNR	SNR	0	High	
Oplopanax horridus Shrubland	G4	S4	0	High	
Salix sitchensis Shrubland	G4	S3?	1	High	1
Vancouverian Tidal Surge Plain Shrub Swamp					
Cornus sericea - Salix (hookeriana, sitchensis) Shrubland	G3	S2	1	High	1
Malus fusca - (Salix hookeriana) / Carex obnupta Shrubland	G3	S2	0	High	
Western North American Vernal Pool Macrogroup					
North Pacific Vernal Pool Group					
North Pacific Hardpan Vernal Pool					
Plagiobothrys scouleri - Plantago bigelovii Herbaceous Vegetation	G2	S1?	0	High	
2.B.7 Salt Marsh Formation					
2.B.7.Nc Temperate & Boreal Pacific Coastal Salt Marsh Division					
North American Pacific Coastal Salt Marsh Macrogroup					
Temperate Pacific Tidal Salt & Brackish Marsh Group					
Temperate Pacific High Brackish Marsh					
Argentina egedii - Juncus balticus Herbaceous Vegetation	GNR	S2	19	Low	7
Argentina egedii - Symphyotrichum subspicatum Herbaceous Vegetation	GNR	S1	3	High	
Calamagrostis nutkaensis - Argentina egedii - Juncus balticus Herbaceous Vegetation	G1	S1	4	Moderate	1
Deschampsia cespitosa - (Carex lyngbyei, Distichlis spicata) Herbaceous Vegetation	G3G4	S2	25	Low	8
Deschampsia cespitosa - Argentina egedii Herbaceous Vegetation	G3G4	S2	16	Low	6
Festuca rubra - (Argentina egedii) Herbaceous Vegetation	G1	S1	3	High	2
Festuca rubra - Juncus lesueurii Herbaceous Vegetation	G3	S1	1	High	1
Temperate Pacific Low Salt Marsh					
Carex lyngbyei - (Distichlis spicata, Triglochin maritima) Herbaceous Vegetation	G4	S2	7	Moderate	2

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Carex lyngbyei - Argentina egedii Herbaceous Vegetation	G4	S1?	0	High	
Distichlis spicata - (Salicornia virginica) Herbaceous Vegetation	G4	S2	24	Low	6
Glaux maritima Herbaceous Vegetation [Provisional]	G3	S1?	6	Moderate	1
Ruppia maritima Estuarine Herbaceous Vegetation	GNR	SNR	0	High	
Salicornia virginica - Distichlis spicata - Triglochin maritima - (Jaumea carnosa) Herbaceous Vegetation	G3	S2	10	Low	3
Salicornia virginica Herbaceous Vegetation	G3G4	S2	20	Low	4
Schoenoplectus (americanus, pungens) Tidal Herbaceous Vegetation [Provisional]	G3	S2	5	Moderate	1
Schoenoplectus maritimus Tidal Herbaceous Vegetation [Provisional]	G3	S1	3	High	1
Triglochin maritima - (Salicornia virginica) Herbaceous Vegetation	G4	S2	7	Moderate	1
Temperate Pacific Tidal Lagoon					
Association(s) Not Yet Identified			3	High	
5 Aquatic Vegetation Class					
5.B Freshwater Aquatic Vegetation Subclass					
5.B.2 Temperate & Boreal Freshwater Aquatic Vegetation Formation					
5.B.2.Na North American Freshwater Aquatic Vegetation Division					
Western North American Freshwater Aquatic Vegetation Macrogroup					
Western North American Temperate Freshwater Aquatic Bed Group					
Western North American Temperate Freshwater Lowland Floating-leaved Rooted Aquatic Bed					
Brasenia schreberi Herbaceous Vegetation	G4?	S3S4	0	High	
Menyanthes trifoliata herbaceous vegetation	G5	S4?	1	High	
Nuphar lutea ssp. polysepala Herbaceous Vegetation	G5	S4S5	9	Low	4
Polygonum amphibium Permanently Flooded Herbaceous Vegetation [Placeholder]	G5	S3?	0	High	
Potamogeton natans Herbaceous Vegetation	G5?	S5	1	High	1
Ranunculus aquatilis Herbaceous Vegetation	G5	SNR	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Western North American Temperate Freshwater Lowland Free-floating Aquatic Bed					
Azolla (filiculoides, mexicana) Herbaceous Vegetation	G4	SNR	0	High	
Callitriche heterophylla Herbaceous Vegetation [Provisional]	G4	S2	0	High	
Lemna minor Herbaceous Vegetation	G5	S5	0	High	
Wolffia (borealis, columbiana) Herbaceous Vegetation [Provisional]	G4	SNR	0	High	
Western North American Temperate Freshwater Lowland Submergent Aquatic Bed					
Ceratophyllum demersum Herbaceous Vegetation	G5	S4S5	0	High	
Elodea canadensis Herbaceous Vegetation	G5	S4?	0	High	
Fontinalis (antipyretica var. antipyretica, antipyretica var. oregonensis) Nonvascular Vegetation	G4G5	SNR	0	High	
Myriophyllum hippuroides Herbaceous Vegetation [Provisional]	G3	S2?	0	High	
Utricularia macrorhiza Herbaceous Vegetation [Provisional]	G5	SNR	0	High	
Western North American Temperate Freshwater Montane Floating-leaved Rooted Aquatic Bed					
Menyanthes trifoliata herbaceous vegetation	G5	S4?	0	High	
Nuphar lutea ssp. polysepala Herbaceous Vegetation	G5	S4S5	1	High	
Ranunculus aquatilis Herbaceous Vegetation	G5	SNR	0	High	
Western North American Temperate Freshwater Montane Submergent Aquatic Bed					
Fontinalis (antipyretica var. antipyretica, antipyretica var. oregonensis) Nonvascular Vegetation	G4G5	SNR	0	High	
Utricularia macrorhiza Herbaceous Vegetation [Provisional]	G5	SNR	0	High	
Western North American Temperate Lowland Peatland Pool					
Brasenia schreberi Herbaceous Vegetation	G4?	S3S4	1	High	
Menyanthes trifoliata herbaceous vegetation	G5	S4?	0	High	
Nuphar lutea ssp. polysepala Herbaceous Vegetation	G5	S4S5	4	Moderate	2
Potamogeton natans Herbaceous Vegetation	G5?	S5	0	High	

USNVC Types	Global Rank	State Rank	Total # of WHCV	Inventory Priority	# of Protected EOS
Schoenoplectus subterminalis Herbaceous Vegetation [Provisional]	G3	S2?	4	Moderate	2
Utricularia macrorhiza Herbaceous Vegetation [Provisional]	G5	SNR	0	High	
Western North American Temperate Montane Peatland Pool					
Menyanthes trifoliata herbaceous vegetation	G5	S4?	0	High	
Nuphar lutea ssp. polysepala Herbaceous Vegetation	G5	S4S5	0	High	
Utricularia macrorhiza Herbaceous Vegetation [Provisional]	G5	SNR	0	High	
6 Rock Vegetation Class					
6.B Temperate & Boreal Rock Vegetation Subclass					
6.B.2 Temperate & Boreal Cliff, Scree & Rock Vegetation Formation					
6.B.2.Nb Western North American Temperate Cliff, Scree & Rock Vegetation Division					
Western North American Wet Cliff Vegetation Macrogroup					
Vancouverian Wet Cliff, Waterfall, Hanging Garden Group					
Vancouverian Lowland Waterfall & Spray Zones					
Association(s) Not Yet Identified			0	High	
Vancouverian Lowland Wet Cliff					
Association(s) Not Yet Identified			0	High	
Vancouverian Montane Waterfall & Spray Zones					
Association(s) Not Yet Identified			0	High	
Vancouverian Montane Wet Cliff					
Association(s) Not Yet Identified			0	High	
Totals			**712**		**223**

*Proposed ranks. These ranks were assigned during the course of this project using NatureServe's Conservation Status Rank calculator. Additional review and discussion within DNR is needed before they are accepted as final S ranks.

Appendix B: Level 1 EIA GIS Protocol Development

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To create an efficient way to calculate Level 1 EIA metrics, the Python programming language was employed to batch process GIS data. This document describes the methods used for this analysis but assumes an understanding of GIS analysis using ArcGIS and scripting language, which is used to loop through small subsets of the data.

Inputs:

1) 30m land cover Grid
2) Coefficient table for land cover types. In this case two parameters were used. One, a scale of 0 to 1 by tenths, represents fuzzy naturalness, and the other, a Boolean 0 or 1 representing non-natural or natural.
3) Wetland polygons (can be overlapping)

Software:

- ArcGIS 9.3.1 sp2
- Python 2.5
- PythonWin 2.5.216.0

Main steps for calculating community naturalness metrics:

- Convert land cover Grid to polygon and join in tables
- Tile community data if needed
- Create community buffers and community edges
- Intersect buffers and edges with the land cover
- Calculate area-weighted naturalness metrics
- Merge tabular data into one final table

Preprocess your land cover Grid in ArcGIS if needed. For instance, it may be necessary to tile the grid for processing, making sure to set the same registration coordinates. Convert the grid or the pieces of the grid to file geodatabase polygons without simplifying. Join up the original land cover tabular information back to the polygons and then join in the coefficient table. Merge all polygonized grid data back together to create one final land cover feature class.

Determine what buffer sized will be needed. In this case, when analyzing the US Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) polygons, the following buffers were used:

1. Wetland boundaries (edges of wetlands)
2. Wetland buffer rings (non-overlapping):
    a. Buffer: 0 to 50m from edge of wetland

b. Core Landscape: 50 to 250m from edge of wetland
c. Supporting Landscape: 250 to 500m from edge of wetland

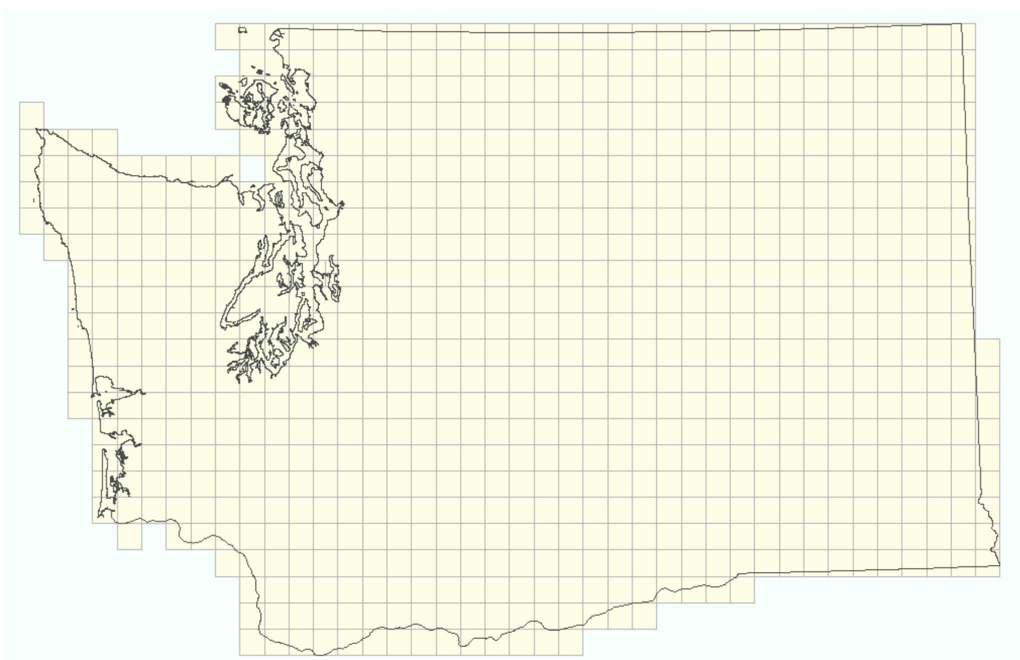
The NWI dataset was pared down using a definition query to analyzed only a subset of the data: "ATTRIBUTE LIKE 'P%RB%' OR ATTRIBUTE LIKE 'P%AB%' OR ATTRIBUTE LIKE 'P%US%' OR ATTRIBUTE LIKE 'P%ML%' OR ATTRIBUTE LIKE 'P%EM%' OR ATTRIBUTE LIKE 'P%SS%' OR ATTRIBUTE LIKE 'P%FO%' OR ATTRIBUTE LIKE 'L%AB%' OR ATTRIBUTE LIKE 'L%EM%' OR ATTRIBUTE LIKE 'R%AB%' OR ATTRIBUTE LIKE 'R%EM%'"

Each wetland and its edge and buffers are tracked by a unique ID which needed to be added to the wetland feature class. Calculate wetland edge lengths (perimeters) to hold the length of each wetland boundary.

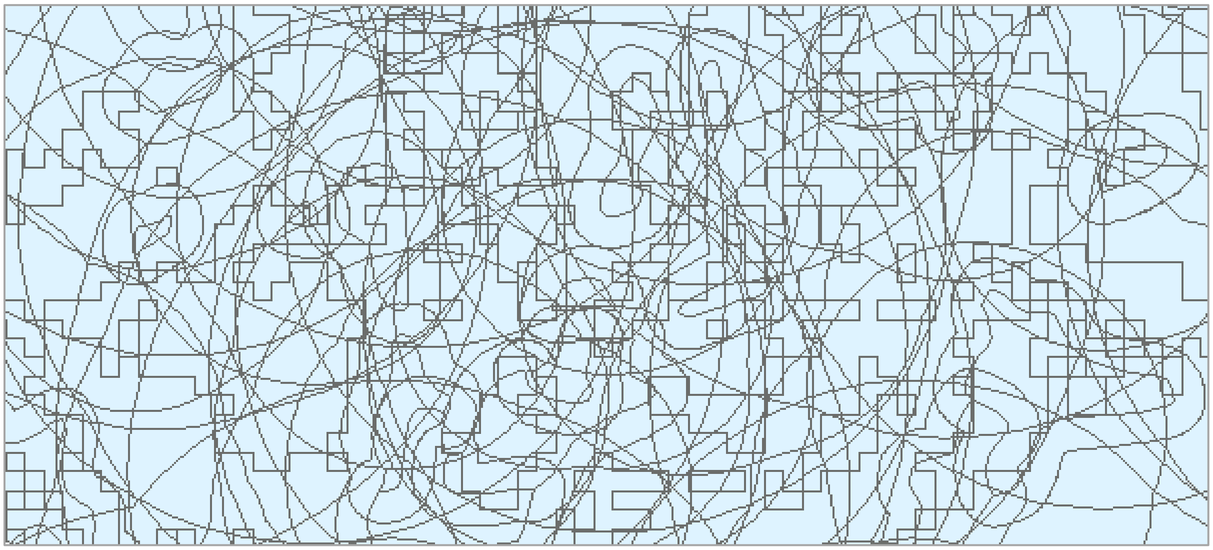
The NWI dataset is too large for ArcGIS to be able to analyze the whole thing at once. At this point, only the wetlands on the western half of the state have been analyzed. Beyond this, it is best to extract a small subset of the wetlands to loop through via a tiling scheme. After extracting a small subset of the wetlands, create the buffers. This is done by looping through each individual polygon, creating each buffer, and clipping out the overlapping part of the previous buffer to create individual, non-overlapping buffers. Alternatively, use the Multi-Ring Buffer tool. Buffers of different wetlands can certainly, and must, overlap. After creating all the buffers for one tile's worth of wetlands, calculate the area for each buffer area.

Note that the tiles don't need to be any particular shape or size. Use whatever works best for your data and computer.

Tiles for processing data



If your communities are close together, the geometry can become quite complex. The example shown below is at a 1:12,000 scale.



It is best to extract a tile's worth of the land cover feature class before doing the overlay with the buffers. To do this, you need to buffer the tile so that you get a tile's worth plus a little extra to account for buffered areas that end up outside the original tile polygon. Clip out the buffered tile's extent of the land cover.

Intersect the buffers with the land cover. If there are problems with the geometry, try running a Repair Geometry command and then possibly an Integrate. Then try the Intersect again.

Using the Feature to Line command, create the perimeters of the wetlands within the tile. Intersect this new line feature class with the tile's worth of land cover.

In both the intersected line and polygon layers, add fields to hold the final metrics. To calculate the area weighted metrics (see table below for weights), multiply your value by the area of the individual polygon and then divide that by the area of the whole buffer. Same thing goes for the perimeter; multiply the value by the individual segment and then divide that by the length of the entire perimeter.

Append each loop's output to a new feature class and keep looping through all of the tiles. If you calculate only a subset of the tiles and then would like to append all of the resulting tiles together, there was a separate script that will go into each geodatabase and append all of the tabular information together.

Please refer to the scripts for detailed information.

> ***Tip***: Setting a very small tolerance and resolution helps when dealing with small polygons. It takes longer to process, but there may be less cleanup in the end.

This general procedure could be used to analyze any sort of community or even point locations as long as you have a high resolution land cover Grid.

The following table shows which land cover types are considered natural/non-natural as well as the land use coefficients assigned to each land cover type (note: all natural types were assigned a "1" while non-native types were assigned a weight based on their perceived impact to ecological integrity (lower scores = assumed higher impact).

Ecological System Land Cover Unit	L.U. Coefficient	Natural / Non-Natural
Columbia Basin Foothill and Canyon Dry Grassland	1.0	1
Columbia Basin Foothill Riparian Woodland and Shrubland	1.0	1
Columbia Basin Palouse Prairie	1.0	1
Columbia Plateau Ash and Tuff Badland	1.0	1
Columbia Plateau Low Sagebrush Steppe	1.0	1
Columbia Plateau Scabland Shrubland	1.0	1
Columbia Plateau Steppe and Grassland	1.0	1
Columbia Plateau Vernal Pool	1.0	1
Columbia Plateau Western Juniper Woodland and Savanna	1.0	1
CRP	0.7	0
Cultivated Cropland	0.2	0
Developed, High Intensity	0.0	0
Developed, Low Intensity	0.1	0
Developed, Medium Intensity	0.0	0
Developed, Open Space	0.2	0
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	1.0	1
East Cascades Oak-Ponderosa Pine Forest and Woodland	1.0	1
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland	1.0	1
Harvested forest-grass regeneration	0.4	1
Harvested forest-shrub regeneration	0.4	1
Harvested forest-tree regeneration	0.7	1
Inter-Mountain Basins Active and Stabilized Dune	1.0	1
Inter-Mountain Basins Alkaline Closed Depression	1.0	1
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	1.0	1
Inter-Mountain Basins Big Sagebrush Shrubland	1.0	1
Inter-Mountain Basins Big Sagebrush Steppe	1.0	1
Inter-Mountain Basins Cliff and Canyon	1.0	1
Inter-Mountain Basins Greasewood Flat	1.0	1
Inter-Mountain Basins Mixed Salt Desert Scrub	1.0	1
Inter-Mountain Basins Montane Sagebrush Steppe	1.0	1

Ecological System Land Cover Unit	L.U. Coefficient	Natural / Non-Natural
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	1.0	1
Inter-Mountain Basins Playa	1.0	1
Inter-Mountain Basins Semi-Desert Grassland	1.0	1
Inter-Mountain Basins Semi-Desert Shrub-Steppe	1.0	1
Introduced Riparian and Wetland Vegetation	0.5	1
Introduced Upland Vegetation - Annual Grassland	0.5	1
Introduced Upland Vegetation - Forbland	0.5	1
Introduced Upland Vegetation - Perennial Grassland	0.5	1
Introduced Upland Vegetation - Shrub	0.5	1
Introduced Upland Vegetation - Treed	0.5	1
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	1.0	1
Non-specific Disturbed	0.5	1
North American Alpine Ice Field	1.0	1
North American Arid West Emergent Marsh	1.0	1
North Pacific Alpine and Subalpine Bedrock and Scree	1.0	1
North Pacific Alpine and Subalpine Dry Grassland	1.0	1
North Pacific Avalanche Chute Shrubland	1.0	1
North Pacific Bog and Fen	1.0	1
North Pacific Broadleaf Landslide Forest and Shrubland	1.0	1
North Pacific Coastal Cliff and Bluff	1.0	1
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow	1.0	1
North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland	1.0	1
North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest	1.0	1
North Pacific Hardwood-Conifer Swamp	1.0	1
North Pacific Herbaceous Bald and Bluff	1.0	1
North Pacific Hypermaritime Shrub and Herbaceous Headland	1.0	1
North Pacific Hypermaritime Sitka Spruce Forest	1.0	1
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest	1.0	1
North Pacific Intertidal Wetland	1.0	1
North Pacific Lowland Mixed Hardwood Conifer Forest and Woodland	1.0	1
North Pacific Lowland Riparian Forest and Shrubland	1.0	1
North Pacific Maritime Coastal Sand Dune and Strand	1.0	1
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	1.0	1
North Pacific Maritime Eelgrass Bed	1.0	1
North Pacific Maritime Mesic Subalpine Parkland	1.0	1
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	1.0	1
North Pacific Mesic Western Hemlock-Silver Fir Forest	1.0	1
North Pacific Montane Massive Bedrock, Cliff and Talus	1.0	1

Ecological System Land Cover Unit	L.U. Coefficient	Natural / Non-Natural
North Pacific Montane Riparian Woodland and Shrubland	1.0	1
North Pacific Montane Shrubland	1.0	1
North Pacific Mountain Hemlock Forest	1.0	1
North Pacific Oak Woodland	1.0	1
North Pacific Serpentine Barren	1.0	1
North Pacific Shrub Swamp	1.0	1
North Pacific Volcanic Rock and Cinder Land	1.0	1
North Pacific Wooded Volcanic Flowage	1.0	1
Northern Rocky Mountain Conifer Swamp	1.0	1
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	1.0	1
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	1.0	1
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland	1.0	1
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	1.0	1
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	1.0	1
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	1.0	1
Northern Rocky Mountain Subalpine Deciduous Shrubland	1.0	1
Northern Rocky Mountain Subalpine Woodland and Parkland	1.0	1
Northern Rocky Mountain Subalpine-Upper Montane Grassland	1.0	1
Northern Rocky Mountain Western Larch Savanna	1.0	1
Open Water	1.0	1
Pasture/Hay	0.4	0
Quarries, Mines and Gravel Pits	0.0	0
Recently burned forest	0.5	1
Recently burned grassland	0.5	1
Recently burned shrubland	0.5	1
Rocky Mountain Alpine Bedrock and Scree	1.0	1
Rocky Mountain Alpine Fell-Field	1.0	1
Rocky Mountain Alpine Tundra/Fell-field/Dwarf-shrub Map Unit	1.0	1
Rocky Mountain Alpine-Montane Wet Meadow	1.0	1
Rocky Mountain Aspen Forest and Woodland	1.0	1
Rocky Mountain Cliff, Canyon and Massive Bedrock	1.0	1
Rocky Mountain Lodgepole Pine Forest	1.0	1
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland	1.0	1
Rocky Mountain Poor-Site Lodgepole Pine Forest	1.0	1
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	1.0	1
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	1.0	1
Rocky Mountain Subalpine-Montane Fen	1.0	1
Rocky Mountain Subalpine-Montane Mesic Meadow	1.0	1

Ecological System Land Cover Unit	L.U. Coefficient	Natural / Non-Natural
Rocky Mountain Subalpine-Montane Riparian Shrubland	1.0	1
Rocky Mountain Subalpine-Montane Riparian Woodland	1.0	1
Temperate Pacific Aquatic Bed	1.0	1
Temperate Pacific Emergent Marsh	1.0	1
Temperate Pacific Mudflat	1.0	1
Temperate Pacific Intertidal Mudflat	1.0	1
Temperate Pacific Subalpine-Montane Wet Meadow	1.0	1
Temperate Pacific Tidal Salt and Brackish Marsh	1.0	1
Unconsolidated Shore	1.0	1
Willamette Valley Upland Prairie and Savanna	1.0	1
Willamette Valley Wet Prairie	1.0	1

Appendix C: Field Forms (EIA, Veg, Stressor)

Ecological Integrity Assessment Form (condensed from individual EIAs found here: http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html)

Site Name: **Site Code:** **Date(s):**

LAND USE [field impression guided by aerial]; Other Landscape metrics to be assessed using GIS	0 – 50 m: A ☐ B ☐ C ☐ D ☐ **M01** A= natural; D=developed	50 – 250 m: A ☐ B ☐ C ☐ D ☐ **M02**	250 – 500 m: A ☐ B ☐ C ☐ D ☐ **M03**	Overall land use score: A ☐ B ☐ C ☐ D ☐

BUFFER LENGTH M04 [length of "*natural buffer*" around perimeter; a 5 m min width & length]		**Buffer Width** (average width of natural buffer extending out from perimeter) **M05**		**BUFFER CONDITION** Estimate condition of vegetation cover within natural buffer length [see left]; if Buffer Length is 30% of perimeter and 15 m wide, assess condition only in that area [BL="D"; BC if excellent="A", very poor="E"] **M06**	
Length is 90 – 100%	**A** ☐	Width is > 200 m	**A** ☐	Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND very little or no trash or refuse	**A** ☐
Length is 75 – 90%	**B** ☐	Width is > 100 - 199 m	**B** ☐	Substantial (85–95%) cover of native vegetation, low (5–15%) cover of non-native plants, minimally disrupted soils, minimal trash, OR minor intensity of human visitation or recreation	**B** ☐
Length is 50 – 75%	**C** ☐	Width is 50-99 0m	**C** ☐	Moderate (50–85%) cover of native plants, moderate (15–50%) cover of non-native plants, moderate soil disruption, moderate amounts of trash refuse, OR moderate intensity of human visitation or recreation	**C** ☐
Length is 25 – 50%	**D** ☐	Width is <50 m	**D** ☐	Low (<50%) cover of native plants, substantial (50–75%) cover of non-native plants, extensive barren ground and highly compacted or otherwise disrupted soils, moderate or greater amounts of trash or refuse, moderate or greater intensity of human visitation or recreation	**D** ☐
"Natural buffer" includes natural communities, roads not hazardous to wildlife, trails, lightly grazed pastures (no longer buffer if agricultural, busy road, RR, lawn, heavily grazed pastures, etc)				Comment: Landscape Context: Buffer Length: Buffer Condition:	

CANOPY STRUCTURE M07 (WOODY INTERTIDAL AND RIPARIAN)	
Average tree cover generally > 25% (50% for Montane Riparian); mixed age. Mature cottonwood and/or conifers present; Trees are of sufficient size to provide future LWD to stream or floodplain.	**AB** ☐
Somewhat homogeneous in density and age, AND canopy cover >90% OR <25% (<50% for Montane Riparian)	**C** ☐
Canopy extremely homogeneous, sparse, or absent (<10% cover).	**D** ☐
Comment:	

COVER OF SHRUBS (BOG/FEN) M08	
Ledum, Kalmia, Vaccinium cover is < 90 cm/3 feet high	**AB** ☐
Ledum, Kalmia, Vaccinium cover is > 90 cm/3 feet high and starting to shade out *Sphagnum* moss and allowing other moss species to establish.	**CD** ☐
Comment:	

COVER OF SHRUBS (WET PRAIRIE) M09	
None or minimal cover (<1%).	**A** ☐
Present and <10% cover.	**B** ☐
<10-25%	**C** ☐
>25%	**D** ☐
Comment:	

LARGE WOODY DEBRIS M10 (WOODY INTERTIDAL AND RIPARIAN)		
Bankfull width	**(piece = >10cm diameter and > 2 m in length; key piece)**	
0-6 m	>38 pieces	**AB** ☐
>6-30 m	>63 pieces	
>30-100 m	>208 pieces	
0-6 m	26-38	**C** ☐
>6-30 m	29-63	
>30-100 m	57-208	
0-6 m	<26	**D**

ORGANIC MATTER ACCUMULATION – (BOG OR FEN) M11	
Characterized by an accumulation of peaty, hummocky organic matter, and organic matter of various sizes, some very old; Fens - Surface organic horizons are present and undisturbed.	**AB** ☐
Some areas lacking an accumulation of peaty, hummocky organic matter, and size of organic matter does not vary greatly, or appear very old; Surface organic thickness has been reduced by > 25 %. Moss layer partially removed.	**C** ☐
Characterized by large areas without peaty,	**D**

ORGANIC MATTER ACCUMULATION – (MARSH, WET MEADOW, AQUATIC BED, MUDFLAT) M12	
At or near expected or if applicable, characterized by mod amt of fine organic matter, occasional CWD of various sizes, but new materials seem more prevalent than old; litter and duff layers and leaf piles in pools or topographic lows are thin	**AB** ☐
Moderately altered or if applicable, site is characterized by either patchy areas of little to no fine organic matter or somewhat excessive amts of fine org matter or CWD	**C** ☐
Greatly altered or if applicable, site lacks or	**D**

>6-30 m	<29	☐
>30-100 m	<57	
Comment:		

hummocky organic matter, and size of organic matter does not vary greatly, or appear very old; Surface organic horizons thickness has been reduced by > 50 %. Moss layer mostly removed.	☐
Comment:	

contains excessive amounts of organic matter	☐
Comment:	

Coarse Woody Debris (Shrub Swamp, Interdunal, Hardwood-Conifer Swamp) M13	
CWD is common or frequently observed; all size classes	**A** ☐
CWD occasionally observed to present; moderate to small size classes	**BC** ☐
CWD is rare absent; mostly small size class	**D** ☐
Comment:	

Large Live Trees – (Hardwood Swamp) M14	
No stumps present and largest tree size is: *Thuja plicata, Tsuga heterophylla* and *Picea sitchensis* (on organic soil) = > 18 inches *Picea sitchensis* (mineral soil), *Alnus rubra* = > 15 inches *Pinus contorta* = > 12 inches	**A** ☐
A few stumps present (not more than remaining live large trees) and largest tree size is: *Thuja plicata, Tsuga heterophylla* and *Picea sitchensis* (on organic soil) = > 18 inches *Picea sitchensis* (mineral soil), *Alnus rubra* = > 15 inches *Pinus contorta* = > 12 inches	**B** ☐
Numerous stumps present (more than remaining live large trees) and largest tree size is: *Thuja plicata, Tsuga heterophylla* and *Picea sitchensis* (on organic soil) = < 18 inches *Picea sitchensis* (mineral soil), *Alnus rubra* = < 15 inches *Pinus contorta* = < 12 inches	**CD** ☐
Comment:	

Canopy Composition – (Hardwood Swamp) M15	
Mixture of conifers/hardwoods or dominated by conifers	**AB** ☐
Some conifers present but stumps are evident indicating that conifers have been removed.	**C** ☐
Alders dominate due to widespread logging of conifers	**D** ☐
Comment:	

Patch Diversity & Connectivity M16 (Woody Intertidal and Riparian)	
Heterogeneous mix of well connected patch types. Mature conifer, mature deciduous (cottonwood, alder, or maple)/conifer mixed, or mature cottonwood (alder) patches present along with early seral stands of trees, wetland shrub and emergent vegetation patches.	**A** ☐
Expected patch diversity present but connectivity between patches is becoming fragmented. OR less diversity than expected, especially of mature stands of trees.	**B** ☐
Patch diversity is low and becoming homogeneous; few if any mature stands of trees present. Many patches isolated due to fragmentation within the riparian system.	**C** ☐
Mostly dominated by one patch type. No mature conifer or deciduous tree patches present. Patch is isolated due to fragmentation within the riparian system.	**D** ☐
Comment:	

Tree Encroachment (Wet Prairie) M17 *need to fix this metric in EIA*	
Fraxinus latifolia, Alnus rubra, or other tree species, are absent or have minimal cover <5%)	**A** ☐
Trees are <10% cover.	**B** ☐
Trees <10-25%	**C** ☐
Trees >25%	**D** ☐
Comment:	

Richness of Wet Prairie Species –(Wet Prairie) M18	
>15 species with moderate or high fidelity toward wet prairies	**A** ☐
10-15 species with moderate or high fidelity toward wet prairies	**B** ☐
5-10 species with moderate or high fidelity toward wet prairies	**C** ☐
<5 species with moderate or high fidelity toward wet prairies	**D** ☐
Comment:	

COVER OF NATIVE PLANT INCREASERS M19	
Absent or incidental: <1% cover ; (Wet Prairie <10%)	**A** ☐
Occasional: 1-10% cover; (Wet Prairie 10-20%)	**B** ☐

EVIDENCE List of increaser species at site. If a B, C, or D rating is assigned, list sp and cover. Ex: some members of *Acer, Betula, Toxicodendron, Rubus, Rhus, Typha, Dennstaedtia*	

Common: 11-20% cover (Wet Prairie 21-50%)	**C** ☐		
Dominant: >20% cover (Wet Prairie >50%)	**D** ☐		
Comment:			

RELATIVE COVER OF [UNDERSTORY FOR RIPARIAN] NATIVE PLANT SPECIES M20 [non-native= both invasive and non-invasive taxa]		**COVER OF EXOTIC <u>INVASIVE</u> PLANT SPECIES M21**		**VEGETATION REGENERATION M22** **(WOODY INTERTIDAL AND RIPARIAN)**	
Cover of native plants 95-100%.	**A** ☐	Exotic invasive plant species absent	**A** ☐	Native saplings and/or seedlings diagnostic of the sys type in expected amts; obvious regen	**A** ☐
Cover of native plants 80-95%.	**B** ☐	Exotic invasive plant species present, but sporadic (<3% absolute cover)	**B** ☐	Native saplings and/or seedlings diagnostic of the system type somewhat less than expected	**B** ☐
Cover of native plants 50 to 79%.	**C** ☐	Exotic invasive plant species prevalent (3–10% cover)	**C** ☐	Native saplings and/or seedling diagnostic of the sys type in low amounts; little regen	**C** ☐
Cover of native plants <50%.	**D** ☐	Exotic invasive plant species abundant (>10% cover)	**D** ☐	No reproduction of native tree species diagnostic of the system type	**D** ☐
Comment:		Comment:		Comment:	

PHYSICAL PATCH DIVERSITY – (INTERDUNAL) M23		**VEGETATION COMPOSITION M24** partially integrates related metrics above		**WATER SOURCE M25** [assess alteration of natural water source – runoff, discharge, groundwater, riverine flows]	
Full range of physical patch types expected at any given interdunal wetland such as wet bare swales, herbaceous swales, shrub swales, open water are present. Human-induced impacts have not eliminated the presence of any patch types.	**AB** ☐	Species diversity/abundance at or near reference standard conditions. Native species sensitive to anthropogenic degradation are present, functional groups indicative of anthropogenic disturbance (ruderal or "weedy" species) are absent to minor, and full range of diagnostic / indicator species are present.	**A** ☐	Non-tidal source is natural or naturally lacks water in the growing season; no indication of direct artificial water sources	**A** ☐
Most physical patch types are present but some may have been lost or eliminated due to human-induced impacts.	**B** ☐	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	**B** ☐	Non-tidal source is mostly natural, but directly receives occasional or small amounts of inflow from anthropogenic sources (indicators include < 20% of core landscape is agricultural or developed land, storm drains etc.)	**B** ☐
Many physical patch types are missing from the site due to human-induced impacts. Patch diversity has been homogenized	**CD** ☐	Species diversity/abundance is different from reference standard condition in, but still largely composed of native species characteristic of the type. This may include ruderal ("weedy") species. Many indicator/diagnostic species may be absent.	**C** ☐	Non-tidal source is primarily urban runoff, direct irrigation, pumped water, artificial impounded water, or other artificial hydrology (indicators include >20% of core landscape is agricultural or developed land, major point sources of discharge, etc)	**C** ☐
		Vegetation severely altered from reference standard. Expected strata are absent or dominated by ruderal ("weedy") species, or comprised of planted stands of non-characteristic species, or unnaturally dominated by a single species. Most or all indicator/diagnostic species are absent.	**D** ☐	Non-tidal water flow has been substantially diminished by human activity	**D** ☐
Comment:		Comment:		Comment:	

HYDROPERIOD	NON-RIVERINE (MARSH, WET MEADOW, WET PRAIRIE, SWAMPS, INTERDUNAL, etc.) M26			BOGS & FENS M27			TIDAL – INTERTIDAL WETLAND M28	
	Natural patterns of saturation or inundation/drawdown	A ☐		Natural patterns of saturation or inundation/drawdown	A ☐		Area is subject to the full tidal prism, with two daily tidal minima and maxima; or restricted to natural tidal inflow during storm surge	A ☐
	Sat patterns or inundation/ drawdown are of a somewhat > magnitude and <or> duration than natural conditions	B ☐		Minor alteration to natural patterns of sat or inundation/drawdown (e.g., from ditches, runoff, etc.)	B ☐		Area is subj to reduced or muted tidal prism, although two daily minima and maxima are observed; or somewhat subj to inputs more or less often than expected under natural conditions, due to artificial alteration of berm ht	B ☐
	Sat patterns or inundation/ drawdown subject to more rapid or extreme drawdown or vice versa	C ☐		Mod alteration to natural patterns of sat or inundation/drawdown (e.g., from ditches, runoff, etc.)	C ☐		Area is subj to muted tidal prism, with tidal fluctuations evident only in relation to extreme daily highs or spring tides; or significantly subj to inputs more or less often than expected under natural conditions, due to artificial alteration of berm ht	C ☐
	Sat patterns or inundation/ drawdown substantially deviate (<or>) from natural conditions	D ☐		Substantial alteration to natural patterns of sat or inund/drawdown (e.g., from ditches, runoff, etc.)	D ☐		Area is subj to muted tidal prism, plus there is inadequate drainage, such that the marsh plain tends to remain flooded during low tide; or berm routinely breached/never breached, due to artificial alteration of berm ht	D ☐

Comment:

HYDROLOGIC CONNECTIVITY RIVERINE M29			NON-RIVERINE M30			TIDAL – INTERTIDAL WETLAND M31	
Completely connected to floodplain/shore; no modifications made to contemporary floodplain/shore	A ☐		No obstruction to the expected natural range of lateral water movement with upland; no unnatural restrictions to natural drainage back to wetland	A ☐		Average tidal channel sinuosity >4.0; absence of channelization. Marsh receives unimpeded tidal flooding. Total absence of tide gates, flaps, dikes culverts, or human-made channels.	A ☐
Minor disconnection from floodplain/shore; <25% of bank/shore is affected	B ☐		Minor restrictions to natural lateral movement; <25% of site restricted by unnatural barriers to drainage back to wetland	B ☐		Average tidal channel sinuosity = 2.5–3.9. Marsh receives essentially unimpeded tidal flooding, with few tidal channels blocked by dikes or tide gates, and human-made channels are few. Culvert, if present, is of large diameter and does not significantly change tidal flow, as evidenced by similar vegetation on either side of the culvert.	B ☐
Mod disconnection from floodplain/shore due to multiple modifications; 25-75% of bank/shore is affected	C ☐		Mod restriction to natural lateral movement; 25-75% of site restricted by unnatural barriers to drainage back to wetland	C ☐		Average tidal channel sinuosity = 1.0–2.4. Marsh channels are frequently blocked by dikes or tide gates. Tidal flooding is somewhat impeded by small culvert size, as evidenced by obvious differences in vegetation on either side of the culvert.	C ☐
Substantially disconnected from floodplain/shore; >75% of bank/shore is affected	D ☐		Little hydrologic connection to upland; most water stages contained; >75% of wetl is restricted by barriers to drainage back to wetl	D ☐		Average tidal channel sinuosity <1.0. Tidal channels are extensively blocked by dikes and tide gates; evidence of extensive human channelization. Tidal flooding is totally or almost totally impeded by tidal gates or obstructed culverts	D ☐

Comment:

WATER TABLE DEPTH – (WET MEADOW) M32	
Seasonal high water table and/or soils saturated for long durations; Hydric Soils present; Water table is within .5 m of soil surface. Surface soil horizons are gleyed or have a chroma value of 2 or less in mottled soils, or 1 less in unmottled soils; Depth to mottles is within 40 cm	A ☐
Seasonal high water table and/or soils saturated for long durations; Hydric Soils present; Water table is within 0.5 m of soil surface. Surface soil horizons are gleyed or have a chroma value of 2 or less in mottled soils, or 1 less in unmottled soils; Depth to mottles is within 40 cm	B ☐
No redoximorphic features present < 40 cm. Soil chromo > 2 Hydric Soils NOT present Indicators of remnant hydric conditions may be present e.g., distinct boundaries between mottles and matrix	CD ☐
Comment:	

CHANNEL STABILITY M33 (WOODY INTERTIDAL AND RIPARIAN)	
Natural channel; no evidence of severe aggradation or degradation;	A ☐
Most of the channel has some aggradation or degradation, none of which is severe	B ☐
Evidence of severe aggradation or degradation of most of the channel	C ☐
Concrete, or artificially hardened, channels through most of the site	D ☐
Comment:	

STREAMBANK STABILITY M34 (WOODY INTERTIDAL AND RIPARIAN)	
Stable; Perennial vegetation to waterline; no raw or undercut banks (some erosion on outside of banks normal); no recently exposed roots; no recent tree falls	A ☐
Slightly Stable; Perennial vegetation to waterline in most places; minor erosion and/or bank undercutting; recently exposed tree roots rare but present	B ☐
Moderately Unstable; Perennial vegetation to waterline sparse (mainly scoured or removed by lateral erosion); bank held in place by hard points (trees, boulders) and eroded back elsewhere; extensive erosion and bank undercutting; recently exposed tree roots and fine root hairs common	C ☐
Completely Unstable ; No perennial vegetation to waterline; banks only held by hard points; severe erosion of both banks; recently exposed tree roots common; tree falls and/or severely undercut trees common	D ☐
Comment:	

SAND DYNAMICS – (INTERDUNAL) M35	
Open/migrating stage, native anchored stage and native stabilized stage are present and transitions among stages functional	A ☐
Open/migrating and native anchored stages present and exotic stabilizing species replacing native stabilizing species on <50% of total area.	B ☐
Either open/migrating or native anchored stage present and exotic stabilizing species- replacing native stabilizing species on <50% of total area open/migrating and native anchored stages present and native stabilized on >50% of total area	C ☐
One or both open/migrating or native anchored stages absent and exotic stabilizing species- replacing native stabilizing species on >50% of total area.	D ☐
Comment:	

SOIL / SUBSTRATE CONDITION M36	
Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails	A ☐
Some bare soil due to human causes but the extent and impact is minimal; depth of disturbance is limited to only a few inches and does not show evidence of ponding or channeling water	B ☐
Bare soil areas due to human causes are common; there may be livestock pugging resulting in several inches of soil disturbance; ORVs or other machinery may have left some shallow ruts	C ☐
Bare soil areas substantially & contribute to altered hydrology or other long-lasting impacts; deep ruts from ORVs or machinery may be present, or livestock pugging and/or trails are widespread; water will be channeled or ponded	D ☐
Comment:	

WATER QUALITY M37	
No evidence of degraded water quality; water is clear; no strong green tint or sheen	A ☐
Some negative water quality indicators are present, but limited to small and localized areas; water may have a minimal greenish tint or cloudiness, or sheen	B ☐
Negative indicators or wetland species that respond to high nutrient levels are common; water may have a moderate greenish tint, sheen or other turbidity with common algae	C ☐
Widespread evidence of negative indicators; algae mats may be extensive; water may have a strong greenish tint, sheen or turbidity; bottom difficult to see during due to surface algal mats and other vegetation blocking light to the bottom	D ☐
Comment:	

SIZE [office metrics, field checked] – Compute Absolute Size in Office)			
Relative Size M38		**Size Condition** **[degree, if any, reduced in size due to human activity] M39**	
Very large compared to other examples of the same type (e.g., top 10% based on known and historic occurrences, or area-sensitive indicator species very abundant)	**A** ☐	Occurrence is at or only minimally reduced (<3%) from its original natural extent	**A** ☐
Large compared to other examples of the same type (e.g. within 10-30%, based on known and historic occurrences, or most area-sensitive indicator species moderately abundant)	**B** ☐	Occurrence is only modestly reduced (3-10%) from its original natural extent	**B** ☐
Moderate compared to other examples of the same type, (e.g., within 30-70% of known or historic sizes; or many area-sensitive indicator species are able to sustain a minimally viable population, or many characteristic species are sparse but present)	**C** ☐	Occurrence is substantially reduced (10-30%) from its original natural extent	**C** ☐
Too small to sustain full diversity and full function of the type. (e.g., smallest 30% of known or historic occurrences, or both key area-sensitive indicator species and characteristic species are sparse to absent)	**D** ☐	Occurrence is heavily reduced (>30%) from its original natural extent	**D** ☐
Comment:		Comment:	

Site Name:____________________________ **Site Code:**_______ **Date(s):**_____________________________________

LEVEL 2.5 STRESSOR CHECKLIST

Stressors: *direct threats*; "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes (e.g., ditching, logging, exotic pest diseases, septic tanks, or pesticide spray). Altered disturbance regime may be stressor (e.g., flooding, fire, or browse).

Some Important Points about Stressors Checklists.

1. Stressors checklists must be completed for Landscape Context (LC), Vegetation, Soils, and Hydrology.
2. Assessment of LC is for stressors found from system perimeter out to 250 m (***not*** how LC stressors may impact the wetland system).
3. Stressors for Vegetation, Soils, and Hydrology are assessed across the **wetland system (WS)**.
4. Threat impact is calculated considering only present observed or inferred stressors (if inferred, the reason for the inference should be clearly stated).
5. If two stressors overlap conceptually, choose one and note overlap.

Assess for up to next 10 yrs	Threat Scope: % of LC or system affected
Small	Affects a small (1-10%) proportion
Restricted	Affects some (11-30%)
Large	Affects much (31-70%)
Pervasive	Affects all or most (71-100%)
Assess for up to next 10 yrs	**Threat Severity: degree of degradation in LC or System [for Veg, Soil, Hydro]**
Slight	Likely to only slightly degrade/reduce
Moderate	Likely to moderately degrade/reduce
Serious	Likely to seriously degrade/reduce
Extreme	Likely to extremely degrade/destroy or eliminate

		LC [250 m]			Vegetation [WS]			Soil/Substrate [WS]			Hydrology [WS]			
	STRESSORS CHECKLIST	Scope	Sever	Impact	Scope	Sever	Impact	Scope	Sever	Impact	Scope	Sever	Impact	Comments [LC=LandCon, V=Veg, S=Soil, H=Hydro]
	Residential													
D	Industrial, commercial, military													
E	Utility/powerline corridor													
V	Sports field, golf course, urban parkland													
L	Row-crop agriculture, orchard/nursery													
O	Hay field													
P	Roads (gravel, paved, highway), railroad													
	Livestock, grazing, excessive herbivory													
	Other [specify]:													
R	Passive recreation (bird, hike, trample, camp)													
E	Active recreation (ATV, mt bike, hunt, fish, boat)													
C	Other [specify]:													
	Woody resource extraction: logs, shrub cuts, debris													
V	Vegetation management: cutting, mowing													
E	Excessive animal herbivory or insect damage													
G	Invasive exotic plant species													
	Herb-Pesticide, vector control, chemicals (give evid)													
	Other [specify]:													
N	Altered nat disturb regime [specify expected regime]													
D	Other [specify]:													
	Incr sediment/org debris, erosion, gully (logged sites)													
S	Filling, spoils, excavation													
O	Soil disturbance: trampling, vehicle, pugging, skidding													
I	Grading, compaction, plowing, discing													
L	Physical resource extraction: rock, sand, gravel, etc													
	Trash or refuse dumping													
	Other [specify]:													
H	Dam, ditch, diversion, dike, levee, unnat inflow, reser													
Y	Water extraction (lake/groundwat; wat table lowered)													
D	Flow obstructions (culverts, paved stream crossings)													
R	Engineered channel (riprap, armored bank, bed)													
O	Actively managed hydrology (controlled lake level)													
L	Tide gate, weir/drop structure, dredged inlet/channel													
O	PS Discharge: treatmt water, non-storm disch, septic													
G	NPS Discharge: urban runoff, farm drainage													
Y	Other [specify]:													
	Other [specify]:													
	Overall Stressor Impact													

WANHP Vegetation Plot Form (example)

Plot Size/Shape	10x10	10x10	20x20	10x10	10x10	10x10	10x10	10x10
Plt Ass	elequi	vaculi / caraqudiv ?	pincon - tsuhet - thupli / vaculi - alnsin	pincon - tsuhet - thupli / vaculi - alnsin	eriang	salped / carcus?	tricae-(hypana)	vaculi-(caraqudiv)
waterquality	ph 6.06 ; temp 23.5 C; cond 86uS	ph 5.30 ; temp 20.0 C; cond n/a uS	ph 6.12; temp 16.1 C; cond 87uS	ph 5.66; temp 14.5 C; cond 59uS	ph 5.41; temp 19.2 C; cond 49 uS	ph 5.46; temp 19.0 C; cond 76 uS	ph 5.23; temp 19.2 C; cond 87 uS	ph 5.32; temp 17.7C; cond 179uS
Site Name	southprairie04	southpraire05	southprairie06	southprairie07	southprairie08	southprairie09	swampmdwS01	swampmdwS02
plotID	40fjr12	41fjr12	42fjr12	43fjr12	44fjr12	45fjr12	46fjr12	47fjr12
SPECIES	Cover Classes 1: trace 2: 0–<1% 3: 1–<2% 4: 2–<5% 5: 5–<10% 6: 10–<25% 7: 25–<50% 8: 50–<75% 9: 75–<95% 10: >95%							
Agrostis scabra	3				3	2	2	
brown/other mosses	3	4	4	5	5	3		
Carex cusickii			5		2	7		
Carex echinata ssp. echinata	5		7	5	2	5		
Carex limosa	2				4	6		
Drosera anglica	4				3		2	
Drosera rotundifolia			2	2	3			
Eleocharis quinqueflora	9				2	4		
Eriophorum angustifolium ssp. angustifolium	6				7		6	
Juncus ensifolius	2	2	2	3	2	2		
Kalmia microphylla	3		3	3	2		2	
Menyanthes trifoliata	2				3			
Packera pseudaurea var. pseudaurea	2	2			2			
Pedicularis groenlandica		2			2			
Salix pedicellaris	2	7	3	4	2	8	4	3
Saxifraga oregana					3	5		
Scheuchzeria palustris ssp. americana					3			
Sphagnum	3		5	6	9	6	2	
Triantha glutinosa	4		3	2	5	6	4	
Utricularia minor	3				3			
Vaccinium oxycoccos	3				7	7		

Appendix D: Wetland Conservation Profile and Reference Standard Sites for Western Washington

(included as accompanying Microsoft Excel workbook file)