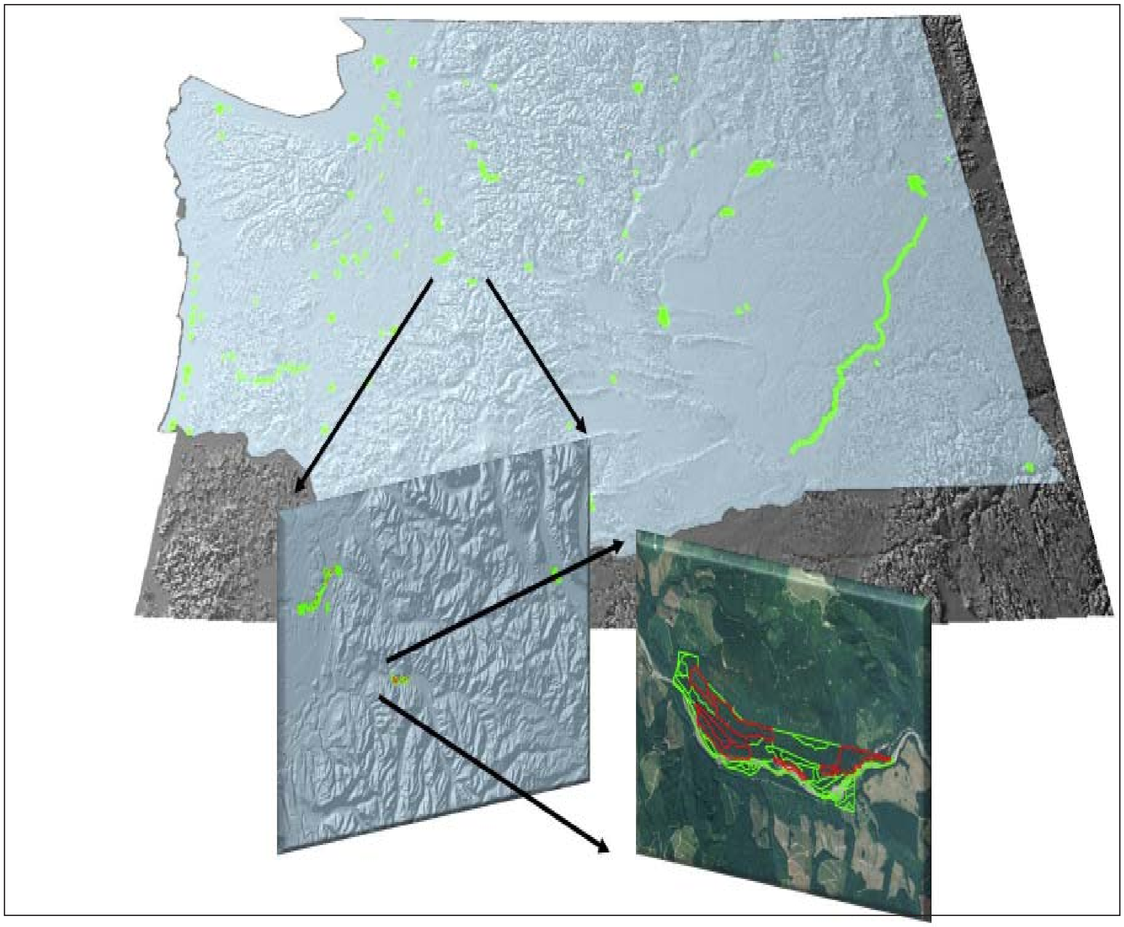
WASHINGTON NATURAL HERITAGE PROGRAM



Using the Ecological Integrity Assessment Framework to Identify Protection and/or Restoration Priorities Washington State Parks

Washington State Parks
and Recreation Commission
Olympia, Washiington

Prepared by
Rex C. Crawford
F. Joseph Rocchio
Eric Aubert

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Natural Resources

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Report Prepared for:
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Prepared by:
Rex C. Crawford and F. Joseph Rocchio
Washington Natural Heritage Program
Eric Aubert
State Uplands GIS Administrator
Washington Department of Natural Resources
Olympia, Washington 98503-1749

Abstract

In order to prioritize protection and restoration actions in 120 parks in the State Park system, the Washington State Parks and Recreation Commission (WSPRC) contracted with the Washington Department of Natural Resources, Natural Heritage Program (WNHP) to provide WSPRC a protocol that identifies priority natural resource habitats for protection and/or restoration using existing information about each park. To accomplish that objective, WNHP employed the Ecological Integrity Assessment (EIA) framework and other measures of biological significance. The long-term objective is to provide the means to conduct this analysis for all units in the State Park system that have existing data associated with them.

The priorities identified using the EIA-framework enables Washington State Parks and Recreation Commission to utilize existing data to determine restoration, protection, and acquisition priorities across the State Park System. As concluded in a pilot study of two parks (Dosewallips and Pearrygin Lake State Parks) in 2010, due to known and unknown human-caused errors in the dataset and because existing Park data were collected with different objectives and with varying survey intensities, the priorities identified using the EIA-framework should be considered coarse-level conclusions. Ideally, a thorough ground-truthing assessment would help identify errors with existing data; however, this is often limited by financial resources. Nonetheless, the EIA-framework described in this report provides a big-picture assessment of restoration and protection needs within the State Park system. These priorities are meant to focus Park managers to those areas in likely need of attention. Prior to implementing these management actions, State Park personnel should conduct on-site assessments to confirm and fine-tune protection and restoration needs.

The information developed for this project appears in a geodatabase (June 15, 2010) that contains all mapped 4030 polygons and their original 138 unique park attributes from120 parks mapped between 2001and 2009. For the EIA, twenty-nine attributes were used in calculation of eighteen EIA metrics (and additional thirteen GIS metrics and s metrics requiring individual polygon photo-interpretation were not calculated due to time constraints). Forty-six ecological systems and 240 plant associations are addressed by the EIA. Also included in the report is a summary of how data standardization was accomplished, metadata of data fields, a procedure of how to use the geodatabase to make information queries about specific parks and among parks, and a discussion about how to interpret EIA scores and limits of application of derived rating to on-the-ground condition and management.

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1.0 Introduction

1.1 Project Objective

In order to prioritize protection and restoration actions across the State Park system, the Washington State Parks and Recreation Commission (WSPRC) contracted with the Washington Department of Natural Resources, Natural Heritage Program (WNHP) to provide WSPRC a protocol that identifies priority natural resource habitats for protection and/or restoration using existing information about each park. To accomplish that objective, WNHP employed the Ecological Integrity Assessment (EIA) framework and other measures of biological significance by incorporating information gathered, techniques used, and evaluation of a pilot project at Dosewallips and Pearrygin Lake State Parks (Rocchio and Crawford 2010). This project's objective is to develop within a single geodatabase an EIA-based analysis across all units in the State Park system with existing mapped data.

Specifically, the project is tasked to:

1) determine the biological significance at each mapped park using existing data,
2) prioritize areas for protection and/or restoration,
3) identify parcels near parks that will increase key size and landscape attributes for resource protection,
4) identify gaps in existing data, and
5) prioritize monitoring areas and protocols.

Below, we describe the assessment and classification framework that will be used to meet the project objectives.

1.2 Ecological Integrity Assessments

Details of the EIA methodology are discussed in the pilot project (Rocchio and Crawford 2010) and in documents on the Washington Natural Heritage and NatureServe websites.

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 associated with the structure, composition, and ecological processes relative to what is expected within the bounds of natural variation for any give 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. An EIA is tailored to individual ecological systems by listing the major or key ecological attributes (KEA) that have an important function in the viability or integrity of each ecological system (see Appendix A for EIA example or dnr.wa.gov/nhp/refdesk/communities/eia.html). Each KEA has associated indicators and/or metrics that provide the specificity needed to assess the major ecological attributes. Indicator or metrics are scored or rated to measure its expression on a particular site relative to natural range of variation (NRV). Each indicator or metric, through its ratings relative to NRV, provides explicit endpoints and standards for management objectives.

Regardless of which metric is being measured a standard ranking scale is used to score each metric. Metrics, key ecological attributes or overall ecological integrity is ranked from "excellent" to "poor" or A", "B", "C" or "D" (Table 1). In order to make such rankings operational, the general ranking definitions need to be more specifically described using a suite of attributes that are assumed to be important to assessing various grades of ecological integrity (Table 2). These descriptions provide guidance when developing specific metric rankings for individual EIAs. The helps ensure that all metrics, regardless of the actual unit of measurement of the field value, is ranked or scored on a comparable scale.

Table 1.Basic Ecological Integrity Ranks

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

Table 2. Ecological Integrity Rank Definitions (Faber-Langendoen et al. 2009a)

Rank Value	Description
A	Occurrence is believed to be, on a global or range-wide scale, among the highest quality examples with respect to major ecological attributes functioning within the bounds of natural disturbance regimes. Characteristics include: the landscape context contains natural habitats that are essentially unfragmented (reflective of intact ecological processes) and with little to no stressors; the size is very large or much larger than the minimum dynamic area ; vegetation structure and composition, soil status, and hydrological function are well within natural ranges of variation, exotics (non-natives) are essentially absent or have negligible negative impact; and, a comprehensive set of key plant and animal indicators are present.
B	Occurrence is not among the highest quality examples, but nevertheless exhibits favorable characteristics with respect to major ecological attributes functioning within the bounds of natural disturbance regimes. Characteristics include: the landscape context contains largely natural habitats that are minimally fragmented with few stressors; the size is large or above the minimum dynamic area, the vegetation structure and composition, soils, and hydrology are functioning within natural ranges of variation; invasives and exotics (non-natives) are present in only minor amounts, or have or minor negative impact; and many key plant and animal indicators are present.
C	Occurrence has a number of unfavorable characteristics with respect to the major ecological attributes, natural disturbance regimes. Characteristics include: the landscape context contains natural habitat that is moderately fragmented, with several stressors; the size is small or below, but near the minimum dynamic area; the vegetation structure and composition, soils, and hydrology are altered somewhat outside their natural range of variation; invasives and exotics (non-natives) may be a sizeable minority of the species

Rank Value	Description
	abundance, or have moderately negative impacts; and many key plant and animal indicators are absent. Some management is needed to maintain or restore[1] these major ecological attributes.
D	Occurrence has severely altered characteristics (but still meets minimum criteria for the type), with respect to the major ecological attributes. Characteristics include: the landscape context contains little natural habitat and is very fragmented; size is very small or well below the minimum dynamic area; the vegetation structure and composition, soils, and hydrology are severely altered well beyond their natural range of variation; invasives or exotics (non-natives) exert a strong negative impact, and most, if not all, key plant and animal indicators are absent. There may be little long-term conservation value without restoration, and such restoration may be difficult or uncertain.[2]

The EIA reports scores or ranks in a tabular format of the individual metrics or produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank (Table 3). The metrics are integrated into a rank factor ranking by placing each metric score into a simple, weight-based algorithm. These algorithms are constructed based on expert scientific judgment regarding the interaction and corresponding influence of these metrics on ecological integrity (e.g., as done by NatureServe 2002, Parrish et al. 2003). All of these characteristics make the EIA a practical, transparent, and easily communicable assessment tool.

Table 3.Ecological Integrity Assessment Scorecard Example for a Level 2 Assessment.

KEY ECOLOGICAL ATTRIBUTES (KEA) Metric	Assigned Metric Rating	Assigned Metric Points	Weight (W)	Metric Score (M)	KEA Score (M/W)	KEA Rank	Ecological Integrity Score	Ecological Integrity Rank (EO rank)
LANDSCAPE CONTEXT					4.3	B		
Buffer Length	A	5	1	5				
Buffer Width	B	4	1	4				
Buffer Condition	B	4	1	4				
Connectivity	B	4	1	4				
			∑=4	∑=17				
SIZE					4.3	B		
Relative Size	A	5	0.5	2.5				
Absolute Size	B	4	1	4				
			∑=1.5	∑=6.5				
VEGETATION (BIOTA)					3.4	C		
Cover of Native Plants	C	3	1	3				
Cover of Invasive Species	C	3	0.5	1.5				
Cover of Native Increasers	B	4	1	4				
Species Composition	B	4	1	4				
Regeneration of Woody Species	C	3	1	3				
Canopy Structure	C	3	1	3				
Organic Matter Accumulation	B	4	0.5	2				
			∑=6	∑=20.5				
HYDROLOGY					4.0	B		
Water Source	C	3	1	3				

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

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

KEY ECOLOGICAL ATTRIBUTES (KEA) Metric	Assigned Metric Rating	Assigned Metric Points	Weight (W)	Metric Score (M)	KEA Score (M/W)	KEA Rank	Ecological Integrity Score	Ecological Integrity Rank (EO rank)
Channel Stability	B	4	1	4				
Hydrologic Connectivity	A	5	1	5				
			$\sum$=3	$\sum$=12				
SOILS (PHYSICOCHEMISTRY)					4.0	B		
Physical Patch Types	B	4	0.5	2				
Water Quality	B	4	1	4				
Soil Surface Condition	B	4	1	4				
			$\sum$=2.5	$\sum$=10				
$\sum$=20								
RATING A=4.5-5.0, B = 3.5-4.4, C=2.5-3.4, D=1.0-2.4							4	B

1.3 Vegetation Classification

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

2.0 Methods

Much of this project was dedicated to collating information from previous mapping projects on 120 State Parks into a compatible geodatabase from which EIA ranking could be estimated. The process of preparing the existing data for use in the EIA framework entailed numerous steps. The major tasks in merging multiple databases to a single geodatabase for EIA calculation were:

1) Merging all GIS information into a single Geodatabase for editing
2) Standardizing attribute or field names across all surveys,
3) Standardize ecological system and vegetation classifications and conservation ranks for all polygons across all surveys,
4) Standardize values of park attributes that inform EIA metrics,
5) Establish park attribute and EIA metric relationships to calculate EIA metric ranks,
6) Describe various relationships among ecological systems, EIA metrics, park attributes and other information for GIS script,
7) Describe relationship among EIA metric ranks and final EIA Rank Factor and EIA Rank for each ecological system for GIS script,
8) P Describe relationship between EIA Rank and plant association conservation rank to designate Protection and Restoration Priorities for GIS script.

Once those data were processed through the EIAs, the subsequent results were then sifted through a prioritization/restoration matrix to identify which polygons were of importance for these management actions.

2.1 Standardize All Park Data into GeoDataBase for Editing

All original GIS data are retained in the Geodatabase (final June 15, 2011). There is no modification of polygons and new fields were created whenever attributes and values were modified. Once all project GIS data were merged into a geodatabase, a matrix of attribute field names and park projects was exported to Microsoft Excel for manipulation and comparison (ReportTables.xlsx: AllFields). Data attributes originally collected at the State Parks were based on a State Park-supplied standardized form (Vegetation Survey Data) requesting a possible 41 attributes (see Individual Park mapping project reports for examples). Modification, addition, and deletion from the original Vegetation Survey Data over several years by different contractors at different parks resulted in the number of attributes recorded per park varying between 22 and 88 with average of 66 (median 64). After grouping park attributes that differed only in spelling or abbreviation of attribute name or by an apparent similarity of values resulted in138 unique park attribute fields.

Mapping at Ginkgo State Park was unique among all state parks in attributes although it is similar to vegetation mapping completed at the Yakima Firing Range, adjacent WDFW lands, and part of the Yakama Reservation. Consequently, Ginkgo Park could not be used in this EIA analysis. With its removal from the data set, attribute number per park is less variable with 34 and 74 attributes with an average of 53 (median 50) and a total list of 124 attributes. The final data matrix for standardization was 120 park projects and 4030 individual polygons with 124 attributes.

To simplify data for review and editing, the attribute files of all parks was divided into 3 files: 1) MASTER with descriptive information about each polygon (Contractor, Park Name, Unique Polygon identifications, GPS, plot number, Date of Survey, Survey Intensity, etc.), 2) MAIN with attributes describing the vegetation and ecological condition of the polygon that could estimate an EIA metric (Total Vegetation Cover, Rock Cover, Livestock Use rating, Plant Associations, etc) and 3) UNIQUE with attributes not in common with other surveys and not related to EIA metrics (Ginkgo State Park attributes, elevation, landform, etc.)

Variation in how data was recorded or represented at each park required standardization in order to be used in the EIA. Field values that are not applicable to EIA ratings were not standardized. Field value standardization involved inspection of values in Excel (ReportTables.xlsx:AllValues) through sorting and filtering individual fields and referencing original park reports from the MAIN table. For example, TOT_VEG_COV is a numeric field with Standardized values. It is the total vegetation cover of all vascular plants, mosses, and foliose lichens (crustose lichens excluded – they are considered rock) in the polygon. This value never exceeds 100%. Cover estimates appear either as CLASS or PERCENT as indicated in a new COVER_ESTIMATOR field. This is a common field in all parks but was recorded with eight different names, for example TOT_VEG, TOTAL_VEG, TotalVeg, etc.

Appendix A. MAIN TABLE Fields lists the metadata for park data including 1) if it represents a numeric or text field, 2) if it has standardized or original values, 3) the number of original data field names and examples, and 4) any assumption or special issues in standardizing values. The subset fields used in EIA ranking are indicated by "INPUT".

2.2 Crosswalk Plant Associations in Park Data to Ecological Systems and the U.S. National Vegetation Classification

Ecological Integrity Assessments are written for individual Ecological Systems. The original park data did not assign ecological system and often included more than one ecological system per polygon. Since the original Park data to be used for calculating EIA metrics were collected at the polygon scale, we were limited to applying the EIA to individual polygons even when more than one System was represented. Thus, each polygon needed to be assigned to a single Ecological System. The procedure used to assign an ecological system is outlined below. All crosswalk and comparisons were accomplished in Microsoft Excel (ReportTables.xlsx:AllValues that includes MAIN table attributes and final vegetation classification fields) through sorting and filtering individual fields and referencing the original park reports.

Existing Park Data does not identify Ecological System but does list up to five plant associations and their relative proportion in each polygon. Since Terrestrial Ecological Systems are groups of plant associations that co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients, Ecological Systems were assigned based on the most abundant plant association which occurs in each polygon (Rocchio and Crawford 2008; NatureServe

Explorer: http://www.natureserve.org/explorer/). The most abundant or representative plant association in a polygon is in the NVC_OR_NHP_ASSOCIATION field and ecological system is ECOLOGICAL_SYSTEM field in the MAIN table.

To establish those relationships, a list of standard plant association names was needed from the diversity of names assigned in the existing park data. Plant associations from most parks were either referenced to classification publications, to names supplied by WNHP or on NatureServe Explorer. Park data listed plant associations as acronyms and because a variety of naming approaches were used by contractors, plant associations acronyms were first standardized into four-letter USDA plants codes. For example, the *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* association is standardized in the as ARTRW8/PSSP6. It was crosswalk from these names, ARTR2/PSSP6, ARTR2/PS, ARTR2/PSSP6 (CRAWFORD), etc as recorded in original data. Other plant association names were non-standard plant association name provided by contractor. In these cases, plant association was based on best professional judgment from inspection of existing vegetation information and location. Those plant association designations are likely broader in concept than the described NVC or WNHP concept.

Plant association names that are equivalent NVC or WNHP names are assigned an existing conservation status rank (Global or State Rank) from either of those sources. Plant associations without either and Global or State rank are labeled as not-ranked (GNR or SNR; see Section 2.4 Protection and Restoration Priority Decision Matrix for description of Global and State Ranks).

Each polygon was characterized by the plant association with the greatest percentage of a polygon and was assigned that association's conservation rank. That most abundant association in the polygon was also used to derive the ecological system type of that polygon. In most cases, multiple plant associations per polygon represented the same ecological system. In almost 80% of polygons a single plant association occupied over two-thirds of the polygon.

The EIA framework is developed to apply to native habitats and their divergence from an intact state. Consequently, polygons attributed with over two-thirds weedy, old field, developed or otherwise modified by human activities were assumed to be either ruderal (novel) systems or developed or cultivated vegetation and, therefore, not are included in EIA calculation. Additionally, Parks located in mountainous regions (with some forests) were assumed to have montane riparian/wetland systems rather than lowland systems. Where it was possible to determine from associated data, all upland polygons labeled as the *Alnus rubra/Polystichum munitum* association are included in North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest system, otherwise they labeled as the North Pacific Lowland Riparian Forest and Shrubland ecological system. All polygons assigned ARTR4/POSE by contractors is assumed to be degraded Wyoming big sagebrush / bluebunch wheatgrass and is assigned to Inter-Mountain Basins Big Sagebrush Steppe system.

For this project, we assumed that plant species and plant association identification by contractors are correct and therefore Ecological System relationships and conservation ranks are correct. We also assume that plant associations that are not in the literature or in WNHP's classification could reliably be assigned to an Ecological System based on best professional judgment of the authors using site information and other vegetation data provided in each park report. Polygons not assigned a plant association by the contactor but with enough descriptive information to allow for ecological system designation were labeled without plant association or conservation rank.

2.3 Development of Ecological Integrity Assessments Specific to State Parks

EIAs were used to assess the ecological integrity of each polygon. This project identified 46 ecological systems composed of 240 plant associations, 185 of which have conservation ranks. Prior to this project, an EIA was prepared for all but 4 ecological systems (http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html) found in the Parks. Those four EIAs are found in Appendix B (see Section 1.2 and Rocchio and Crawford (2009) for further details about EIA development). While EIAs are developed for Ecological Systems, the overall EIA and metric ratings (conveyed as A, B, C, or D; see Section 1.2) are applicable to component associations of each system.

2.3.1 Using Park Data in EIA Calculations.

Each of the polygon attributes associated with State Park dataset were evaluated in terms of their relevance to the metrics in 44 EIAs (representing 46 ecological systems) applicable to this project. All EIA tables were copied to Microsoft Excel and were merged into a single spreadsheet (ReportTables.xlsx:EIAs). That spreadsheet shows each individual metric with category, attribute, indicator, metric rating scales and the ecological system it references. The 44 applicable EIAs contain 132 metrics and rating value combinations. For example, the Soil Surface Condition metric applies to all 44 ecological systems but has six different rating values depending if the ecological system is a forest, a grassland, wetland, etc.

A comparison of EIA attribute metrics to existing park attribute information (Appendix A. MAIN TABLE) concluded that the 132 unique metric and value combinations in the 44 EIAs could be synthesized into 49 metrics. For example, six different Soil Condition rating schemes could be estimated by the same set of park attributes. Of the 49 metrics, 18 metrics could be estimated using 29 state parks attributes, 13 metrics could be estimated with GIS analysis, 16 metrics could be estimated with photo-interpretation, and 2 metrics could only be addressed with new site inventory (ReportTables.xlsx: EIAs). Time constraints limited the analysis in the Geodatabase to using metric estimates based on state park attributes collected in polygons. The only GIS rating used was individual polygons size. Most GIS metrics and all other metrics were not calculated.

The 29 park attributes used in metric estimation (referred to as INPUT fields) were combined in logic statements for EIA rank calculation. INPUT fields are a subset of the original data fields in the MAIN table (TOT_VEG_COV) and standardized original fields with categorical values(LOGGING that is standardized as LOGGING_EIA) in the input field. The INPUT fields were used in logic statements to develop metric ranks or "OUTPUT fields". For example, the EIA metric CANOPY_STRUCTURE is approximated by the following fields and values: if TOT_TREE_COV >50% and STAND AGE=3 OR 4 OR 6 OR 8 OR 9 it rates "AB", if TOT_TREE_COV 10-50% and STAND AGE=2 OR 5 OR 7 it rates "C" or if TOT_TREE_COV > 10% and STAND AGE=1 it rates "D". OUTPUT field relationships to the EIA metrics, original park data, INPUT fields, rationales and assumptions are summarized in Appendix C. OUTPUT Metadata (ReportTables.xlsx: EIA_OUTPUT). Appendix C. OUTPUT metadata also lists the EIA metrics that were not used in this analysis and suggests a source or means to acquire that information. For example, COVER OF NATIVE INCREASER RANK which appears in EIA tables as Relative Cover of Native Increaser Species or as Relative Cover of Understory Native Increasers, could not be assessed with available information. This metric might be calculated with inspection of DOM_SHRUB, DOM_GRAM, and DOM_FORB fields looking for species categorized as increasers in individual ecological system reports and assuming cover value in the appropriate life form category represented "native increasers".

The logic statements in OUTPUT that calculate ranks for individual metrics are defined in the GIS script in the June 15, 2010 Geodatabase. The GIS script calculated roll-up ranks by taking the letter rankings of each metric and converting them to the following numeric scores A=5.0, B=4.0, C=3.0, D=1.0. Roll-up ranks are (1) average metric scores for each Rank Factor and (2) average Rank Factor scores for overall EIA Rank.

Once metric ranks are calculated they are rolled-up into ranks for each "Rank Factor" (i.e. Landscape Context, Condition, and Size) as well as into an overall EIA Rank for each ecological system. Since individual ecological systems can have a unique set of metrics, roll-up ranks require a set of relational statements. For example, the Columbia Basin Foothill and Canyon Dry Grassland ecological system EIA rank is the average of Vegetation Condition Rank Factor Attributes (COVER_NATIVE_UNDERSTORY_RANK + COVER_OF_NATIVE_INCREASER_RANK + EXOTIC_INVASIVE_RANK + SPECIES_COMPOSITION_RANK + NATIVE_BUNCHGRASS_RANK), Physical site Condition Rank attributes (SOIL_SURFACE_CONDITION_RANK), Landscape Condition Rank attributes (EDGE_CONDITION_RANK + EDGE_LENGTH_RANK + EDGE_WIDTH_RANK + LANDSCAPE_CONDITION_MODEL_INDEX_RANK + CONNECTIVITY_RANK) and Size Condition Rank attributes (ABSOLUTE_SIZE_RANK_P, RELATIVE_RANK).

Once metric ranks are calculated they are rolled-up into ranks for each "Rank Factor" (i.e. Landscape Context, Condition, and Size) as well as into an overall EIA Rank for each ecological system. Since individual ecological systems can have a unique set of metrics, roll-up ranks require a set of relational statements. For example, the Vegetation Condition Rank factor for the Columbia Basin Foothill and Canyon Dry Grassland ecological system is VEG_CONDITION_RANK_1 = average rank of COVER_NATIVE_UNDERSTORY_RANK + EXOTIC_INVASIVE_RANK + SPECIES_COMPOSITION_RANK + NATIVE_BUNCHGRASS_RANK.
The Rank Factor scores are used in the same way to calculate an overall Ecological Integrity Assessment score for each ecological system. For example, the Columbia Basin Foothill and Canyon Dry Grassland ecological system EIA_Rank is calculated by the average of LANDSCAPE_RANK, PHYSICAL_CONDITION_RANK_, VEG_CONDITION_RANK, and SIZE_RANK. Because landscape metric ranks were not calculated, EIA rank is approximated for the Columbia Basin Foothill and Canyon Dry Grassland ecological system by the average of PHYSICAL_CONDITION_RANK, VEG_CONDITION_RANK, and ABSOLUTE_SIZE_RANK_P. The relationship between OUTPUT_EIA statements and ecological systems appears in ReportTables.xlsx: EcolSysMetrics. Overall EIA scores are converted to text ranks by

Rank Score	Rank
4.5-5.0	A
3.5-4.4	B
2.5-3.4	C
1.0-2.4	D

2.4 Protection and Restoration Priority Decision Matrix

The conservation ranking systems developed by NatureServe and Natural Heritage programs is used to estimate conservation priorities (Faber-Langendoen et al 2009b). The ranking system facilitates a quick assessment of an entity's rarity or risk of extirpation. Plant associations are assigned conservation ranks by NatureServe across their full distribution (Global or G-Rank) and individual Natural Heritage Programs determine ranks at the state level (State or S-Rank). Both a global and state rank appear on a scale of 1 (high risk of extirpation) to 5 (low risk of extirpation). A rank of G1 indicates critical imperilment on a global basis; the plant association is at great risk of extinction. S1 indicates critical imperilment within a particular state, regardless of its status elsewhere. A global rank cannot be rarer than the state rank. Factors such as the total range, the number of occurrences, trends, severity of threats, and natural resilience, contribute to the assignment of global and state ranks. Uncertainty in conservation rank is expressed as a Range Rank. For example, S2S3 indicates a range of uncertainty such that there is a roughly equal chance of S2 or S3. A rank of SU expresses that a rank is unable to be assigned to an association due to lack of information or due to conflicting information about status or trends. When the taxonomic distinctiveness of an association is questionable, it is assigned a rank of SQ in combination with a standard numerical S rank if possible, for example S3Q. When insufficient information is available to provide a global and/or state rank, it is indicated as GNR/SNR. For this project, these ranks were only used to identify priorities within the Restoration category (i.e., Tiers, as described below). The information supporting these ranks is developed and maintained by the Natural Heritage Program and NatureServe.

Priority areas for protection and restoration were determined by combining conservation rank (G-rank and S-Rank) and overall EIA Rank (ReportTables.xlsx:TIER_PRIORITY). Protection priority is suggested for rare associations and/or high integrity occurrences while a restoration focus is recommended for less rare elements and occurrences which have been degraded. Plant associations ranked G or S UQ are not included in this decision matrix. An additional filter (Tier) is used to differentiate priorities within the Protection and Restoration categories (ReportTables.xlsx: TIER_PRIORITY). Using Table 4, each polygon was assigned a Protection or Restoration priority based on the predominant plant association that occurs in the polygon.

Table 4. Protection and Restoration Priority Decision Matrix.

		EIA Rank			
Global Rank	**State Rank**	**A**	**B**	**C**	**D**
G1/G2	S1/S2	Tier 1		Tier 1	
G3	S1/S2/S3	Tier 2		Tier 2	

G4/G5	S1/S2	Tier 3	Tier 3		No Action
G4/G5	S3/S4/S5	Tier 4	Tier 4	No Action	

Protection Priorities (green) = management should focus on maintaining viability or integrity of priority element. This may result in active management actions if needed.
Restoration Priorities (blue) = actions should be taken to restore key ecological attributes of targeted element; in some cases successful restoration may result in reassigning a polygon to a Protection priority. In other case, restoration actions may be ongoing.
Protection & Restoration Priorities (purple) = this category is designated for very rare elements that are in need of immediate protection restoration attention.
No Action = no recommended action is prescribed for these element occurrences. This does not imply they should, by default, be targeted for development or recreation as they may support general wildlife habitat value.

2.5 Additional Protection Criteria

The analysis thus far has focused on ecosystem priorities. In order to ensure that species priorities were accounted for, we recommend intersecting Park polygons with two additional datasets: WNHP's rare plant element occurrences and Washington Department of Fish and Wildlife's Priority Habitats and Species (PHS; http://wdfw.wa.gov/conservation/phs/). Any polygon that has a rare plant or PHS within it, and is not already identified as being a Priority polygon from the EIA analysis, should be designated as such. This process ensures that critical habitat for rare and sensitive plant and animal species is not missed in the analysis.

2.6 Identification of Restoration Needs

While overall EIA rank is used to prioritize protection and restoration priorities, individual metric ratings are used to identify restoration needs for any given polygon. For example, for those polygons assigned a Restoration priority, restoration needs are identified via a filter of the relevant EIA metrics associated with the Ecological System assigned to the polygon. Any EIA metric which currently has a C or D rating would be considered a restoration need for any given polygon. Thus, restoration needs can then be identified for each polygon by filtering the geodatabase for any metric with a C or D rating applicable to the ecological system assigned to the polygon.

2.7 Identification of Adjacent Parcels for Potential Acquisition

In the pilot study (Rocchio and Crawford 2010), GIS was used to determine whether lands adjacent to Park boundaries had the potential to improve the ecological integrity of priority polygons. For example, if a restoration need of a priority polygon is improved connectivity, then acquiring and/or managing relatively intact parcels for such purposes would be beneficial to the ecological integrity of that polygon. Another example may be a need to protect additional acreage of a specific priority element found in a polygon. In other words, a rare shrub-steppe polygon is found on the Park but is a small occurrence. However, additional acreage of this community occurs adjacent to Park boundaries. Protecting this additional acreage could improve the ecological integrity of the priority element found in the Park.

Due to time constraints, we were prevented applying a GIS overlay exercise to generate a process of identifying adjacent parcels for acquisition. A recommended approach is to identify polygons as restoration priorities and then display them on a map by their respective Ecological System classification. Next, the Ecological System map for Washington (http://www.natureserve.org/getData/USecologyData.jsp) is used to display the modeled locations of these Ecological Systems adjacent to Park boundaries. This process helps identify where the specific Ecological Systems are located and whether they could assist with restoration or protection needs (Table 4).

3.0 Results

3.1 Utility of Park Data for Calculating EIA Metrics

The number of EIA metrics that were feasible to calculate from the existing Park datasets varied by Ecological System. A comparison of EIA attribute metrics to existing park attribute information (Appendix A. MAIN TABLE) concluded that the 132 unique metric and value combinations in the 44 EIAs could first be synthesized into 49 metrics. For example, six different Soil Condition rating scheme could be estimated by the same set of park attributes. Of the 49 metrics, 18 metrics could be estimated using 29 state parks attributes, 13 metrics could be estimated with GIS analysis, 16 metrics could be estimated with photo-interpretation, and 2 metrics require new site inventory (ReportTables.xlsx: EIAs). This is comparable to the results of the pilot survey with nine ecological systems at Dosewalips and Pearrygin State Parks were between ten to fifteen park attributes were used to calculate the EIA metrics.

3.2 Comparison of Automated and Field-based EIA ranks

For this project addressing 120 State Parks, it was not feasible to field verify park attribute data and we assumed that the information recorded is correct. That assumption is could be questioned based on 2010 field validation at Dosewallips and Pearrygin State Parks (Rocchio and Crawford 2010). Field validation EIA ranking compared to EIA rating from previous mapping data showed that of the 88 metric comparisons across all systems at Dosewalips, 57% rated the same, 28% were within one rank and 15% were within two ranks. However, only one polygon had a two-rank disagreement within any of the Rank Factor categories suggesting that despite the disagreement at the metric level, overall ranks are within an acceptable range of error. At Pearrygin, of the 60 metric comparisons across all systems, 72% rated the same, 27% were within one rank and 17% were within two ranks. No polygon had a two-rank disagreement within any of the Rank Factor categories suggesting that despite the disagreement at the metric level, overall ranks are within an acceptable range of error.

3.3 Protection and Restoration Priorities

Protection and Restoration priorities were identified in Dosewallips and Pearrygin State Parks pilot project by a map displayed according to Tiers within each of the Protection and Restoration categories (ReportTables.xlsx: TIER_PRIORITY). Time prevented developing and evaluating the geodatabase script to assign Tier and Protection/Restoration categories to all polygons and prevented estimation of Landscape and Size Rank, therefore, overall EIA Rank was not calculated. Condition Rank estimates the overall integrity rank of a polygon and will substitute for EIA Rank in priority calculation at the polygon scale. Protection/Restoration categories can thus be estimated using ARCMAP selection queries following the example below:

In selection tool, select by attributes, the query

```
"eia_input.G_RANK" = 'G1' OR "eia_input.G_RANK" = 'G2' AND
eia_output.CONDITION_RANK >=3.5
```

That selection can then be used to create a shapefile with polygons in the Protection category. A series of such queries could create a set of shapefiles of each protection/restoration categories for individual evaluation for addition action. Figures 1 and 2 are examples of how the geodatabase can be used to identify restoration and protection prioritie. Figures 3 and 4 show restoration needs extracted from the geodatabase.

3.5 Priority Acquisitions

This was not addressed in the project because Landscape metric required developing new GIS procedures. However, Figures 5 and 6 provide examples of how this might be done. Applicable GIS procedures are being developed by WNHP that may have direct application to estimating landscape metrics that in combination with mapping projects surrounding parks may give a means address potential acquisitions.

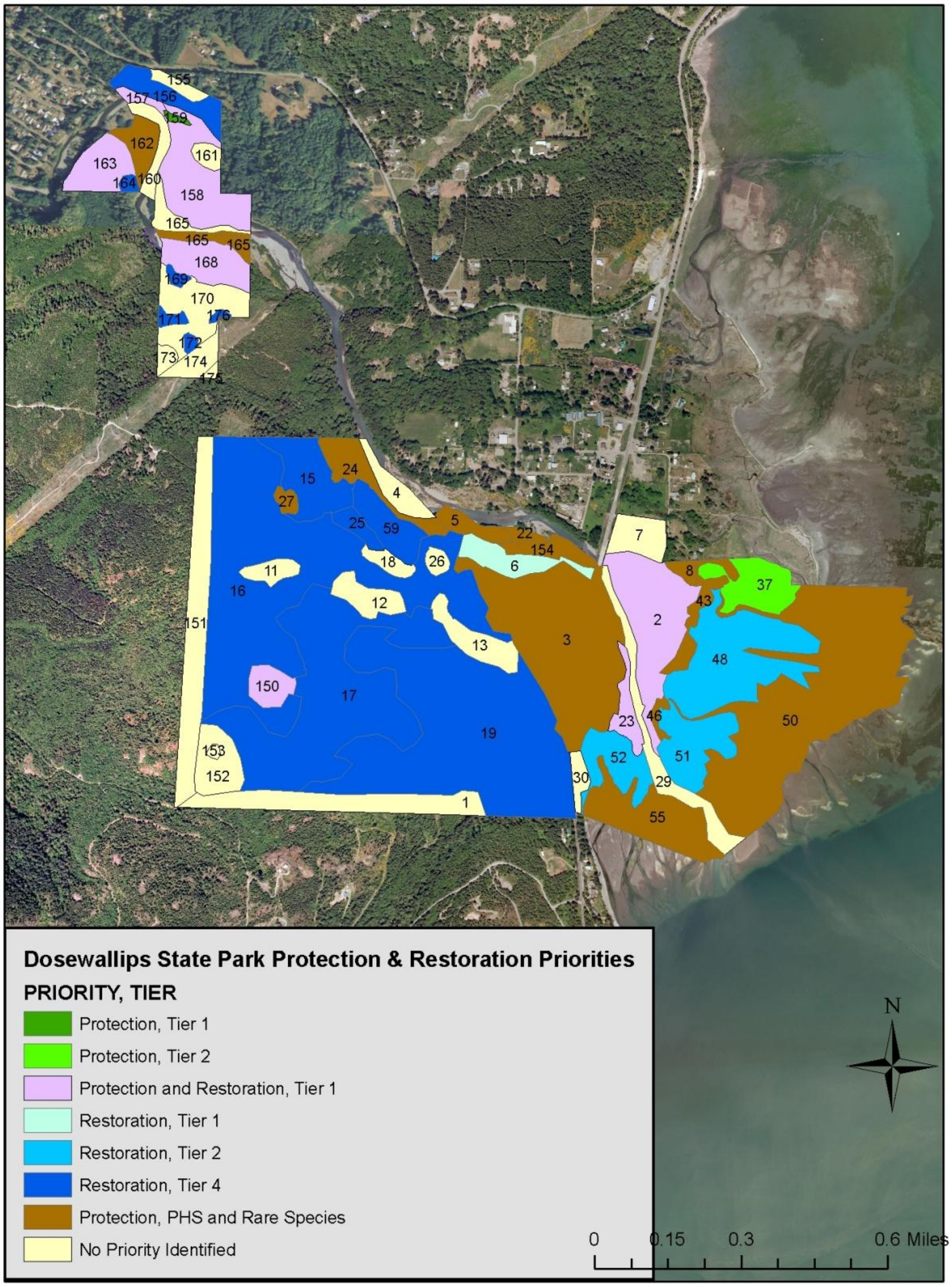

Figure 1. Protection and Restoration Priorities for Dosewallips State Park (Numbers = Polygon ID). See Table 5 for an interpretation of protection and restoration tiers.

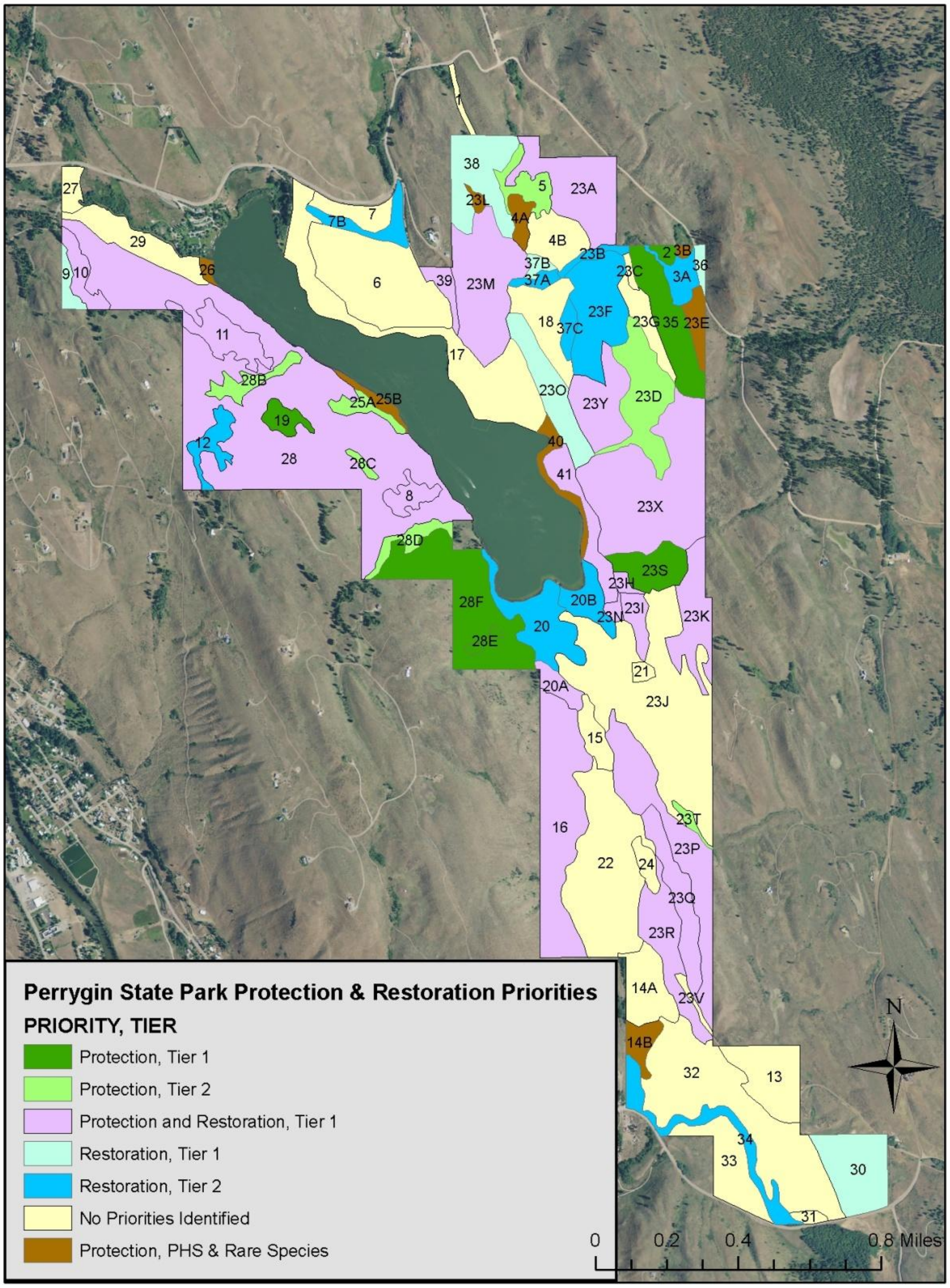

Figure 2. Protection and Restoration Priorities for Pearrygin State Park (Numbers = Polygon ID). See Table 5 for an interpretation of protection and restoration tiers.

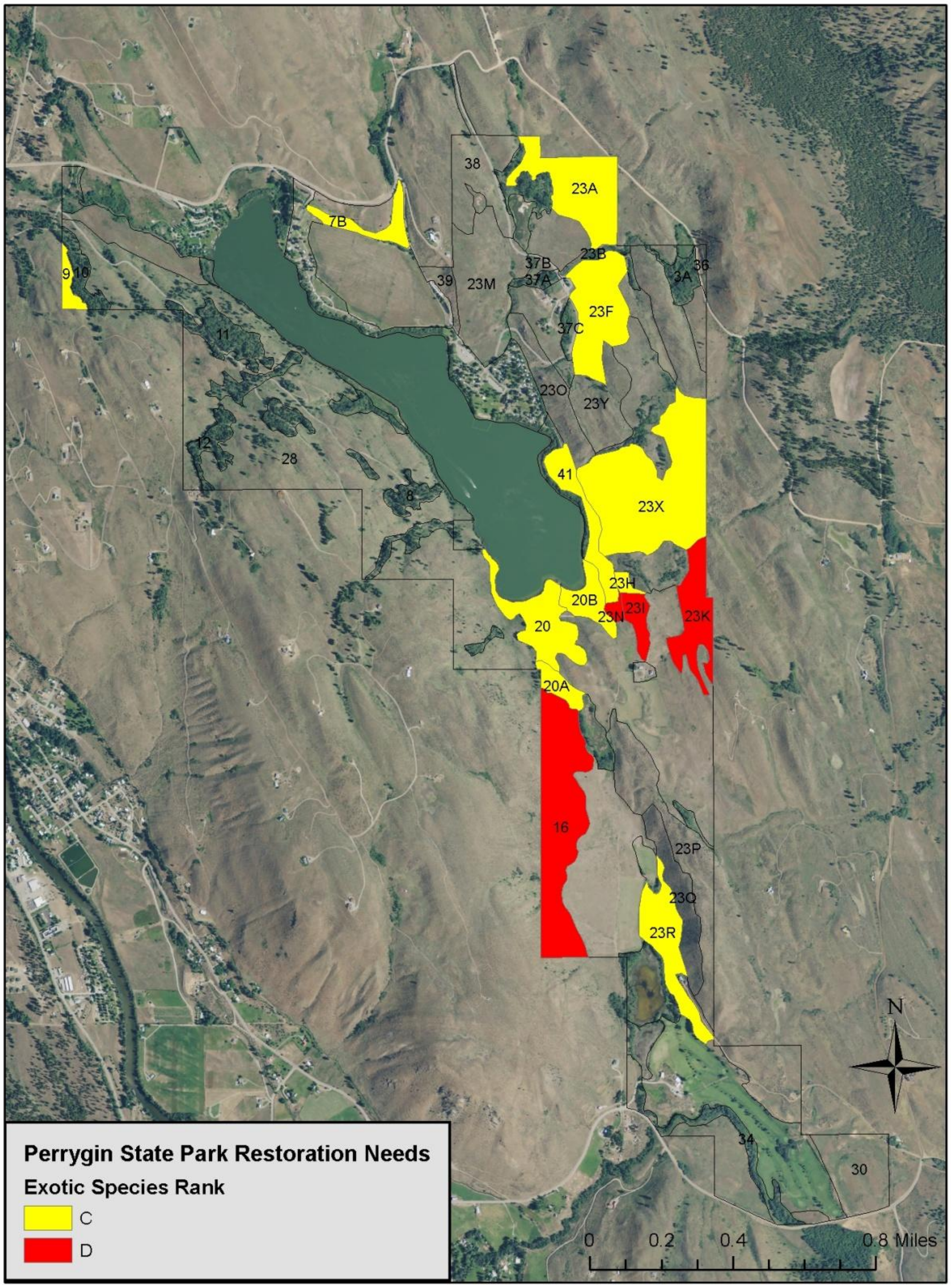

Figure 3. Polygons in Need of Exotic Species Control at Pearrygin State Park. See Table 5 for an interpretation of protection and restoration tiers.

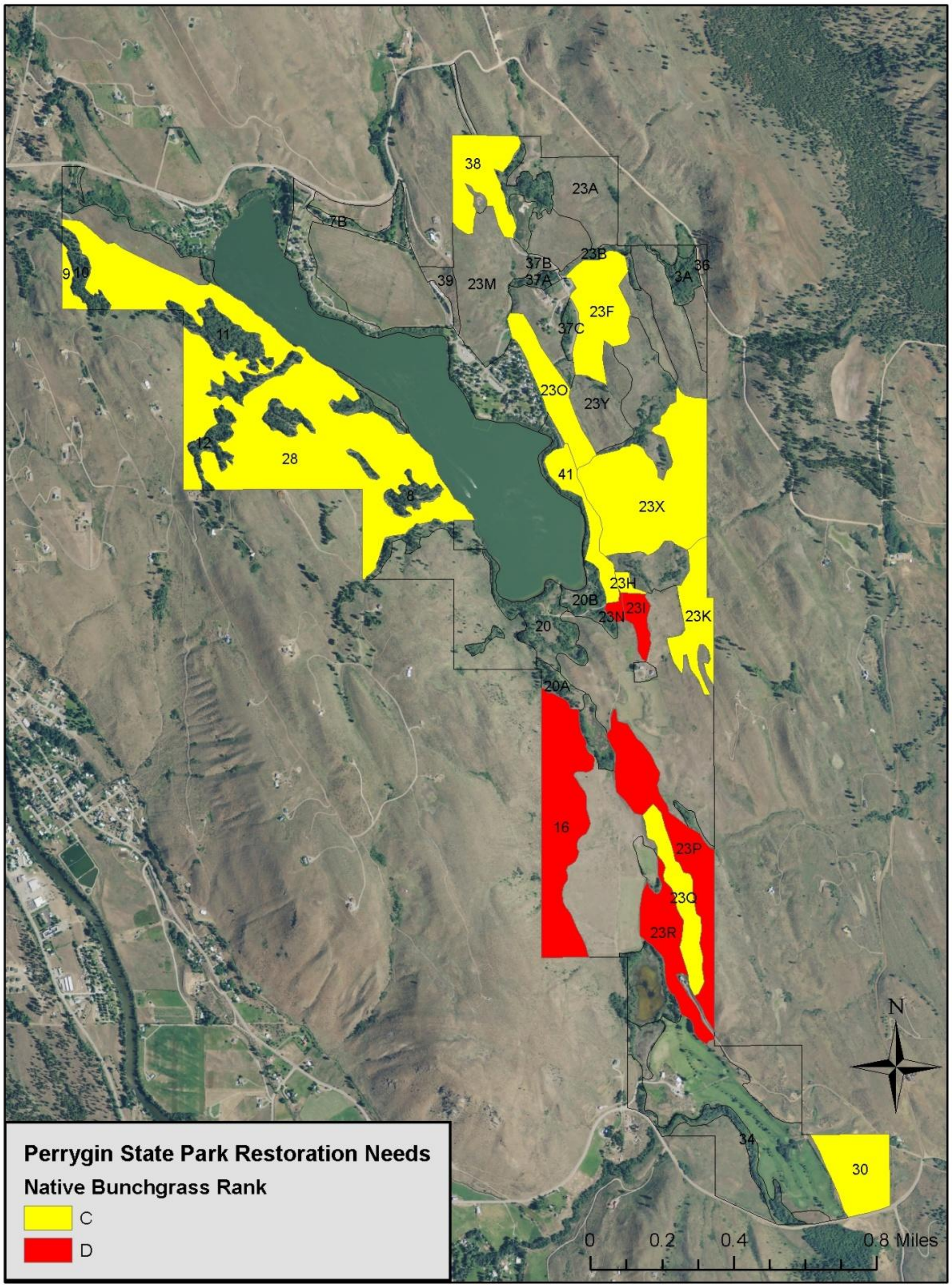

Figure 4. Native Bunchgrass Restoration Needs at Pearrygin State Park. See Table 5 for an interpretation of protection and restoration tiers.

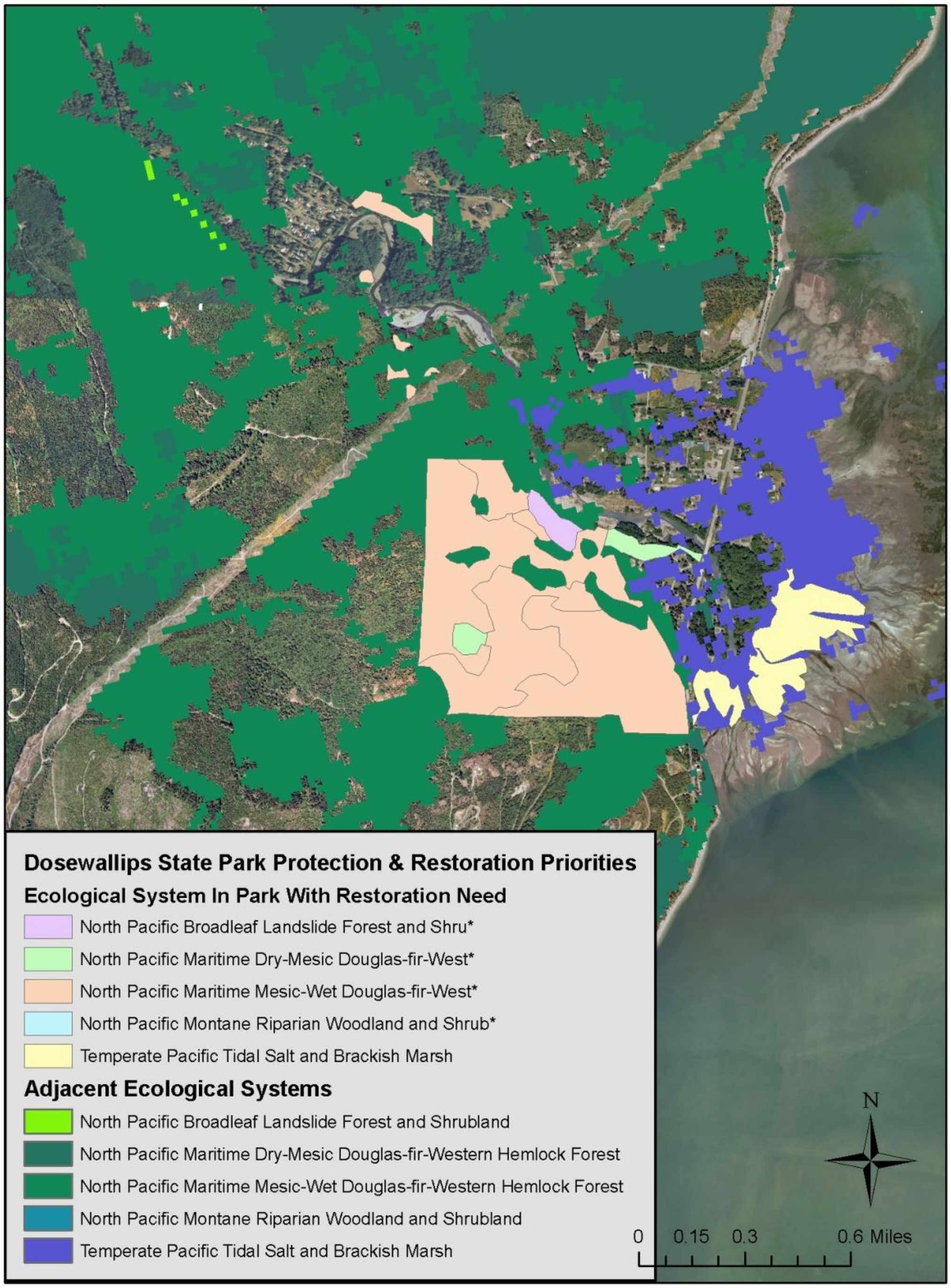

Figure 5. Acquisition Priorities to Improve Ecological Integrity of Restoration Priorities at Dosewallips State Park.

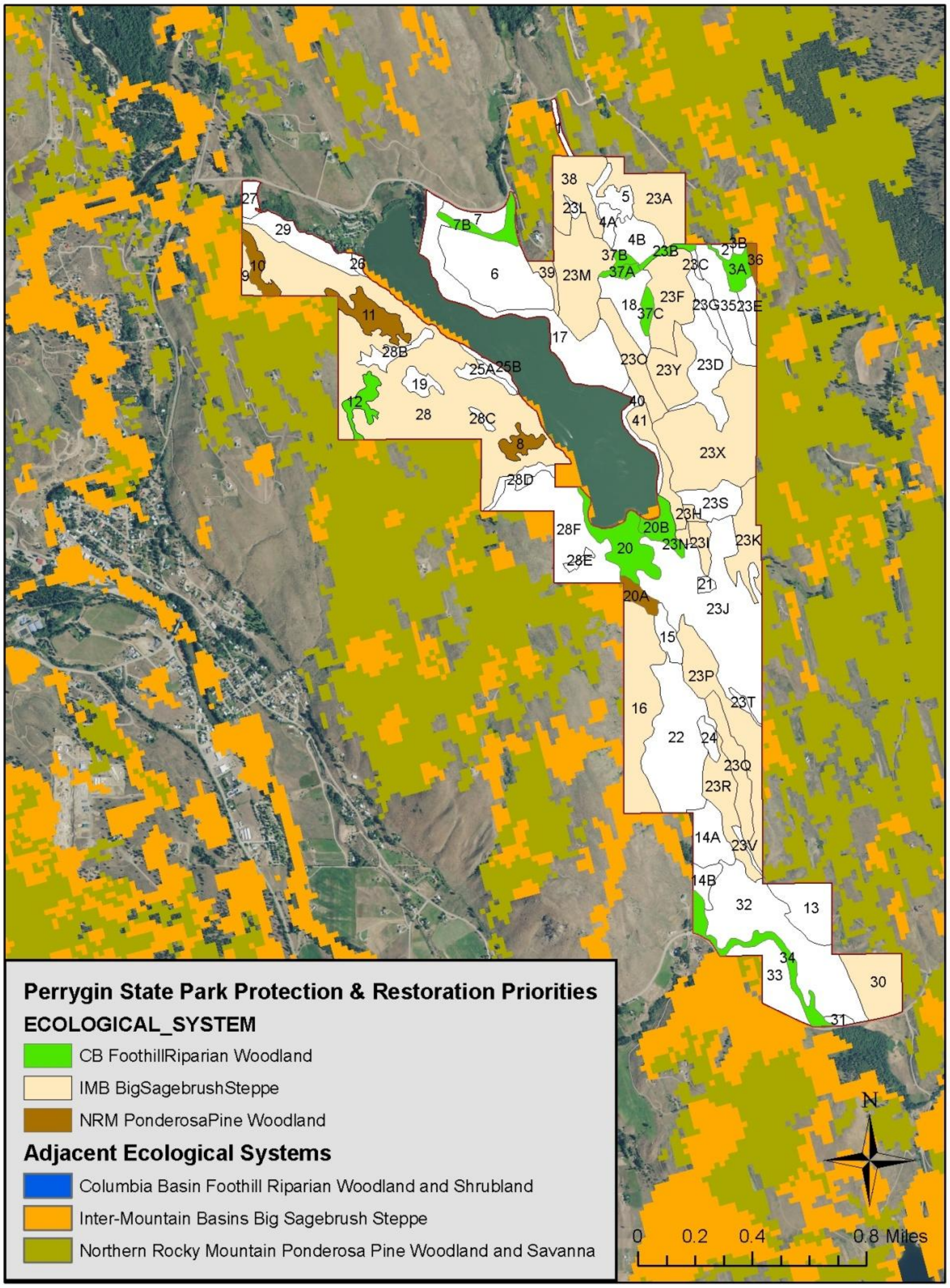

Figure 6. Acquisition Priorities to Improve Ecological Integrity of Restoration Priorities at Pearrygin State Park.

4.0 Discussion

4.1 Discussion of ability to Use Existing Data to Calculate EIA Ranks

The time constraints created by the amount and diversity of information from 120 previously mapped State Parks did not allow calculation of Landscape Context and Relative Size metrics. However, these can be calculated using GIS. The only landscape metric calculated was the Absolute Size metric estimated from polygon size. Of the 49 Vegetation Condition metrics, 18 metrics could be estimated using 29 state parks attributes, 13 metrics could be estimated with GIS analysis, 16 metrics could be estimated with photo-interpretation, and 2 metrics will require new site inventory. Only 38% of EIA Condition metrics were calculated due to insufficient information in the existing Park dataset. A few Vegetation Condition metrics, Species Composition, Percent Cover of Native Understory species and Percent Cover of Invasive Species, were common to most EIAs.

The Soil_Surface_Condition metric was common to most EIAs and was estimated from several land-use rating scales. At Dosewalips and Pearrygin State Parks, these basic measures of ecological condition showed high disagreement between automated and field-based calculations (Rocchio and Crawford 2010). This is somewhat of concern since they are some of the most important and often only measure of Condition within any given polygon. In the pilot study, this disagreement was also expressed in overall disagreement of the Condition Rank Factor ranks, although disagreement at this level was only once outside the range of acceptability (i.e. varied by more than two ranks).

Variation in metric ratings reflects differences in the how they were scored between the park data and the EIA. For example, some cover data was collected in cover classes (i.e. 1-5% and 6-25%) while EIA metrics were often rated based on a different cover class scale (i.e. <10%, 11-20% and >20% native plant cover). In other situations, the Park data was surrogate data for calculation of EIA metrics but was not a direct analogue to the EIA metric. For example, total cover of exotics species (a Park data attribute) was used as a surrogate measure of cover of invasive species (an EIA metric) even though the latter is a subset of the former. Other possible sources of error are different years of sampling, different contractors collecting data, unclear definition of "exotic", season of sampling (i.e., plant phenology) and survey routes of polygons. Each metric's degree of relationship to the park data used in its estimation is discussed in the metadata.

4.2. Strengths and Weakness of EIA-Framework for State Park Priority Setting

The EIA-framework presented here provides a systematic process for synthesizing existing large datasets into management priorities for the State Park System. Another strength of the EIA-framework is that it is a nationally recognized approach for assessing ecological condition and is being used for prioritizing management actions at a variety of scales by various land management organizations such as Washington Department of Fish and Wildlife (Rocchio and Crawford 2009), U.S. Environmental Protection Agency (Faber-Langendoen et al. 2008; Vance et al. *In Progress*), and U.S. National Park Service (Tierney et al. 2009). The prioritization scheme presented here also utilizes other existing data (WNHP's rare plant occurrences and WDFW's Priority Species) to ensure that Park priorities are considered in light of these irreplaceable resources.

As summarized in Rocchio and Crawford (2010) the "weakness of the approach presented here is the heavy dependence on State Parks' vegetation community and rare plant survey datasets that was were collected for slightly different objectives than assessing ecological integrity. For example, polygons were delineated based on different criteria than would be most useful for applying the EIA. As such, the Size metric ratings are difficult to apply. The cover classes used in the existing Park dataset were developed for different analytical purposes than rating metrics of ecological integrity. This has created some errors in cross-walking Park data value into EIA ranks. Although the errors do not appear to result in dramatic differences from field-based data, they are widespread enough to warrant caution about use of the resulting priorities without some additional assessments prior to implementing the recommend action. That is, the EIA-based prioritization framework presented here should be viewed as an important coarse-level assessment. Results from this process are intended to be used as an initial filter / identifier of protection priorities and restoration needs. Prior to implementing these management actions, State Park personnel should conduct on-site assessments to confirm and fine-tune protection and restoration needs." The pilot project field validation at Dosewalips and Pearrygin State Parks did encounter some mapping and classification inaccuracies and data management that points to the need specific on-site evaluation as needed.

Even with the limitations discussed above the single geodatabase of all the Park shapefiles (and associated data) provide a convenient means to assess natural resource priorities and needs at each park. The standardization of attributes (fields) allow for some comparison across parks. The attributes that were used in the analysis have a standardized set of values reducing the need to refer to individual park reports for clarification of map attributes.

5.0 Conclusion

The EIA-framework enables Washington State Parks and Recreation Commission to utilize existing data in order to determine restoration and protection priorities across the 120 State Parks. However, due to known and unknown human-caused errors in the dataset the priorities identified using the EIA-framework should be considered coarse-level conclusions. Ideally, a thorough ground-truthing assessment would help identify errors with existing data. In the near term, this is limited by financial resources. Nonetheless, the EIA-framework described in this report provides a big-picture assessment of restoration and protection needs across the State Park system. These priorities are meant to focus Park managers to those areas in likely need of attention should be viewed as an initial coarse assessment.

The results of merging mapping projects from 120 State Parks and standardization of their 138 map attributes provide a basis **to determine the biological significance** at each mapped park using that existing data as well as a state perspective of their relative importance. The EIA framework summarizes a subset (29 attributes) of existing data into ranks indicating aspects of the condition and significance of biological resources in each park at the polygon layer. The significance of each of the 4030 polygons is largely based on the global and state conservation rank of 190 plant associations and their apparent condition. This project identified 34 plant associations of high conservation significance based on conservation rank on the surveyed parks.

The EIA framework provides a means **to prioritize areas for protection and/or restoration** by comparing all polygons across 120 State Parks. This was estimated by correlating polygons with plant associations of high biological significance with polygons estimated to have high ecological integrity as indicated by EIA ratings. This project identified 406 polygons with high ecological integrity, 629 with moderately high ecological integrity, 1185 with fair ecological integrity and 678 with low ecological integrity. Polygons that did not ecological integrity rating (1442) estimated included those without enough metrics to be ranked (12) and mostly polygons labeled as developed, highly disturbed, water or otherwise without an ecological system name.

The EIA framework provides a means **to identify parcels near parks** that will increase key size and landscape attributes for resource protection but was not implemented because GIS metrics could not be developed. The results of the project does provide the basis for identifying polygons at individual part that would best be evaluated for probable benefit from increased protection on adjacent land. The polygons or clusters of polygons with high protection / restoration potential near park boundaries represent possible candidate areas. These locations in association with land use/land cover maps or target habitat or species maps developed by Washington Department of Fish and Wildlife, Washington Natural Heritage, etc. will indicate areas for on-site evaluations.

The merging of 120 individual map projects into a single geodatabase provides the means **to identify gaps in existing data**. Existing EIA protocols for the 44 ecological systems that occur at State Parks included in this project address 49 rating metrics. Of those metrics, 18 metrics could be estimated using 29 state parks attributes and 18 metrics could be estimated with photo-interpretation or with additional site inventory indicating were data gaps may exist to address specific management needs.

Evaluation of individual metrics used in application of the EIA framework provides a means to **prioritize monitoring areas** and protocols. Inspection of metrics used in EIA ranking at specific sites indicates the possible status of specific condition indicators that could be used in monitoring trend in specific areas (Faber-Langendoen et al. 2006). On-site evaluation of the potential areas based on the EIA would point to what the best indicators are needed to monitor for the specific management needs.

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Appendix A. Main Table Metadata.

This appendix lists the attributes found in almost all individual park mapping projects. A subset of these attribute (fields) were used in EIA calculation and are indicated in the descriptions as INPUT. "**Non-standardized**" means the original data as recorded by each contractor appears in that field. Comparison of non-standard information or its interpretation across parks needs at least a perusal of the appropriate contractor reports. "**Standardized**" means that values in that field have been standardized to comparable values. Each field description indicates when the original value recorded was changed for standardization.

KEYLINK
Text field.
Unique polygon label (park name and sequential number, i.e. AltaLake_1)

LOCATION
Text field, Non-Standardized values.
Narrative information on location in park

COVER_ESTIMATOR
Text field, Standardized values.
Two values: "CLASSES" indicates that cover estimates recorded as code in the table below.

Code	Cover (percent)	Cover (mid-point)
0	0	0
1	<1	0.5
2	1–5	3
3	5–25	15
4	25–60	43
5	60–90	75
6	>90	95

"PERCENT" indicates cover estimates are to the nearest percent between 1 and 100. In EIA metrics, mid-points were used in threshold determinations.

TOT_VEG_COV
Numeric field, Standardized values. INPUT
Total vegetation cover is the cover of all vascular plants, mosses, lichens, and foliose lichens (crustose lichens excluded – they are considered rock) of the polygon as seen from above. This never exceeds 100%. Space between leaves/branches is included in "cover." Cover estimate is CLASS or PERCENT. This is common field for eight field names in original data, for example TOT_VEG, TOTAL_VEG, TotalVeg.

TOT_TREE_COV
Numeric field, Standardized values. INPUT
Cover estimate of all trees in polygon as CLASS or PERCENT. This is common field for seven field names in original data, for example TreesTotal, TREES_TOT, TREES_TTL.

DOM_TREES
Text field, Non-Standardized values.
Dominant tree species listed, assumed in order of abundance. Species were recorded using different coding methods, typically a four-letter abbreviation, such as "ALRU" and "ALRU2" for *Alnus rubra* or red alder. This is common field for five field names in original data, for example Trees, DOM_TREES, TREE_SPP, and was not recorded in all projects.

EMERGENT_COV
Numeric field, Standardized values. INPUT
Cover estimate of the tallest trees in polygon as CLASS or PERCENT. This is common field for names in original data field names, EMERGENT and EMERGENT_2.

MAIN_CANOPY_COV
Numeric field, Standardized values. INPUT
Cover estimate of mid canopy usually most of the trees in polygon as CLASS or PERCENT. This is common field for eight names in original data.

SUBCANOPY_COV
Numeric field, Standardized values. INPUT
Cover estimate of all trees below main canopy in polygon as CLASS or PERCENT. This is common field for four names in original data.

TOT_SHRUB_COV
Numeric field, Standardized values. INPUT
Cover estimate of all shrubs in polygon as CLASS or PERCENT. This is common field for six names in original data.

DOM_SHRUBS
Text field, Non-Standardized values.
Dominant shrub species (can include broadleaf tree seedling) listed, assumed in order of abundance. Species were recorded using different coding methods, typically a four-letter abbreviation, such as "ALRU" and "ALRU2" for *Alnus rubra* or red alder. This is common field for five field names in original data and was not recorded in all projects.

TALL_SHRUB_COV
Numeric field, Standardized values.
Cover estimate of all shrubs over 1.5 feet tall in polygon as CLASS or PERCENT. This is common field for eleven names in original data.

SHORT_SHRUB_COV
Numeric field, Standardized values.
Cover estimate of all shrubs fewer than 1.5 feet tall in polygon as CLASS or PERCENT. This is common field for eleven names in original data.

TOT_GRAM_COV
Numeric field, Standardized values. INPUT

Cover estimate of all grasses, sedges and other grass-like plants in polygon as CLASS or PERCENT. This is common field for eight names in original data.

DOM_GRAM
Text field, Non-Standardized values.
Dominant grasses, sedges and other grass-like plants species listed, assumed in order of abundance. Species were recorded using different coding methods, typically a four-letter abbreviation, such as “HECO26”, “STCO2” and “STCO4” for *Hesperostipa comata (Stipa comata)* or needle-and-threadgrass. Descriptive or common names (e.g. annual bromes) can appear. This is a common field for six field names in original data and was not recorded in all projects.

PERR_GRAM_COV
Numeric field, Standardized values. INPUT
Cover estimate of all perennial grasses, sedges and other grass-like plants in polygon as CLASS or PERCENT. This is common field for seven names in original data.

ANN_GRAM_COV
Numeric field, Standardized values. INPUT
Cover estimate of all annual and biennial grasses, sedges and other grass-like plants in polygon as CLASS or PERCENT. This is common field for eight names in original data.

TOT_FORBS_COV
Numeric field, Standardized values. INPUT
This is a cover estimate of all herbaceous broadleaf plants (can include evergreen ground cover plants) in polygon as CLASS or PERCENT. This is common field for seven names in original data.

DOM_FORBS
Text field, Non-Standardized values.
Dominant herbaceous broadleaf plant (can include evergreen ground cover plants) species listed, assumed in order of abundance. Species were recorded using different coding methods, typically a four-letter abbreviation, such as “ACMI” and “ACMI2” for *Achillea millefolium* or yarrow. Descriptive or common names (e.g. WEEDS) can appear. This is a common field for five field names in original data and was not recorded in all projects.

PERR_FORBS_COV
Numeric field, Standardized values.
Cover estimate of all perennial herbaceous broadleaf plants in polygon as CLASS or PERCENT. Inspection DOM_FORBS species list indicates that this cover estimate can include evergreen ground cover plants depending on contractor surveyor. This is common field for eight names in original data.

ANN_FORBS_COV
Numeric field, Standardized values.
Cover estimate of all annual and biennial herbaceous broadleaf plants in polygon as CLASS or PERCENT. This is common field for seven names in original data.

FERNS_TOTAL_COV
Numeric field, Standardized values. INPUT

Cover estimate of all fern and fern allies in polygon as CLASS or PERCENT. This is common field for four names in original data. Not all projects have this field and those cases, ferns are included in FORB fields. A subset of PBI contractor surveys without FERNS_TOTAL_COV values were recorded by summing FERNS_EVER_COV and FERNS_DEC_COV into FERNS_TOTAL_COV.

FERNS
Text field, Non-Standardized values.
Dominant fern and fern allies listed by a subset of PBI contractor surveys (16 parks) and ferns, wetland, aquatic and other plant species list in Dominant_2 by all URS contractor surveys . Species were recorded using different coding methods, typically a four-letter abbreviation, such as "ATFI" for *Athryium filx-femina* or lady-fern. Descriptive or common names (e.g. skullcap which is not a fern or fern ally) can appear. This is a common field for two field names in original data and was not recorded in all projects and in many of those recorded there appear to be confusion or inconsistent listing of ferns and wetland and aquatic plants.

FERNS_EVER_COV
Numeric field, Standardized values.
Cover estimate of all evergreen fern and fern allies in polygon as CLASS or PERCENT. This is common field for five names in original data. Not all projects have this field and those cases, ferns are included in FORB fields.

FERNS_DEC_COV
Numeric field, Standardized values.
Cover estimate of all herbaceous fern and fern allies in polygon as CLASS or PERCENT. This is common field for six names in original data. Not all projects have this field and those cases, ferns are included in FORB fields.

TOT_EXOTIC_COV
Numeric field, Standardized values. INPUT
Cover estimate of all non-native species in polygon as CLASS or PERCENT. This is common field for ten names in original data. A subset of URS contractor surveys lacked TOT_EXOTIC_COV but had PER_EXOTIC_COV and ANN_EXOTIC_COV values. These values were not summed because it was unclear if those values represented estimated cover class or proportion of TOT_EXOTIC_COV. As such, NATIVE_UNDERSTORY_SPECIES_COV in those polygons may under estimate actual influence of exotic plants.

PER_EXOTIC_COV
Numeric field, Standardized values.
Cover estimate of all perennial non-native species in polygon as CLASS or PERCENT. This is common field for nine names in original data.

ANN_EXOTIC_COV
Numeric field, Standardized values.
Cover estimate of all annual or biennial non-native species in polygon as CLASS or PERCENT. This is common field for ten names in original data.

NOXIOUS
Text field, Non-Standardized values.
Dominant exotic species on a "noxious weed" list are listed, assumed in order of abundance. Species were recorded using different coding methods, typically a four-letter abbreviation, such

as “ACRE3” for *Acroptilon repens* (*Centaurea repens)* or Russian knapweed. This is a common field for five field names in original data and was not recorded in all projects.

PRMRY_EXOT
Text field, Non-Standardized values.
Dominant exotic species are listed, assumed in order of abundance. Species were recorded using different coding methods. This is a common field for eight field names in original data and was not recorded in all projects.

SCNDRY_EXO
Text field, Non-Standardized values.
Secondary exotic species are listed, assumed in order of abundance. Species were recorded using different coding methods. This is a common field for eight field names in original data and was not recorded in all projects.

OTHEREXO
Text field, Non-Standardized values.
This is an alternate list of exotic species that could be merged with the SCNDRY_EXO field. Species were recorded using different coding methods. This is a field name in the original data and was recorded in seventeen projects.

WATER_COV
Numeric field, Standardized values.
Percent cover of water in the polygon at time of survey as seen from above. This added to ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is a common field for two field names in original data.

ROCK_OUTCR_COV
Numeric field, Standardized values.
Percent cover of bedrock or rock over 1 meter across in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is a common field for seven field names in original data.

GRAVEL_COV
Numeric field, Standardized values.
Percent cover of gravel and cobble in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is the field name in all original data.

BARE_GRND_COV
Numeric field, Standardized values.
Percent cover of exposed sand and finer mineral soil in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is a common field for four field names in original data.

MOSS_LICHE_COV
Numeric field, Standardized values.

Percent cover of non-vascular plants on the soil surface in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, LITTER_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is a common field for six field names in original data.

LITTER_COV
Numeric field, Standardized values.
Percent cover of dead and decomposing organic material (litter, branches, and logs) and basal area of plants in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, TALUS_COV, CAVES_COV, and MINES_COV total to 100%. This is a field name in all original data.

TALUS_COV
Numeric field, Standardized values.
A subset of Rock this is the percent cover of talus on slope in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, CAVES_COV, and MINES_COV total to 100%. This is the field name in original data and was not recorded in all projects.

CAVES_COV
Numeric field, Standardized values.
Percent cover of caves in the polygon at time of survey as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, and MINES_COV total to 100%. This is the field name in original data and was not recorded in all projects.

MINES_COV
Numeric field, Standardized values.
Percent cover of mines in the polygon as seen from above. This never exceeds 100%. This added to WATER_COV, ROCK_OUTCR_COV, GRAVEL_COV, BARE_GRND_COV, MOSS_LICHE_COV, LITTER_COV, TALUS_COV, and CAVES_COV total to 100%. This is the field name in original data and was not recorded in all projects.

LOGGING
Text field, Non-Standardized values.
Coded values, listed below, as recorded in the original survey that indicate the amount of tree removal in the polygon. Text comments are present. This is a common field for two field names in original data.

1 = unlogged, no evidence of past logging or occasional cut stumps not part of systematic harvest of trees, no or very little impact on stand composition

2 = selectively logged: frequent cut stumps but origin of dominant or co-dominant cohort appears to be natural disturbance

3 = heavy logging disturbance with natural regeneration: many cut stumps that predate the dominant or co-dominant cohort with no tree planting

4 = tree plantation: dominant cohort appears to be planted after clearcutting

LOGGING_EIA
Text field, Standardized values. INPUT
Coded values edited into standardized values for EIA calculation indicating the amount of tree removal in the polygon. Comments in fields allowed for standardizing codes 0 (scattered old stumps) and 2 (ONLY IN PART) and 2 (patches of salvage logging) and 5 (logged a long time a = 2, 3 (and/or bur and 2-3 and LOGGED = 3 and "?" = "null". Multiple codes were lumped into the category with most tree removal, i.e. original "2/3" is listed as "3".

1 = unlogged, no evidence of past logging or occasional cut stumps not part of systematic harvest of trees, no or very little impact on stand composition

2 = selectively logged: frequent cut stumps but origin of dominant or co-dominant cohort appears to be natural disturbance

3 = heavy logging disturbance with natural regeneration: many cut stumps that predate the dominant or co-dominant cohort with no tree planting

4 = tree plantation: dominant cohort appears to be planted after clearcutting

STAND_AGE
Text field, Non-Standardized values.
Coded values, listed below, indicate the age or stand structure of the polygon. Text comments are present. This is a common field for two field names in original data.

1 = very young, 0–40 years

2 = young, 40–90 years

3 = mature, 90–200 years

4 = old growth, 200+ years

5 = young with scattered old trees, (2–10 trees per acre)

6 = mature with scattered old trees

STAND_STRUCT_EIA
Text field, Standardized values. INPUT
Coded values, listed in STAND_AGE and edited into standardized values for EIA calculation, indicate the age or stand structure of the polygon. Multiple codes were lumped into new categories of stand structure listed below, i.e. original data"2,3" is listed as "8". Values 7-9 are synthetic and cannot be applied across all parks.

1 = very young, 0–40 years

2 = young, 40–90 years

3 = mature, 90–200 years

4 = old growth, 200+ years

5 = young with scattered old trees, (2–10 trees per acre)

6 = mature with scattered old trees

7 = young multi-age (young with very young)

8 = mature multi-age (mature with young and/or very young)

9 = old multi-age (old-growth with mature and/or young and/or very young)

AGRICULTURE
Text field, Non-Standardized values.
Coded values, listed below, indicate the type of vegetation cropping or harvesting is apparent in the polygon. Text comments are present. This is a common field for two field names in original data.

1 = active annual cropping

2 = active perennial herbaceous cropping

3 = active woody plant cultivation

4 = fallow, plowed no crops this yr

5 = CRP

6 = other

AGRICULTURE_EIA
Text field, Standardized values. INPUT
Coded values, listed in AGRICULTURE and edited into standardized values for EIA calculation, indicate the type of vegetation cropping or harvesting apparent in the polygon. Comments in fields allowed for standardizing codes 0 (note! Farming with GIS BND)=null, ACTIVE =1, 1 (parts are currently mowed by adj. farmer) and 1 (mowed field and 6 (ALFALFA FIELD) =2, (6 former field, OLD FIELD, OLD) were used to create a new code listed below, i.e. 2,3 listed as 8. This additional code “8” is synthetic and cannot be applied across all parks.

1 = active annual cropping

2 = active perennial herbaceous cropping

3 = active woody plant cultivation

4 = fallow, plowed no crops this yr

5 = CRP

6 = other

7 = Old Field left fallow for several years

LIVESTOCK
Text field, Non-Standardized values.
Coded values, listed below estimates the degree of use by domestic animal in the polygon. Text comments are present. This is a field name in the original data.

1 = active heavy grazing (most forage used to ground soil compaction or churning)

2 = active moderate grazing (25-75% forage used)

3 = active light grazing (abundance previous yr’s litter)

4 = no current, heavy past grazing

5 = no current, light past grazing

6 = no obvious sign of grazing

LIVESTOCK_EIA
Text field, Standardized values. INPUT
Coded values, listed in LIVESTOCK and edited into standardized values for EIA calculation, estimate the degree use by of domestic animal apparent in the polygon. Comments in fields allowed for standardization of codes “?” = “null”, ACTIVE and GRAZED ACTIVE and GRAZED = 2 and 3 (active grazing in places) and 3 CATTLE HERE IN SPRING and SOME GRAZING COW & HORSE SHIT = 3.

1 = active heavy grazing (most forage used to ground soil compaction or churning)

2 = active moderate grazing (25-75% forage used)

3 = active light grazing (abundance previous yr’s litter)

4 = no current, heavy past grazing

5 = no current, light past grazing

6 = no obvious sign of grazing

DEVELOPMENT
Text field, Non-Standardized values.
Coded values, listed below, the degree of human structural and landscaping in the polygon. Text comments are present. This is a common field for four field names in original data.

1 = actively used facilities

2 = roads

3 = established trails

4 = abandoned facilities

5 = none obvious

6 = multiple types

DEVELOPMENT_EIA
Text field, Standardized values. INPUT
Coded values, listed in DEVELOPMENT and edited into standardized values for EIA calculation, estimates the degree of human structural and landscaping in the polygon. Comments in fields allowed for standardizing codes all values with comments beginning with 1=1, beginning with 2=2, beginning with 3=3, beginning with 4=4,
6 - campground and parking/recreational and 6 - water treatment plant and parking l and, 6 (house, road), 6 (HOUSES NEAR), 6 (paved trail, interstate, powerlines, lights, packing plant), 6 (road, house, 6 (road, house), 6 (roads, bathrooms) , 6 (roads, campground, facilities, trails), 6 (roads, power lines, small fort) , 6 (roads, trails, facilities, parking lot), 6 (SUBURBAN NEIGHBORHOOD AND ROAD), 6 (trail, picnicing), 6 (trash, tires, deer parts, outhouse, campground , 6, buildings and roads, 6, campground, roads, trails, 6, house, road at edge, la, 6 houses, roads, lawns, 6, powerline, trails, campground, 6, railroad, footpaths, picnic spots, 6, road, campground extends into polygon on S, 6, roads, active facilities, etc., 6, roads, ranger's house, 6, septic field, roads, houses, 6, trails, homest, 6, transmission line crosses polygon & TV an, 6 (created wetlands; trail; fence), 6, beach duelling, trail, 6 (powerline swath thru - bulldozed, highway below), 6 (powerlines, lots of disturbance), 6 (roads, power lines), 6 (roads, trails, powerline), 6 (transmission lines), DUMP SITE, ROADS, 5 (roads, houses) = 1,
6 - roads/trails and, 6 (abandoned facilities, roads, 6 (road, houses nearby), 6 (ROADS, HOUSES NEARBY), 6 (BRIDGE), 6 (roads & mowed field), 6 (roads and trails). 6 (roads, trails, surrounding housing development North and East boundaries, 6 RAILBED, 6 TRAIL, RAILBED, 6, camping/trails, 6, trails, roads, “D”, DISTUBED, DISTURBED, FARMED FROM RAIL BED, 5 (ORV trails) = 2,
6 (heavily used trail adjacent), 6 (old rail bed, current trail, other disturbances, fences), 6 (paved trail, mowing), 6 (paved trail, RR, powerlines), 6 (trails & powerline), 6 (trails, area dredged?), 6 trails, pipeline, 6 (beach), 6, walkers, swimmers, small boat activity, TRAIL, TRAILS, TRIAL, TRAL = 3
6 (1, 2, 3), 6 (2, 3), ALL, MULTIPLE= 6
5; NEAR PRIVATE PROPERTY= 5
6 FENCE and 6 (fence) = “null”
6 (dam, reservoir), 6 (impoundments), 6 (reservoir), 6 (riprap), Antificial ponds, CAMPGROUND AND RESERVOIR, 5, lake created by evacuation and dredging were used to create a new code ‘7’ listed below. This additional code was defined after surveys and cannot be applied across all parks.

1 = actively used facilities

2 = roads

3 = established trails

4 = abandoned facilities

5 = none obvious

6 = multiple types

7 = Hydrologic developments (created channels, ponds, reservoir)

WILDLIFE
Text field, Non-Standardized values.
Coded values, listed below, the list observation of wildlife use in the polygon. Text comments are present. This is a field name in original data.

1 = heavy ungulate use

2 = moderate ungulate use

3 = light to no ungulate use

4 = burrowing animals

5 = active beaver

6 = active porcupine

7 = other, list animal

REC_SEVERITY
Text field, Non-Standardized values.
Coded values, listed below, estimate degree of site disturbance from recreational activity in the polygon. Text comments are present. This is a common field for ten field names in original data.

1 = heavy use, abundant soil and vegetation displacement off trail/road

2 = moderate use, frequent soil and vegetation displacement off trail/road

3 = light use, little sign of activity off trail/road

REC_SEVERITY_EIA
Text field, Standardized values. INPUT
Coded values, listed in REC_SEVERITY and edited into standardized values for EIA calculation, estimate the degree of site disturbance from recreational activity apparent in the polygon. Comments in fields allowed for standardizing codes all values with comments beginning with 1=1, beginning with 2=2, and beginning with 3=3.

1 = heavy use, abundant soil and vegetation displacement off trail/road

2 = moderate use, frequent soil and vegetation displacement off trail/road

3 = light use, little sign of activity off trail/road

REC_TYPE
Text field, Non-Standardized values.
Coded values, listed below, categorize predominant recreation in the polygon. Text comments are present. This is a common field for six field names in original data.

1 = wheeled

2 = hoofed

3 = boots

4 = combination of above

5 = other

HYDROLOGY
Text field, Non-Standardized values.
Coded values, listed below, categorize if hydrology alteration was apparent in the polygon. Text comments are present. This is a field name in original data.

1 = unaltered

2 = altered; dams, dikes, ditches, culverts, etc

3 = not assessed

HYDROLOGY_EIA
Text field, Standardized values. INPUT
Coded values, listed in HYDROLOGY and edited into standardized values for EIA calculation, categorize if hydrology alteration was apparent in the polygon or not. Comments in fields allowed for standardizing codes all values with comments beginning with 1as 1, beginning with 2 as 2, beginning with 3 as 3, and 4 WATER TABLE ROSE DUE TO RESERVOIR and values beginning with 5 as “null”.

1 = unaltered

2 = altered; dams, dikes, ditches, culverts, etc

3 = not assessed

FIRE
Text field, Non-standardized.
Text comments describing fire history and other indication of fire frequency and/or intensity. This is a common field for two field names in original data.

ECOLOGICAL_SYSTEM
Text field, Standardized values. INPUT
Most abundant ecological system in the polygon is listed in this field. Based on plant association(s) abundance in the polygon, ecological system was assigned from association-system

relationships in Rocchio and Crawford (2008) and NatureServe Explorer: http://www.natureserve.org/explorer/). Plant associations that are not in the literature or in WNHP's classification were assigned to an Ecological System from site information and other compositional data provided in each park report based on best professional judgment. Polygons not assigned a plant association by the contactor were assign ecological system if enough descriptive information was present. In general, polygons that were attributed as over two-thirds weedy, old field, developed or otherwise modified by human activities were assumed to be ruderal (novel) systems, developed or cultivated vegetation and not assign a system name, therefore not in EIA evaluation. Parks located in mountainous regions within a forest zone were assumed to have montane riparian/wetland systems rather than lowland ecological systems. Parks with coastal dune herbaceous or shrub-dominated wetlands assumed to be Interdunal wetlands, whereas, tree-dominated wetlands and fen and bog plant associations in dunes area are not included in the interdunal wetland ecological system. Where possible to determine from associated data, all upland *Alnus rubra/Polystichum munitum* association labeled polygons are included in North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest system and the remaining were included in riparian systems. Polygons assigned ARTR4/POSE by contractors are assumed to be degraded and are assigned to Inter-Mountain Basins Big Sagebrush Steppe system.

NVC_OR_NHP_ASSOCIATION
Text field, Standardized values. INPUT
This field lists coded values (standardized plant association acronyms) of the most abundant plant association (PA1 through PA5) in the polygon derived from PERCENT1 through PERCENT5 fields. A list of standard plant association names is needed from the diversity of names assigned in the existing park data for comparisons. Plant associations from most surveys were referenced to classification publications, to names supplied by WNHP or NatureServe Explorer. Original Park data listed plant associations as acronyms and because a variety of naming approaches were used by contractors, plant associations acronyms were standardized into four-letter USDA plants codes. For example, the *Artemisia tridentata* ssp. *wyomingensis / Pseudoroegneria spicata* association is standardized in the as ARTRW8/PSSP6 was recorded as ARTR2/PSSP6, ARTR2/PS, ARTR2/PSSP6 (CRAWFORD), etc in original data. Some plant associations were determined by inspection of existing vegetation information (EXISTVEG field) in combination with the non-standard plant association name provided by contractor, in other words, plant association designation maybe broader than the described IVC or WNHP concept. Crosswalk of PA1 through PA5 was liberal, that is, based on best professional judgment, PA names, associated species or site information that appeared to be a condition variant of an accepted plant association were listed as the accepted name rather than list of unique types.

EXISTVEG1, EXISTVEG2
Text fields, Non-standardized.
A subset of surveys by PBI contractor, lists non-standard land cover and existing vegetation types found in polygon. Vegetation reflects a combination of most dominant species in tree, shrub and herbaceous layers. Species in vegetation type names are recorded using different coding methods, typically a four-letter abbreviation, such as "ACMI" and "ACMI2" for *Achillea millefolium* or yarrow. Descriptive or common names (e.g. introduced trees) can appear. Vegetation naming follow the convention of separating lifeform by "/" and within lifeform by "-", for example, ALRU2/ATFI-ACMI2 is *Alnus rubra* (trees)/*Athryium filx-femina -Achillea millefolium* (co-dominant herbaceous species). Surveys by URS appear to similarly list dominance type vegetation (Plant_Asso) and are included in this field.

PA1, PA2, PA3, PA4, PA5

Text fields, Non-standardized.
These fields are plant association names as listed by contractor that were derived from Natural Heritage Program vegetation classifications or published (citable) vegetation classification or are dominance type vegetation given by the contractor. A subset of surveys by PBI lists plant association as the "potential vegetation" in parallel with EXISTVEG1and EXISTVEG2. Species in vegetation type names are recorded using different coding methods, typically a four-letter abbreviation, such as "ACMI" and "ACMI2" for *Achillea millefolium* or yarrow. Descriptive or common names (e.g. introduced trees) can appear. Vegetation naming follow the convention of separating lifeform by "/" and within lifeform by "-", for example, ALRU2/ATFI-ACMI2 is *Alnus rubra* (trees)/*Athryium filx-femina -Achillea millefolium* (co-dominant herbaceous species).

RANK1, RANK2, RANK3, RANK4, RANK5
Text fields, Non-standardized.
These are Standardized values of the surveyor's estimate of ecological condition (the degree of departure from an undisturbed state generally indicated by abundance of invasive and disturbance increaser species, presence of key indicator species and site factors such as soil disturbance) of the assessed plant association in the polygon. Plant association condition was recorded using different coding methods, typically on a three or four-scale rank.

RANK1_EIA, RANK2_EIA, RANK3_EIA, RANK4_EIA, RANK5_EIA
Text fields, Standardized. INPUT
These are Standardized values of the surveyor's estimate of ecological condition (the degree of departure from an undisturbed state generally indicated by abundance of invasive and disturbance increaser species, presence of key indicator species and site factors such as soil disturbance) on a four scale rank with intermediate ranks of the assessed plant association in the polygon. Condition rank was recorded using different coding methods (individual park reports) and is crosswalked to the standard NatureServe element occurrence (EO) rating system below (http://www.natureserve.org/prodServices/eodraft/all.pdf).

A excellent estimated viability

"A", EXCELLENT, "E", "3"

AB excellent to good estimated viability

"A/B"

B good estimated viability

"B", GOOD, "G"

BC good to fair estimated viability

"BC", "B/C", "2", "M", MODERATE, MEDIUM

C fair estimated viability

"C", FAIR

CD fair to poor estimated viability

“C/D”

D poor estimated viability

“D”, “D/F”, “3”, POOR, BAD

DF (non-standard NatureServe rank) poor to unknown estimated viability

“F”

DEVELOPED, OTHER OWNERSHIP = null

PERCENT1, PERCENT2, PERCENT3, PERCENT4. PERCENT5
Numeric fields, Standardized values. INPUT
Estimate percent cover of the assessed plant association in the polygon. This is a common field for four field names in original data.

PATTERN1, PATTERN2, PATTERN3, PATTERN4. PATTERN5
Text fields Non-standardized.
These fields are coded descriptions of the spatial arrangement of the assessed plant association within the polygon. This is a common field for four field names in original data. Coded numeric or text values as listed in table below or alternative descriptive text.

1 = matrix (most of polygon)

2 = large patches

3 = small patches

4 = clumped, clustered, contiguous

5 = scattered, more or less evenly repeating

6 = linear

7 = other

PA1NOTES, PA2NOTES, PA3NOTES
Text fields Non-standardized.
These fields contain additional information on the assessed plant associations with the polygon.

NOTES
Text field Non-standardized.
This field contains additional information on the assessed polygon, such as land use, wildlife, exotic species etc. might be applied to standardized fields. This is a common field for four field names in original data.

MASTER TABLE Fields and stateparks_veg

These are basic descriptive fields about each polygon in each State Park mapping project. **Non-standard** means the original data as recorded by contractor appears in that field. Comparison across parks or interpretation of that information needs at least s a perusal of the appropriate contractor reports. **Standardized** means that values in that field have been standardized to comparable values. Standardized field are used in EIA evaluations.

OBJECTID
Numeric field
Unique polygon number in geodatabase.

KEYLINK
Text field
Unique polygon label (park name and sequential number, i.e. AltaLake_1) that links all files in the geodatabase.

PARKCODE
Numeric field, Standardized values.
Unique park code provided by Washington State Parks and Recreation.

PARKNAME
Text field, Standardized values.
State Park name for mapping project.

REGION
Text field, Standardized values.
State Park Region provided by Washington State Parks and Recreation.

CONTRACTOR
Text field, Standardized values.
Contractor or entity responsible for original State Park mapping project list by abbreviations:

AB = Arnett and Beck
LYRA = Lyra and associates
MB = Methow Biodiversity
PBI = Pacific Biodiversity Institute
URS = URS
SEE = SEE Botanical

ID1, ID2
Text field, Non-standardized values.
Polygon identifiers assigned by original mapper that are cited in individual Park reports.

OBSERVER
Text field, Non-standardized values.
Initials of polygon surveyors listed in original mapping project in individual Park reports.

SURVEY_DATE
Text field, Standardized values.

Date of polygon survey from original mapping project.

SURVEY_YEAR
Text field, Standardized values.
Year of polygon survey derived from mapping project in individual Park reports.

SURVEY_INTENSITY
Text field, Standardized values.
Coded value of survey effort as listed in original mapping project in individual Park reports.

1 = walked or could see most of polygon (higher confidence)

2 = walked/saw part of polygon (moderate confidence)

3 = walked perimeter/minor portion of polygon viewed (low confidence)

4 = photo interpretation/remote survey

SURVEY_INTENSITY
Text field, Standardized values.
Coded value of survey effort as listed in original mapping project in individual Park reports.

LINK
Text fields, Non-standardized.
This is information from geodatabases provided by State Parks at beginning of project.

Appendix B. Four Ecological Integrity Assessments not located on-line Natural Heritage Program website

http://www1.dnr.wa.gov/nhp/refdesk/communities/eia.html.

North Pacific Montane Mesic Subalpine Parkland

Ecological Summary

The North Pacific Montane Mesic Subalpine Parkland system is a large patch system found in the Pacific Northwest coastal mountain ranges from the southern Cascades of Oregon to south-central Alaska. In Washington, it appears throughout the Olympic and Cascade Mountains as clumps of trees to small patches of trees or forest interspersed with low shrublands and meadows are characteristic at the subalpine forest-meadow ecotone. The elevation range of the system is typically located between 4,500 feet to 5,000 feet and can transition into alpine environment between 6000 and 7,000 feet (Crawford et al. 2009). Sites are typically on ridge crests, shoulders, and upper slopes.

The system occurs almost exclusively on the west side of the Cascade Mountains and in the Olympics where deep, late-lying snowpack, steepness of slope and temperature are important environmental factors (Zald 2010). The system is characterized by very deep, long-lasting snowpack that limits tree regeneration to favorable microsites (mostly adjacent to existing trees) or during drought years with low snowpack. Tree establishment is periodic depending on seed years, weather, climate and snowpack with sometimes hundreds of years between tree establishments (LANDFIRE 2007). Snow damage to trees, which was significant 500 years ago but now reduced under current climate, favors conversion of tree islands to meadows (LANDFIRE 2007). During milder wet cycles, tree islands can coalesce and convert parklands into a more closed forest habitat or can displace alpine conditions through tree invasions. A parkland today in Oregon was mostly un-forested in 1600,then slowly invaded by trees into the 1920's, and then rapidly invaded to 1980 (Zald 2010). Zald (2010) determined trees occurred in 8% of meadows in 1950 and increased to 35% in 2007.

Plant associations include woodlands, shrubland, and meadow types. LANDFIRE (2007) estimated that 95% of this landscape was dominated by non-forest dwarf-shrubs and meadows in pre-settlement period. Major tree species forming tree-islands in a meadow parkland landscape are dominated by *Tsuga mertensiana, Abies amabilis, Chamaecyparis nootkatensis*, and *Abies lasiocarpa*. Meadows among tree patches include a mosaic of *Phyllodoce empetriformis, Cassiope mertensiana*, and *Vaccinium deliciosum* dominated dwarf-shrublands and *Lupinus arcticus* ssp. *subalpinus, Valeriana sitchensis, Carex spectabilis*, and *Polygonum bistortoides* dominated meadows (Henderson et al. 1989, 1992).

There is very little disturbance, either windthrow or fire. Fire rarely occurs as lightning strikes in tree islands that may kill individual trees or tree clumps. These parklands function as fire breaks suppressing fires originating at lower elevations (LANDFIRE 2007).

The North Pacific Montane Mesic Subalpine Parkland system is distinguished from the interior mountain, drier/colder Northern Rocky Mountain Subalpine Woodland and Parkland primarily by the presence of *Tsuga mertensiana* or *Abies amabilis* and absence or paucity of *Pinus albicaulis* and *Larix lyallii*. Trees are more likely to be scattered individuals and fire is more important in the Northern Rocky Mountain system than in the North Pacific system.

Stressors

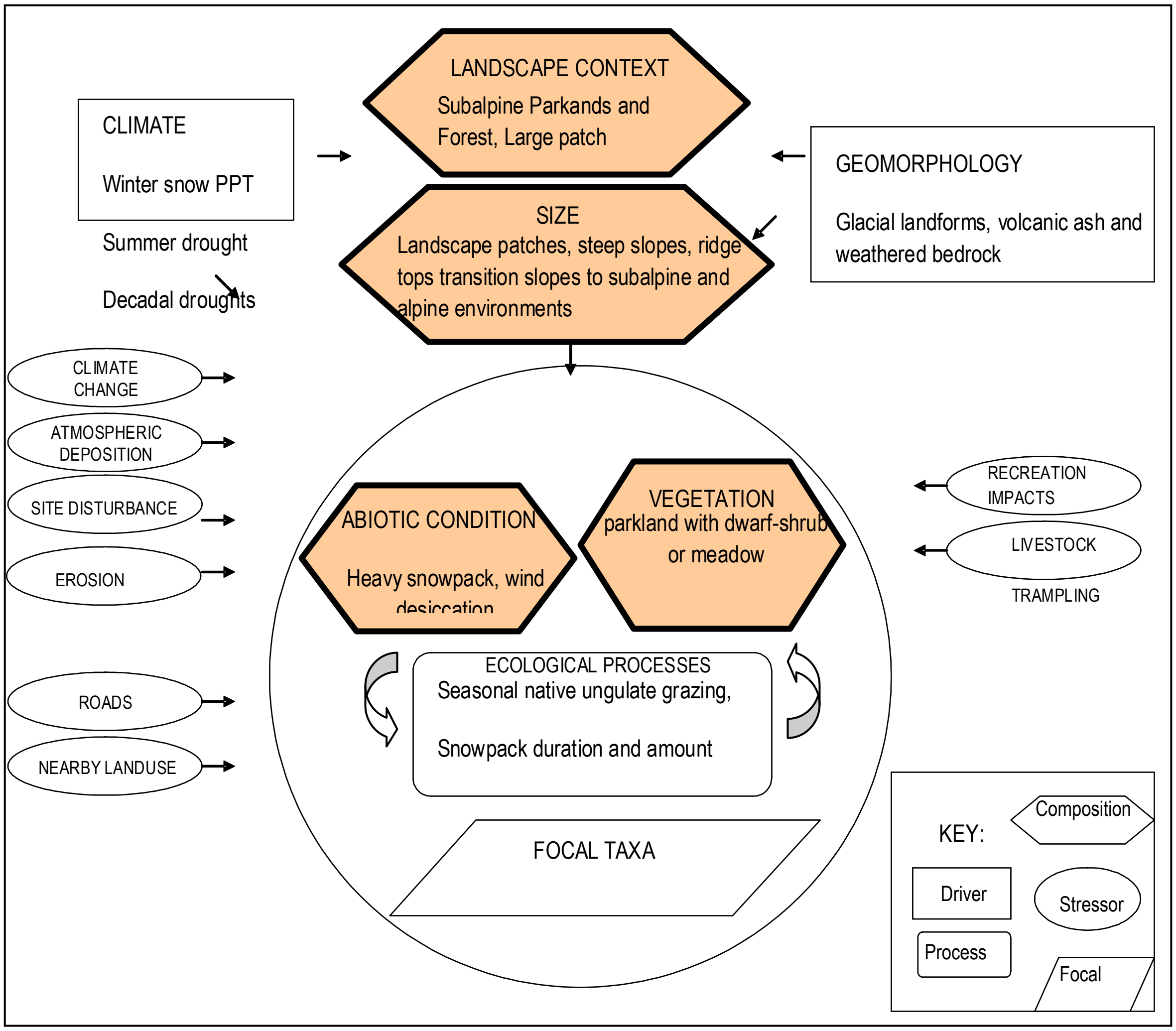
The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

The primary land uses that alter the natural processes of the North Pacific Montane Mesic Subalpine Parkland system are associated with exotic species and direct soil surface disturbance. Introduction of exotic ungulates can have noticeable impacts (e.g., mountain goats in the Olympic Mountains. Locally trampling and associated recreational impact can affect sites for decades or longer (Lilybridge et al 1995). Sites are natural low in timber productivity and in stocking rate such that remove of trees can have very long-lasting influence on ecological processes (Lilybridge et al 1995).

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the North Pacific Montane Mesic Subalpine Parkland System are presented in Figure 1.

Figure 1. Conceptual Ecological Model for the North Pacific Montane Mesic Subalpine Parkland Ecological System.



Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

Level 2 EIA

The following tables display the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas**. Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 4. North Pacific Montane Mesic Subalpine Parkland Ecological Integrity Assessment Scorecard

Metric	**Justification**	**Rank**			
		A (5 pts.)	**B (4 pts.)**	**C (3 pts.)**	**D (1 pts.)**
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Edge Effects*					
Edge Length	The intactness of the edge can be important to biotic and abiotic aspects of the site.	75 – 100% of edge is bordered by natural communities	50 – 74% of edge is bordered by natural communities	25 – 49% of edge is bordered by natural communities	< 25% of edge is bordered by natural communities
Edge Width		Average width of edge is at least 100 m.	Average width of edge is at least 75-100 m.	Average width of edge is at least 25-75 m.	Average width of edge is at least <25 m.

Edge Condition		>95% cover native vegetation, <5% cover of non-native plants, intact soils	75–95% cover of native vegetation, 5–25% cover of non-native plants, intact or moderately disrupted soils	25–50% cover of non-native plants, moderate or extensive soil disruption	>50% cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils
Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index > 0.8		Landscape Condition Model Index 0.79 – 0.65	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation*					
Relative Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Relative Cover of native plants 95-100%.	Relative Cover of native plants 80-95%.	Relative Cover of native plants 50 to 80%.	Relative Cover of native plants <50%.
Absolute Cover of Invasive Species	Invasive species, *Poa pratensis,* can inflict a wide range of ecological impacts.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).

Relative Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors such as *Achillea millefolium, Lupinus* spp., *Juncus parryi,*	Absent or incidental	<10% cover	10-20% cover	>20% cover
Species Composition Note: Once developed, the Floristic Quality Assessment index could used here instead.	The overall composition of native species can shift when exposed to stressors.	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.	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	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.	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.
Key Ecological Attribute: *Physicochemical*					

Soil Surface Condition	Soil disturbance can result in compaction, erosion thereby negatively affecting many ecological processes (Napper et al 2009)	**Soil-disturbance Class 0** Undisturbed • No evidence of past equipment. • No depressions or wheel tracks. • Forest-floor layers are present and intact. • No soil displacement evident. • No management-generated soil erosion. • No management-created soil compaction. • No management-created platy soils.	**Soil-Disturbance Class 1** • Wheel tracks or depressions evident, but faint and shallow. • Forest-floor layers are present and intact. • Surface soil has not been displaced. • Soil burn severity from prescribed fires is low (slight charring of vegetation, discontinuous). • Soil compaction is shallow (0 to 4 inches). • Soil structure is changed from undisturbed conditions to platy or massive albeit discontinuous.	**Soil Disturbance Class 2** • Wheel tracks or depressions are evident and moderately deep. • Forest-floor layers are partially missing. • Surface soil partially intact and maybe mixed with subsoil. • Soil burn severity from prescribed fires is moderate (black ash evident and water repellency may be increased compared to preburn condition). • Soil compaction is moderately deep (up to 12 inches). •Soil structure is changed from undisturbed conditions and may be platy or massive.	**Soil Disturbance Class 3** • Wheel tracks or depressions are evident and deep. • Forest-floor layers are missing. • Surface soil is removed through gouging or piling. • Surface soil is displaced. • Soil burn severity from prescribed fires is high (white or reddish ash, all litter completely consumed, and soil structureless). • Soil compaction is persistent and deep (greater than 12 inches). • Soil structure is changed from undisturbed and is platy or massive throughout.
Rank Factor: SIZE					
Key Ecological Attribute: ***Size***					
Relative Size	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)

Absolute Size	Large occurrences support a mosaic of plant associations likely to contain variability of biophysical gradients and natural disturbances.	Over 450 ha (1110 ac)	45-450 ha (110-1110 ac)	4.5-45 ha (10 -110 ac)	Less than 4.5 ha (10 ac)

Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- Fire Regime Condition Class standard landscape worksheet method (FRCC 2010)
-

4.?.5 Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

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Authorship: Rex Crawford, Washington Natural Heritage Program

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Northern Rocky Mountain Conifer Swamp

Ecological Summary

The Northern Rocky Mountain Conifer Swamp ecological system is dominated by coniferous trees in poorly drained environments with slowly moving or stagnant surface water. These swamps mostly are large to small-patch in the northern Rocky Mountains from northwestern Wyoming north into the Canadian Rockies and west into eastern Oregon and Washington. It occurs on benches, toeslopes or valley bottoms along mountain streams, sporadically in glacial depressions, around the edges of lakes and marshes, or on slopes with seeps. They are primarily found on flat to gently sloping in montane environments up to the lower limits of continuous forest (below the subalpine parkland). These sites are indicative of poorly drained, seasonally or permanently saturated mucky areas. The system may occur on steeper slopes where wet soils are shallow over unfractured bedrock. Groundwater or streams and creeks which do not experience significant overbank flooding are major hydrological drivers. Surface water may be slowly moving through the site or occur as stagnant pools. Accumulation of organic matter (woody peat or muck) can be important in some occurrences. Soils can be woody peat but are more typically muck or mineral soils often with a thin veneer of organic surface layers.

Windthrow creates canopy gaps and pit-mound topography which increases microsite diversity. Downed trees, root wads, and mounds provide suitable substrates for tree and shrub species that are not able to establish on saturated soils. Hollows created by windthrow are often dominated by species tolerant of saturated soil conditions. Canopy gaps create a diversity of light conditions in the swamp. Beaver activity might also occur in these swamps. This system experiences rare stand replacement fires (>200yrs+) (LANDFIRE 2007). The frequency of fire depends largely on fire in adjacent vegetation and swamp size is relative to the surrounding matrix (Kovalchik and others 2004).

These Northern Rocky Mountain swamps are dominated by *Thuja plicata, Tsuga heterophylla*, and *Picea engelmannii* that are capable of growing on saturated or seasonally flooded soils. The hardwood tree *Populus balsamifera* ssp. *trichocarpa* can rarely appear in these sites. Many shrubs are often found growing on elevated microsites, especially on downed trees and mound topography. On extremely wet sites, shrubs are often confined to higher microsites such as root wads, rotten logs, and root buttresses. Shrub species include *Oplopanax horridus, Ribes lacustre* and V*accinium membranaceum*. Herbaceous species, often dominate water-filled depressions sometimes created by windthrow. Common herbaceous species include *Athyrium filix-femina, Dryopteris* spp., *Lysichiton americanus, Equisetum* *arvense, Senecio triangularis, Mitella breweri, Mitella pentandra, Streptopus amplexifolius, Calamagrostis canadensis*, or *Carex disperma*.

Similar ecological systems include the North Pacific Hardwood and Conifer Swamp and the North Pacific Shrub Swamp systems, which are in wetter environments west of the Cascades. The Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland are also similar systems differing in that occur as a linear fringe along stream or river channels where exposure to overbank flooding is an important ecological driver.

Stressors

The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

Historic and contemporary use practices have impacted hydrologic, geomorphic, and biotic structure and function of conifer swamps in Washington. Adjacent and upstream land uses also have the potential to contribute excess nutrients, alter hydrology, and provide a vector for non-native species into this ecological system. Logging activities tend to reduce the amount of large woody debris and remove future sources of that debris. Logging also increases insolation of the soil surface resulting in higher temperatures, lower humidity, and more sunlight reaching the understory all of which can affect hydrological and nutrient processes and species composition. Timber harvest can also alter hydrology, most often resulting in post-harvest increases in peak flows. Logging can also result in mass wasting and related disturbances (sedimentation, debris torrents) in steep topography increase in frequency with road building and timber harvest. Increases in nutrients and pollutants are other common anthropogenic impacts. Exotic species can occur. This system has also decreased in extent due to agricultural development, roads, dams and other flood-control activities.

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with this system are presented in Figure 1.

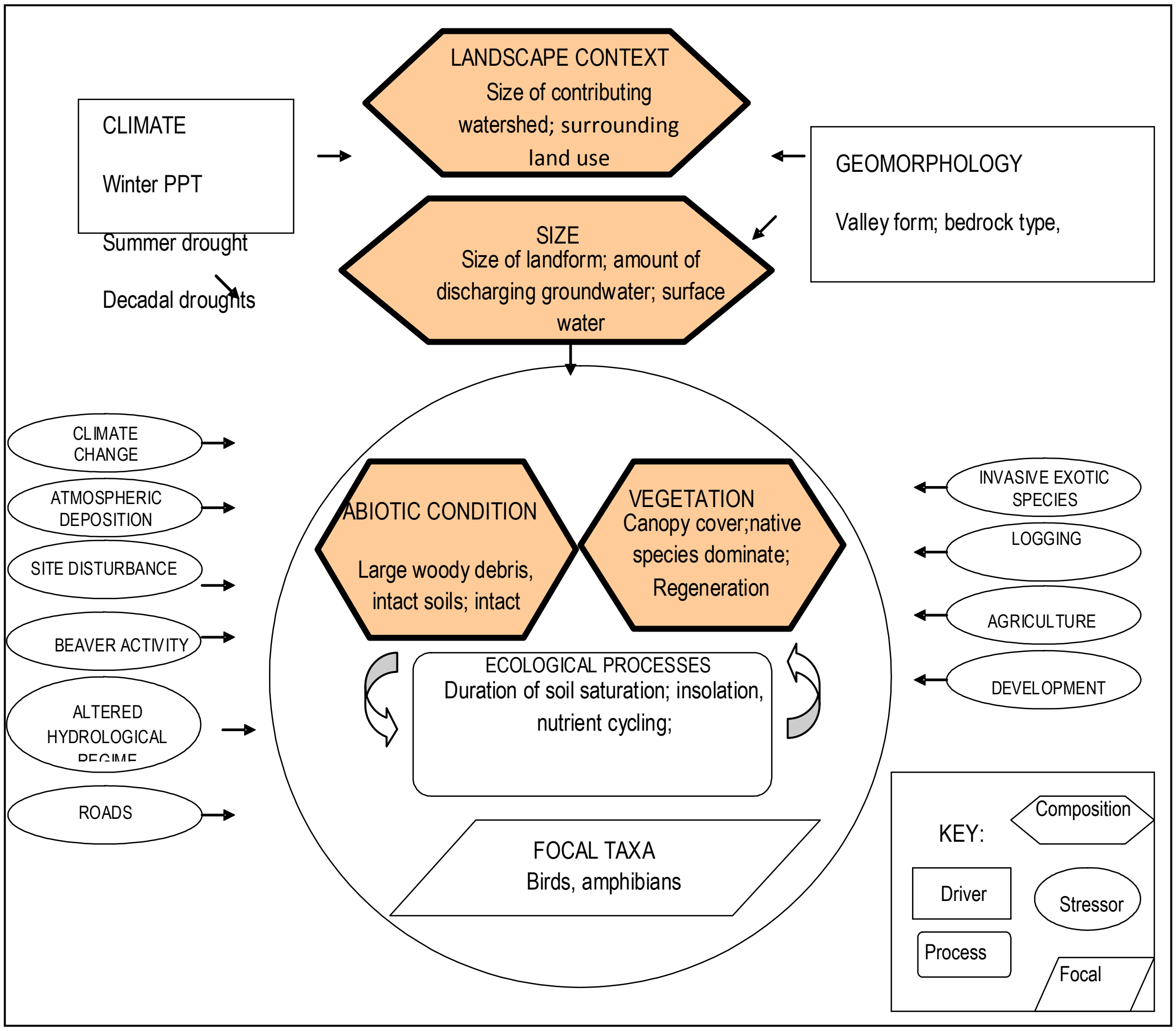

Figure 2. Conceptual Ecological Model for the Northern Rocky Mountain Conifer Swamp.

Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences.

Level 3 EIAs often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

Level 2 EIA

The following table displays the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas. **Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 5. Northern Rocky Mountain Conifer Swamp Level 2 EIA.

Metric	Justification	Rank			
		A (5 pts.)	B (4 pts.)	C (3 pts.)	D (1 pts.)
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer*					
Buffer Length	The buffer can be important to biotic and abiotic aspects of the wetland. Buffer Width Slope Multiplier 5-14% -->1.3; 15-40%--	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.
Buffer Width		Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.

Buffer Condition	>1.4; >40%-->1.5	Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
Key Ecological Attribute: *Landscape Structure*					
Connectivity (within 1 km of site)	Intact areas have a continuous corridor of natural or semi-natural vegetation between shrub steppe areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index > 0.8		Landscape Condition Model Index 0.79 – 0.65	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
Relative of Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Cover of native plants 95-100%.	Cover of native plants 80-95%.	Cover of native plants 50 to 79%.	Cover of native plants <50%.
Absolute Cover of Exotic Invasive Species	Invasive species can inflict a wide range of ecological impacts.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).

Species Composition Note: Once developed, the Floristic Quality Assessment index could be used here instead.	The overall composition of native species can shift when exposed to stressors.	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.	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	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.	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.
Key Ecological Attribute: *Vegetation Structure*					
Large Live Trees	Stands with late seral trees provide the structural attributes that are found in forested wetlands functioning with its natural range of variability	Considering the natural stand development stage, there are only a few if any cut stumps; Large trees >150 yr. old	Considering the natural stand development stage, there are many more large trees than large cut stumps; Some (10-30%) of the old trees have been harvested	Considering the natural stand development stage, there are around as many large trees as large cut stumps; Many (over 50%) of the old trees have been harvested.	
Coarse Woody Debris	Accumulation of coarse woody debris is minimal in these forests due to recurring fire. Too much CWD can increase risk from fire.	CWD is common or frequently observed; all size classes	CWD occasionally observed to present; moderate to small size classes		CWD is rare absent; mostly small size class
Key Ecological Attribute: *Hydrology*					
Water Source	Anthropogenic sources of water can have detrimental effects on the hydrological regime	Source is natural or naturally lacks water in the growing season. No indication of direct artificial water sources	Source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources	Source is primarily urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology	Water flow has been substantially diminished by human activity

Hydroperiod	Alteration in hydrology or sediment loads or some onsite stressors can degrade channel stability	Hydroperiod of the site is characterized by natural patterns of filling or inundation and drying or drawdown.	The filling or inundation patterns in the site are of greater magnitude (and greater or lesser duration than would be expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	The filling or inundation patterns in the site are characterized by natural conditions, but thereafter are subject to more rapid or extreme drawdown or drying, as compared to more natural wetlands. OR filling or inundation patterns are of substantially lower magnitude or duration than expected under natural conditions, but thereafter, the site is subject to natural drawdown or drying.	Both the filling/inundation and drawdown/drying of the site deviate from natural conditions (either increased or decreased in magnitude and/or duration).
Hydrological Connectivity (Non-riverine)	Surface water movement should not be impeded by anthropogenic structures or activities.	Rising water in the site has unrestricted access to adjacent upland, without levees, excessively high banks, artificial barriers, or other obstructions to the lateral movement of flood flows.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, but < than 50% of the site is restricted by barriers to drainage. Restrictions may be intermittent along the site, or the restrictions may occur only along one bank or shore. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	Lateral excursion of rising waters is partially restricted by unnatural features, such as levees or excessively high banks, and 50-90% of the site is restricted by barriers to drainage. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	All water stages in the site are contained within artificial banks, levees, sea walls, or comparable features or greater than 90% of wetland is restricted by barriers to drainage. There is essentially no hydrologic connection to adjacent uplands.
Key Ecological Attribute: *Physicochemical*					

Soil Surface Condition	Soil disturbance can result in compaction, erosion thereby negatively affecting many ecological processes (Napper et al 2009)	Undisturbed; No evidence of past equipment. No depressions or wheel tracks. Forest-floor layers are present and intact. No soil displacement evident. No management-generated soil erosion. No management-created soil compaction. No management-created platy soils.	Wheel tracks or depressions evident, but faint and shallow. Forest-floor layers are present and intact. Surface soil has not been displaced. Soil burn severity from prescribed fires is low (slight charring of vegetation, discontinuous). Soil compaction is shallow (0 to 4 inches). Soil structure is changed from undisturbed conditions to platy or massive albeit discontinuous.	Wheel tracks or depressions are evident and moderately deep. Forest-floor layers are partially missing. Surface soil partially intact and maybe mixed with subsoil. Soil burn severity from prescribed fires is moderate (black ash evident and water repellency may be increasedcompared to preburn condition). Soil compaction is moderately deep (up to 12 inches). Soil structure is changed from undisturbed conditions and may be platy or massive.	Wheel tracks or depressions are evident and deep. Forest-floor layers are missing. Surface soil is removed through gouging or piling. Surface soil is displaced. Soil burn severity from prescribed fires is high (white or reddish ash, all litter completely consumed, and soil structureless). Soil compaction is persistent and deep (greater than 12 inches). Soil structure is changed from undisturbed and is platy or massive throughout.
Water Quality	Excess nutrients, sediments, or other pollutant have an adverse affect on natural water quality	No evidence of degraded water quality. Water is clear; no strong green tint or sheen.	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.	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.	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.
Rank Factor: SIZE					
Key Ecological Attribute: ***Size***					
Relative Size	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
Absolute Size	Absolute size may be important for buffering impacts originating in the surrounding landscape	Very large (> 200 ac/80 ha)	Large (75-200 ac/30-80 ha)	Moderate (5-75 ac/2-30 ha)	Small (< 5 ac/2 ha)

Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, the following metrics should be considered in a Level 3 EIA:

- Amphibian composition and density
- Specific water quality measures (e.g., the temperature, dissolved oxygen, pH, conductivity, turbidity of stream water
- Specific nutrient levels of riparian vegetation (e.g., carbon to nitrogen (C:N) ratio in the aboveground biomass of plants)
- Insolation of swamp surface.

Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 6. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

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Authorship: Rex Crawford and Joe Rocchio, Washington Natural Heritage Program

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North Pacific Coastal Cliff and Canyon

The North Pacific Coastal Cliff and Bluff ecological system is a small patch system which often appears as a linear feature near coastlines from central Oregon to British Columbia. The North Pacific Montane Massive Bedrock, Cliff and Talus, a similar system occurs in the Cascade Range and Olympic Mountains differing in adjacent vegetation and montane environment. The North Pacific Coastal Cliff and Bluff ecological system is unvegetated or sparsely vegetated rock cliffs and very steep bluffs of glacial deposits along Washington's coastline and associated marine and estuarine inlets. It is composed of barren and sparsely vegetated substrates, typically including exposed sediments, bedrock, and scree slopes. This includes unstable scree, rubble, and talus that typically occurs below cliff faces (NatureServe 2007). Exposure to waves, eroding and desiccating winds, slope failures and sheet erosion create gravelly to rocky substrates that are often unstable. The climate is hypermaritime (ameliorated by the ocean). Soil development is limited and there can be a sparse cover of forbs, grasses, lichens and low shrubs. Small areas of rock outcrop within a mosaic of vegetated systems are best considered part of a different, adjacent system (e.g., North Pacific Herbaceous Bald and Bluff or North Pacific Hypermaritime Shrub and Herbaceous Headland). The North Pacific Hypermaritime Shrub and Herbaceous Headland and this cliff system sometimes occur adjacent or in a mosaic together.

Any vegetation established in this system typically reflects species composition of adjacent ecosystems, unless the latter is associated with an extreme parent material (i.e. North Pacific Serpentine Barren ecological system in the San Juan Islands). Vegetation typically includes scattered trees and/or shrubs occasionally with small dense patches of shrubs or herbaceous plants. Characteristic trees in Washington include *Picea sitchensis*, *Tsuga* spp., *Thuja plicata*, *Pseudotsuga menziesii or Alnus rubra*. There may be scattered shrubs present, such as *Acer circinatum*, *Alnus* spp., and *Ribes* spp. Herbaceous cover is limited to pockets of soil in bedrock or temporarily stable microsites. Mosses or lichens may be very dense, well-developed and display cover well over 10%. In the San Juan Islands and other locations in the Olympic rainshadow, occasional wind-pruned *Juniperus maritima* trees may be present.

Cliffs are generally cited to support high endemism of plants and refugia for old trees (Larson et al. 2000) as well as habitat for roosting or nesting birds and bats (Johnson and O'Neil 2001). Cliffs act as refugia for many rare plants that currently occur on cliffs and were often more common prior to increased human disturbance (Larson et al 2000). Due to the sparse nature of vegetation on cliffs, fire rarely has a direct influence on cliff vegetation although this lack of fire influence creates an environment for fire refugia (Graham and Knight 2004; Camp and others 1997). In Colorado, species richness of cliff communities appears to be controlled by coarser scale variables affecting the species pool in the immediate area (Graham and Knight 2004). Aspect, microsite size, and cliff surface roughness explain most of the plant richness in cliffs in Colorado (Graham and Knight 2004). Diversity increases when cliff microhabitats are compressed into a small area. For example, unfractured cliffs with no rooting space for vascular plants is habitat for lichens often next to a ledge where accumulated organic matter, minerals and water support grasses, sedges or small trees (Larson et al. 2000).

Cliff and barren systems have relatively discrete boundaries, very specific ecological settings, and strong links to local landscape conditions (Decker 2007). Decker (2007) stated that such small patch communities are often dependent on ecological processes in the surrounding communities. Graham and Knight (2004) concluded that cliff size appears to less important than the cliff micro-topography and, therefore, larger cliff areas would not necessarily contain greater number of species. Total plant species lists were least similar between large and small cliff faces (Graham and Knight 2004).

Colorado Natural Heritage summarized environmental processes of cliff ecology as follows:

> "Larson et al. (2000) define three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support the same plants and animals (Larson et al. 2000). Within the larger cliff habitat, steep slopes, small terraces ledges, overhangs, cracks and crevices often form a mosaic of microhabitat types that appears to be the primary factor contributing to cliff biodiversity (Graham and Knight 2004). In addition, the cliff rim is often windier than the surrounding plateau, providing a distinct microhabitat that differs from the nearby flatter areas. At cliff faces there is less hydraulic pressure retaining water within the rock, so liquid water is more consistently found than in the surrounding habitat types (Larson et al. 2000).
>
> Cliff environments are shaped by the parent rock type and strength, climate, aspect, and the weathering patterns produced by physical and chemical processes. Physical weathering includes the downward movement of rock and soil under the influence of gravity (mass wasting), including larger slips, slides and rockfalls, shrinking/swelling in response to changes in water content (mostly in shales and mudstones), direct pressure effects from the formation of ice and mineral crystals, thermal stress, and frost action (Larson et al. 2000). Chemical weathering in cliff environments is directly controlled by precipitation amount and chemistry, rock temperature, and the chemical composition of the rock. Chemical weathering is most prevalent under

conditions of higher temperature and high precipitation, whereas physical weathering is more important at lower temperatures (Larson et al. 2000). The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000)."

Stressors

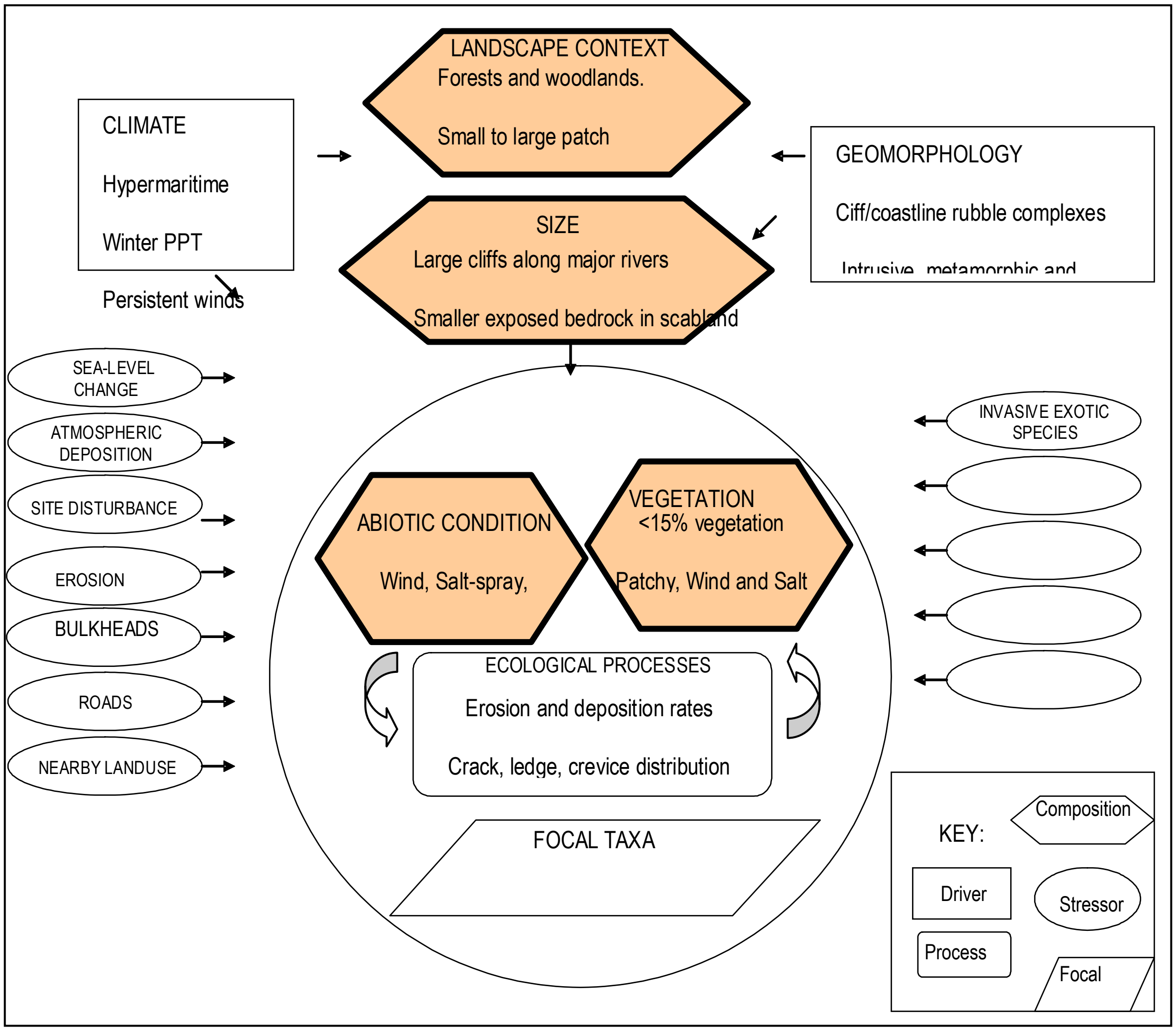
The stressors described below are those primarily associated with the loss of extent and degradation of the ecological integrity of existing occurrences. The stressors are the cause of the system shifting away from its natural range of variability. In other words, type, intensity, and duration of these stressors is what moves a system's ecological integrity rank away from the expected, natural condition (e.g. A rank) toward degraded integrity ranks (i.e. B, C, or D).

This system usually occurs in inaccessible locations and thus is protected from much disturbance resulting from human activities. Direct human stressors to this system may include road construction and maintenance, recreation (climbing), and the effects of mining and quarrying. Wind and water erosion, chemical and physical effects of plant growth, such as salt-spray and desiccating winds, and the force of gravity are the primary natural processes in the cliff environment. The rate of erosion and the size of eroded rock particles have a strong influence over which organisms occur on cliffs and talus (Larson et al. 2000).

Conceptual Ecological Model

The general relationships among the key ecological attributes associated with natural range of variability of the North Pacific Coastal Cliff and Bluff Ecological System are presented in Figure 1.

Figure 3. Conceptual Ecological Model for North Pacific Coastal Cliff and Bluff System.



Ecological Integrity Assessments

The assessment of ecological integrity can be done at three levels of intensity depending on the purpose and design of the data collection effort. The three-level approach is intended to provide increasing accuracy of ecological integrity assessment, recognizing that not all conservation and management decisions need equal levels of accuracy. The three-level approach also allows users to choose their assessment based in part on the level of classification that is available or targeted. If classification is limited to the level of forests vs. wetlands vs. grasslands, the use of remote sensing metrics may be sufficient. If very specific, fine-scale forest, wetland, and grassland types are the classification target then one has the flexibility to decide to use any of the three levels, depending on the need of the assessment. In other words, there is no presumption that a fine-level of classification requires a fine-level of ecological integrity assessment.

Because the purpose is the same for all three levels of assessment (to measure the status of ecological integrity of a site) it is important that the Level 1 assessment use the same kinds of metrics and major attributes as used at Levels 2 and 3. Level 1 assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about landscape integrity and the distribution and abundance of ecological types in the landscape or watershed. Level 2 assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment. Level 3 assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences. They often use quantitative, plot-based protocols coupled with a sampling design to provide data for detailed metrics.

Although the three levels can be integrated into a monitoring framework, each level is developed as a stand-alone method for assessing ecological integrity. **When conducting an ecological integrity assessment, one need only complete a single level that is appropriate to the study at hand.** Typically only one level may be needed, desirable, or cost effective. But for this reason it is very important that each level provide a comparable approach to assessing integrity, else the ratings and ranks will not achieve comparable information if multiple levels are used.

Level 1 EIA

A generalized Level 1 EIA is provided in Rocchio and Crawford (2009). Please refer to that document for the list of metrics applicable to this ecological system.

Level 2 EIA

The following tables display the metrics chosen to measure most of the key ecological attributes in the conceptual ecological model above. The EIA is used to assess the ecological condition of an assessment area, which may be the same as the element occurrence or a subset of that occurrence based on abrupt changes in condition or on artificial boundaries such as management areas**. Unless otherwise noted, metric ratings apply to both Level 2 and Level 3 EIAs. The difference between the two is that a Level 3 EIA will use more intensive and precise methods to determine metric ratings.** To calculate ranks, each metric is ranked in the field according the ranking categories listed below. Then, the rank and point total for each metric is entered into the EIA Scorecard and multiplied by the weight factor associated with each metric resulting in a metric 'score'. Metric scores within a key ecological attribute are then summed to arrive at a score (or rank). These are then tallied in the same way to arrive at an overall ecological integrity score.

Table 7. North Pacific Coastal Cliff and Bluff Ecological Integrity Assessment Scorecard

Metric	Justification	Rank			
		A (5 pts.)	**B (4 pts.)**	**C (3 pts.)**	**D (1 pts.)**
Rank Factor: LANDSCAPE CONTEXT					
Key Ecological Attribute: *Buffer Effects*					
Buffer Length	The buffer can be important to biotic and abiotic aspects of the ecosystem as it provides connectivity and a 'filter' from exogeneous	Buffer is > 75 – 100% of occurrence perimeter.	Buffer is > 50 – 74% of occurrence perimeter.	Buffer is 25 – 49% of occurrence perimeter	Buffer is < 25% of occurrence perimeter.
Buffer Width		Average buffer width of occurrence is > 200 m, adjusted for slope.	Average buffer width is 100 – 199 m, after adjusting for slope.	Average buffer width is 50 – 99 m, after adjusting for slope.	Average buffer width is < 49 m, after adjusting for slope.

Buffer Condition	threats.	Abundant (>95%) cover native vegetation, little or no (<5%) cover of non-native plants, intact soils, AND little or no trash or refuse.	Substantial (75–95%) cover of native vegetation, low (5–25%) cover of non-native plants, intact or moderately disrupted soils; minor intensity of human visitation or recreation.	Moderate (25–50%) cover of non-native plants, moderate or extensive soil disruption; moderate intensity of human visitation or recreation.	Dominant (>50%) cover of non-native plants, barren ground, highly compacted or otherwise disrupted soils, moderate or greater intensity of human visitation or recreation, no buffer at all.
Key Ecological Attribute: *Landscape Structure*					
Connectivity	Intact areas have a continuous corridor of natural or semi-natural vegetation between cliff and rock areas	Intact: Embedded in 90-100% natural habitat; connectivity is expected to be high.	Variegated: Embedded in 60-90% natural or semi-habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification;	Fragmented: Embedded in 20-60% natural or semi-natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 20% natural or semi-natural habitat; connectivity is essentially absent
Landscape Condition Model Index	The intensity and types of land uses in the surrounding landscape can affect ecological integrity.	Landscape Condition Model Index > 0.8		Landscape Condition Model Index 0.75 – 0.65	Landscape Condition Model Index < 0.65
Rank Factor: CONDITION					
Key Ecological Attribute: *Vegetation Composition*					
Relative Cover Native Plant Species	Native species dominate this system; non-natives increase with human impacts.	Cover of native plants = relative 95-100%.	Cover of native plants relative 80-95%.	Cover of native plants relative 50 to 79%.	Cover of native plants < relative 50%.
Absolute Cover of Invasive Species	Invasive species (e.g. *Cytisus scoparius*) can inflict a wide range of ecological impacts. Early detection is critical.	None present.	Invasive species present, but sporadic (<3% cover).	Invasive species prevalent (3–10% absolute cover).	Invasive species abundant (>10% absolute cover).

Relative Cover of Native Increasers	Some stressors such as grazing can shift or homogenize native composition toward species tolerant of stressors.	Absent or incidental	<10% cover	10-20% cover	>20% cover
Species Composition Note: Once developed, the Floristic Quality Assessment index could used here instead.	The overall composition of native species can shift when exposed to stressors.	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.	Species diversity/abundance close to reference standard condition. Some native species reflective of past anthropogenic degradation present. Some indicator/ diagnostic species may be absent.	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.	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.
Key Ecological Attribute: *Vegetation Structure*					
Patch diversity	Spatial heterogeneity of microhabitats strongly influence the abundance and distribution of species that use a particular habitat (Pulliam et al. 1992). Human-induced stress can decrease the range of biotic/abiotic patches from an un-impacted site.	No or little change in patch types* due to human stressors	Less than 50% change in expected patch types* due to human stressors	Over 50% change in expected patch types due to human stressors	All or most patch types changed due to human stressors
Key Ecological Attribute: *Physicochemical*					

Soil Surface Condition	Site disturbance can result in erosion thereby negatively affecting many ecological processes; the amount of bare ground or newly exposed rock varies naturally with site type.	Bare \areas are limited to naturally caused disturbances such as frost-cracking or animal trails	Some bare soil due to human causes but the extent and impact is minimal.		Bare soil areas due to human causes are common.
Rank Factor: SIZE					
Key Ecological Attribute: *Size*					
Relative Size	Indicates the proportion lost due to stressors.	Site is at or minimally reduced from natural extent (>95% remains)	Occurrence is only modestly reduced from its original natural extent (80-95% remains)	Occurrence is substantially reduced from its original natural extent (50-80% remains)	Occurrence is severely reduced from its original natural extent (<50% remains)
Absolute Size	Plant species lists were least similar between large and small cliff faces (Graham and Knight 2004).	Large cliffs (>20 m high)	Medium cliffs (10 - 20 m high)	Small cliffs (5 and 10 m high)	>5 m high

*Patch types: Tree- Shrub-, Perennial herbaceous-, Annual-, Non-vascular-dominated, Cliff bedrock, Plateau bedrock, Cavities or cracks in bedrock, Unconsolidated rocks (i.e. talus) and Bare ground.

Level 3 EIA

Level 3 metrics would include more quantitative measures of the metrics listed above. In addition, further consideration might be given to:

- Lichen and moss species composition and abundance (Eldridge and Rosentreter 1999).

Triggers or Management Assessment Points

Ecological triggers or conditions under which management activities need to be reassessed are shown in the table below. Since the Ecological Integrity rankings are based on hypothesized thresholds, they are used to indicate where triggers might occur. Specific details about how these triggers translate for each metric can be found by referencing the values or descriptions for the appropriate rank provided in the Table above.

Table 2. Triggers for Level 2 & 3 EIA

Key Ecological Attribute or Metric	Trigger	Action
Any metric (except Connectivity)	▪ C rank ▪ Shift from A to B rank ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.
Any Key Ecological Attribute	▪ any metric has a C rank ▪ > ½ of all metrics are ranked B ▪ negative trend within the B rating (Level 3)	Level 2 triggers: conduct Level 3 assessment; make appropriate short-term management changes to ensure no further degradation Level 3 triggers: make appropriate management adjustments to ensure no additional degradation occurs. Continue monitoring using Level 3.

Protocol for Integrating Metric Ranks

If desired, the user may wish to integrate the ratings of the individual metrics and produce an overall score for the three rank factor categories: (1) Landscape Context; (2) Condition; and (3) Size. These rank factor rankings can then be combined into an Overall Ecological Integrity Rank. This enables one to report scores or ranks from the various hierarchical scales of the assessment depending on which best meets the user's objectives. Please see Table 5 in Rocchio and Crawford (2009) for specifics about the protocol for integrating or 'rolling-up' metric ratings.

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Authorship: Rex Crawford, Washington Natural Heritage Program

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Appendix C. EIA_OUTPUT Table Metadata.

This appendix lists the fields used in the Ecological Integrity Assessment (EIA) tables and placeholder supplementary fields used for planning. These fields are the standardized original fields that best estimate the ecological indicators and metrics in the EIA. Each OUTPUT field description includes the MAIN table (INPUT) fields used and their relationship to metrics. EIA metrics are assigned four ratings: “A” not or least impaired condition to “D” most impaired condition. Summary Rank calculations used the following scale: “A”=5, “B”=4, “C”=3, “D”=1. Summary Ranks are calculated numeric values with the rating ranges:

EIA_RANK SCORE	EIA_RANK TEXT
4.5-5.0	A
3.5-4.4	B
2.5-3.4	C
1.0-2.4	D

Fields are listed by EIA Vegetation Condition attributes, Physicochemical Condition attributes, Hydrological condition attributes, and Size attributes that had enough information in the Park Data for EIA rank calculation. EIA Landscape field attributes along with other attributes that were not calculated for this project follow fields used in calculation for this project. Lastly, summary or rollup ranking fields that calculate final or summary EIA ranks are listed.

KEYLINK
Text field.
Unique polygon label (park name and sequential number, i.e. AltaLake_1) and is the key field linking all tables.

VEGETATION Attributes

CANOPY_COMPOSITION_RANK
Numeric field, Standardized values.
These are EIA VEGETATION metrics Canopy Composition, Large Live Trees, Late Seral Patches, Mid-Seral Patches, Old, Large-tree Stand Structure, and Patch Diversity. Stands with late seral trees provide the structural attributes that are found in forests functioning with their natural range of variability. We assume that the presence or abundance of cut stumps represent loss of stand structural elements. It is approximated by field and values LOGGING_EIA=1 rates "A", LOGGING_EIA= 2 rates "BC", and LOGGING_EIA=3 rates "D".

CANOPY_DOMINANT_AGE_RANK
Numeric field, Standardized values.
This is EIA VEGETATION CONDITION metric Large Tree Age that is not a structural feature that is included because some of the biological diversity of old growth requires a long time to develop and accumulate after stand-replacement disturbance (Pabst 2005). It is approximated with field and values STAND_STRUCT_EIA= 3 OR 4 OR 6 OR 8 OR 9 as "A", STAND_STRUCT_EIA =2 OR 5 OR 7 as "BC" and STAND_STRUCT_EIA =1 as "D".

CANOPY_STRUCTURE

Numeric field, Standardized values.

This is EIA VEGETATION metric Canopy Structure. Intact riparian areas should have a diversity of tree age classes. It is approximated by field and values TOT_TREE_COV >50% and STAND AGE=3 OR 4 OR 6 OR 8 OR 9 it rates "AB", TOT_TREE_COV 10-50% and STAND AGE=2 OR 5 OR 7 it rates "C" or TOT_TREE_COV > 10% and STAND_STRUCT_EIA =1 it rates "D".

CONIFER_ENCROACHMENT

Numeric field, Standardized values.

This is VEGETATION metric Douglas-fir encroachment. The amount of encroachment by *Pseudotsuga menziesii* is an indication of the integrity of the fire regime. It is approximated with field and values TOT_TREE_COV >25% rate as "D" and TOT_TREE_COV <25% rate as "B".

COVER_NATIVE_UNDERSTORY_RANK

Numeric field, Standardized values.

This is VEGETATION CONDITION metrics Cover Native Understory Plant Species, Relative Cover Native Understory Plant Species, and Relative Cover Native Plant Species. The relative cover of native plants indication the degree of naturalness of a site. It is approximated with field and values (TOT_SHRUB_COV + TOT_GRAM_COV + TOT_FORB_COV + FERNS_TOTAL_COV) - TOT_EXOTIC_COV / (TOT_SHRUB_COV + TOT_GRAM_COV + TOT_FORB_COV + FERNS_TOTAL_COV + TOT_EXOTIC_COV). If that calculation >95% it is rated "A", if 80-94%, it is rated "B", if 50-79%, it is rated "C", or if <50, it is rated "D".

EXOTIC_INVASIVE_RANK

Numeric field, Standardized values.

This is VEGETATION CONDITION metrics Absolute Cover of Invasive Herbaceous Species and Absolute Cover of Invasive Species. Invasive plants indicate the degree of deviation from a natural state because they can alter natural processes of a site. For this assessment, we assumed all exotics plants are invasive and thus approximated with field and values; TOT_EXOTIC_COV <1% rate as "A", 1-5% rate as “B”, if 6-30% and rate as “C” and if >30% it is "D".

FIRE_SENSITIVE_SHRUBS_RANK

Numeric field, Standardized values.

This is VEGETATION metric Fire-sensitive Shrubs. Natural fire regime promotes patchy low cover big sagebrush or bitterbrush cover. We assume that all mid-shrubs are deep-rooted, non-sprouting species so this likely over estimates fire sensitive species since values include all shrub species. It is approximated by field and values TALL_SHRUB_COV <10% it rates "A", TALL_SHRUB_COV 11 to 20% it rates "B", and (TALL_SHRUB_COV >20% it rates "CD".

LARGE_LIVE_TREES_RANK

Numeric field, Standardized values.

This is VEGETATION CONDITION metrics Biological Legacies and Large Live Trees. Large trees are a characteristic and vital part of the forest (Franklin and Spies 1984; Pabst 2005). It is approximated with field and values STAND_STRUCT_EIA = 4 OR 6 and LOGGING_EIA=1then rate as "A", or if LOGGING_EIA= 2 then rate as "BC", or if LOGGING_EIA=3 then rate as "D".

LATE_SERAL_TREE_SIZE_AND_AGE

Numeric field, Standardized values.

This is VEGETATION STRUCTURE metrics Old, Large-tree Stand Structure and Tree Age and Size Class. It is approximated with field and values STAND_STRUCT_EIA = 4 OR 6 and

LOGGING_EIA=1then rate as "A", or if LOGGING_EIA= 2 then rate as "BC", or if LOGGING_EIA=3 then rate as "D".

NATIVE_BUNCHGRASS_RANK
Numeric field, Standardized values.
This is VEGETATION metric Relative Cover of Native Bunchgrass. Native bunchgrasses dominate sites and its high cover is related to community resistance to species invasion. It is approximated with field and values (PERR_GRAM_COV / (TOT_GRAM_COV+TOT_FORB_COV+TOT_EXOTIC_COV) if >80% it rates "A", if 50 to 79% it rates "B", if 30-49% it rates "C" or if <30% it rates "D".

NATURAL_TREE_REGENERATION
Numeric field, Standardized values.
This is the VEGETATION STRUCTURE metric Natural Tree regeneration. Natural Vegetation (including semi-natural) has ecological processes that primarily determine species and site characteristics; that is, vegetation is comprised of a largely spontaneously growing set of plant species that are shaped by both site and biotic processes (Kuchler 1969, Westhoff and Van der Maarel. 1973). We assume that natural regeneration followed most past tree harvest activities unless recorded as “plantation”. It is approximated with field and values LOGGING_EIA 1, 2 or 3 rate as "B” and LOGGING_EIA 4 rate as "D".

OAK_COVER
Numeric field, Standardized values.
This is the VEGETATION STRUCTURE metric Percent live tree canopy cover (Quercus garryana and native conifers). It is approximated with field and values TOT_TREE_COV 25 to 50% rate as "AB", TOT_TREE_COV 15 to 24% or 51-60% rate as "C" and TOT_TREE_COV <15% OR >60% rate as "D".

RELATIVE_SHRUB_COVER
Numeric field, Standardized values.
This is VEGETATION metric Relative Shrub Cover. Shrub cover outside of Historical Range of Variability can indicate past disturbance such as grazing or fire suppression. *Arctostaphylos columbiana* thickets are within the Historical Range of Variability. It is approximated by field and values TOT_SHRUBS_COV/TOT_VEG_COV <1% rate as "A", TOT_SHRUBS_COV/TOT_VEG_COV 1 to 10% rate as "B", TOT_SHRUBS_COV/TOT_VEG_COV 11-25% rate as "C", and TOT_SHRUBS_COV/TOT_VEG_COV >25% rate as "D".

SHRUB_COVER
Numeric field, Standardized values.
This is VEGETATION metric Cover of Shrubs. Shrub density/cover can increase as water tables decline resulting in detrimental shading of *Sphagnum* (only use in non-forested *Sphagnum*-dominated peatlands) (Kulzer et al. 2001). It is approximated by field and values TOT_SHRUBS_COV <90% rate as "AB" and TOT_SHRUBS_COV >90% rate as "CD".

TREE_ABUNDANCE
Numeric field, Standardized values.
This is VEGETATION metric Tree Abundance. Tree cover alters grassland composition and structure. It is approximated by field and values TOT_TREE_COV =0 rate as "A", EMERGENT_COV + MAIN_CANOPY_COV =0 rate as "BC" and MERGENT_COV + MAIN_CANOPY_COV >1% rate as "D".

PHYSIOCHEMICAL Attributes

SOIL_SURFACE_CONDITION_RANK
Numeric field, Standardized values.
This is PHYSIOCHEMICAL metric Soil Surface Condition. Soil disturbance can result in compaction, erosion thereby negatively affecting many ecological processes (Napper et al 2009). No single mapping attribute addressed this metric and we assume certain activities or land uses are associated with soil disturbance. It is approximated by field and values AGRICULTURE_EIA=7 or DEVELOPMENT_EIA=1 OR 4 OR 6, or LIVESTOCK_EIA=1 or LOGGING_EIA=3 OR 4, or REC_SEVERITY_EIA=1 rate as "D"; DEVELOPMENT_EIA=2 or LIVESTOCK_EIA=2 OR 4,"C" or LOGGING_EIA=2 rate as "C"; LIVESTOCK_EIA=3 or REC_SEVERITY_EIA=2 rate as "BC"; DEVELOPMENT_EIA=5 or LIVESTOCK_EIA=6 or LOGGING_EIA=1 or REC_SEVERITY_EIA=3 rate as "A".

HYDROLOGICAL Attributes

HYDROPERIOD_RANK; HYDROPERIOD_TIDAL_RANK
Numeric field, Standardized values.
These are HYDROLOGICAL metrics Hydroperiod, Hydrological Alterations, Hydrological Connectivity (non-riverine), Hydrological Connectivity (riverine), Hydrological Connectivity (tidal), Hydroperiod – Tidal and Water Source. Hydroperiod of the site is characterized by natural patterns of filling or inundation and drying or drawdown. The degree to which onsite or adjacent land uses and human activities have altered hydrological processes (Rocchio 2005). Only a single mapped attributes addresses hydrology and it was applied to all of the metrics above. In summary ranks, only one hydrological metric was used per Ecological System. All hydrology metric are approximated by field and values Hydrology=1 rate as "AB" and Hydrology=2 rate as "CD".

Attributes not used in Assessment

VEGETATION Attributes not used in Assessment

ADJACENT_INVASIVE_SPECIES_COVER
Cannot be assessed with available information.
This is the EIA VEGETATION metric Relative Cover of Upland Exotic Invasive Species of vernal pools. Invasive species can inflict a wide range of ecological impacts. Early detection is critical. *Apera interrupta*, annual *Bromus*, *Hypericum perforatum*, *Lactuca serriola*, *Poa bulbosa*, *Sisymbrium altissimum*, and *Taeniatherum caput-medusae* (Environmental Science Associates 2007). A GIS approach might estimate this attribute rating GIS if surrounding polygons TOT_EXOTIC_COV =0 rate as "A", surrounding polygons TOT_EXOTIC_COV / TOT_SHRUB_COV + TOT_GRAM_COV + TOT_FORB_COV + TOT_EXOTIC_COV <50% rate as "B"', surrounding polygons TOT_EXOTIC_COV / TOT_SHRUB_COV + TOT_GRAM_COV + TOT_FORB_COV + TOT_EXOTIC_COV <75% rate as "C"' and surrounding polygons TOT_EXOTIC_COV / TOT_SHRUB_COV + TOT_GRAM_COV + TOT_FORB_COV + TOT_EXOTIC_COV >75% rate as "D".

AMMOPHILA_ABUNDANCE
Cannot be assessed with available information.
This is the VEGETATION STRUCTURE metric *Ammophila* species Abundance. Detailed review of existing data might estimate ratings from DOM_GRAM, PERR_GRAM_COV, and PRMRY_EXOT fields.

CLIFF_PATCH_DIVERSITY

Cannot be assessed with available information.
This is the VEGETATION STRUCTURE metric Patch Diversity. Spatial heterogeneity of microhabitats strongly influence the abundance and distribution of species that use a particular habitat (Pulliam et al. 1992). Human-induced stress can decrease the range of biotic/abiotic patches from an un-impacted site. This might be assessed with photo-interpretation.

COVER_OF_NATIVE_INCREASER_RANK
Numeric field, Standardized values.
Cannot be assessed with available information.
This is VEGETATION CONDITION metrics Relative Cover of Native Increaser Species and Relative Cover of Understory Native Increasers. Without cover data, it might be indicated by inspection of DOM_SHRUB, DOM_GRAM, and DOM_FORB fields species lists categorized by system increaser lists.

FIRE_SENSITIVE_SHRUBS_SCABLAND
Cannot be assessed with available information.
This is the VEGETATION STRUCTURE metric Fire-sensitive Shrubs in scabland systems those with long fire frequency. Patch diversity reflects natural dynamics. This might be assessed with photo-interpretation.

FINE_SCALE_MOSAIC
Cannot be assessed with available information.
This is the VEGETATION STRUCTURE metric Fine-Scale Mosaic. Patch diversity reflects natural dynamics of mixed slide movements and gap replacement processes. This might be assessed with photo-interpretation or with GIS analysis.

FOREST_PATCH_ DIVERSITY
Cannot be assessed with available information.
This is the VEGETATION STRUCTURE metric Patch Diversity. The diversity and interspersion of seral patches across the occurrence is indicative of intact mixed severity disturbance regimes (Landfire 2007). This might be assessed with photo-interpretation.

GRASSLAND_PROXIMITY
Numeric field, Standardized values.
Unassessed GIS approach would estimate Proximity to Nearby Prairies attribute. The occurrence of nearby prairies patches increases the likelihood that dispersal/pollinator processes are intact (Alverson). Intersection of existing polygons with the Washington Natural Heritage Program BIOTICS map layer so that those with 3 balds element occurences (>10 acres) within 1 km rate as “A”, 2 balds (>10 acres) within 1 km rate as “B”, 1 balds (>10 acres) within 1 km rate as “C” and No balds (>10 acres) within 1 km rate as “D”.

PATCH_DIVERSITY_ORIGIN_WITHIN_1_KM_RANK PROXIMITY
Numeric field, Standardized values.
Unassessed GIS approach would estimate this VEGETATION STRUCTURE metric is Patch Diversity Origin within 1 km. This is a GIS or photo-interpretation field that assesses the amount of naturally regenerated forests within a 1 km of a polygon. The diversity and interspersion of seral patches across the occurrence is indicative of intact mixed severity disturbance regimes.

PATCH_DIVERSITY_CONNECTIVITY
Cannot be assessed with available information.

This is the VEGETATION STRUCTURE metric Patch Diversity and Connectivity. This riparian system metric assesses when hydrological processes are intact, a diversity of seral patches and habitat types are present within this system. The patches are well connected without interruption from anthropogenic land cover/use. This might be assessed with photo-interpretation.

SPECIES_COMPOSITION_RANK
Numeric field, Standardized values.
This is VEGETATION metric Species Composition. The overall composition of native species can shift when exposed to stressors. We assume that the field assigned condition ranks primarily reflect native species composition or degrees of deviation from the expected native composition. Not all contractors recorded ranks and used differing criteria. It is approximated by averaging field and values CONDITION_RANK1 times PERCENT1 + CONDITION_RANK2 times PERCENT2 + CONDITION_RANK3 times PERCENT3 + CONDITION_RANK4 times PERCENT4 + CONDITION_RANK5 times PERCENT5.

TREE_SIZE_DIVERSITY_RANK
Cannot be assessed with available information.
This is VEGETATION STRUCTURE metric Tree Size Diversity. Old growth and mature forests are diverse of vertically and horizontally and estimated by the range of tree dbh classes: small=5-24 cm, moderate=25-49 cm, large=50-99 cm, and> 100 (Gray et al 2009; Pabst 2005).

- Other EIA VEGETATION attributes not possible to assess with available information: Absolute Cover of Scotch broom (*Cytisus scoparius*), Abundance of Salt Tolerant Species, Mean Coefficient of Conservatism, Richness of Prairie Associated Plant Species, Aspen Stand Condition, Biological Soil Crust, Coarse Woody Debris, Coarse Woody Debris, Coarse Woody Debris (upland), Coarse Woody Debris (upland), Density of large (> 38 cm DBH) oak or conifer trees & snags, Large Snags, Large Woody Debris, Organic Matter Accumulation, Regeneration of Woody Species, Relative live canopy cover of *Quercus garryana*, and Tree Regeneration.

PHYSIOCHEMICAL Attributes not used in Assessment

SLOPE_ALTERATION
Cannot be assessed with available information.
This is the EIA PHYSIOCHEMICAL metric Slope Alteration. Poor construction practices, roads, heavy timber harvests on unstable slopes and efforts to stabilize slopes influence natural processes. This might be assessed with photo-interpretation.

WATER_QUALITY_RANK
Cannot be assessed with available information.
This is the PHYSIOCHEMICAL metric Water Quality. Excess nutrients, sediments, or other pollutant have an adverse affect on natural water quality and ecosystem processes.

- Other EIA PHYSIOCHEMICAL attributes not considered because of lack of available information is Physical Patch Diversity Sand Dynamics, and Water Table Depth

HYDROLOGICAL Attributes not used in Assessment

CHANNEL_STABILITY
Cannot be assessed with available information.

This is the EIA HYDROLOGICAL metrics Channel Stability and Streambank Stability. Alteration in hydrology or sediment loads or some onsite stressors can degrade channel stability.

HYDRO_CONNECTIVITY_RANK
Because of limited available information, this HYDROLOGICAL metric was included in "HYDROPERIOD_RANK" and to avoid duplicating ranks in EIA's with both attributes. This applies to Hydrological Connectivity (riverine and non-riverine) and Hydrological Connectivity (tidal). Tidal and floodwater should have access to the floodplain. Stressors resulting in entrenchment affect hydrological connectivity (EPA 2006).

SIZE Attributes

RELATIVE_SIZE_RANK
Cannot be assessed with available information.
This is the EIA SIZE metric Relative Size. This metric indicates the proportion of the ecological systems lost due to stressors at a site. This might be assessed with photo-interpretation.

ABSOLUTE_SIZE_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate the SIZE metric Absolute size. For this project, ABSOLUTE_SIZE is the size of the polygon indentified with a particular ecological system and, in most cases, the polygon is part of a larger occurrence. As calculated, ABSOLUTE_SIZE may only applied to small patch ecological systems. Larger sizes may be important for buffering impacts originating in the surrounding landscape and provide area for natural dynamics. Most ecological systems have unique size values approximated from the concept of minimum dynamic area and have separate ABSOLUTE_SIZE_RANK ratings. Rationale for areas is listed in individual EIAs. We assume that the most of a polygon is occupied by a single system. A more appropriate application of this metric would sum the area of all polygons of the same ecological system within 1 km. Size is in hectares (ha=2.47 ac) in statements.

ABSOLUTE_SIZE_RANK_A	GIS, IF(POLYGON AREA>10000, "A", IF(POLYGON AREA>1000, "B", IF(POLYGON AREA>100, "C", IF(POLYGON AREA<100, "D"))))
ABSOLUTE_SIZE_RANK_B	GIS, IF(POLYGON AREA>8000, "A", IF(POLYGON AREA>4000, "B", IF(POLYGON AREA>2000, "C", IF(POLYGON AREA<2000, "D"))))
ABSOLUTE_SIZE_RANK_C	GIS, IF(POLYGON AREA>7500, "A", IF(POLYGON AREA>500, "B", IF(POLYGON AREA>500, "C", IF(POLYGON AREA<500, "D"))))
ABSOLUTE_SIZE_RANK_D	GIS, IF(POLYGON AREA>5000, "A", IF(POLYGON AREA>500, "B", IF(POLYGON AREA>50, "C", IF(POLYGON AREA<50, "D"))))
ABSOLUTE_SIZE_RANK_E	GIS, IF(POLYGON AREA>2025, "A", IF(POLYGON AREA>203, "B", IF(POLYGON AREA>20, "C", IF(POLYGON AREA<20, "D"))))
ABSOLUTE_SIZE_RANK_F	GIS, IF(POLYGON AREA>3200, "A", IF(POLYGON AREA>320, "B", IF(POLYGON AREA>32, "C", IF(POLYGON AREA<32, "D"))))
ABSOLUTE_SIZE_RANK_G	GIS, IF(POLYGON AREA>1000, "A", IF(POLYGON AREA>500, "B", IF(POLYGON AREA>10, "C", IF(POLYGON AREA<10, "D"))))
ABSOLUTE_SIZE_RANK_H	GIS, IF(POLYGON AREA>1000, "A", IF(POLYGON AREA>500, "B", IF(POLYGON AREA>1, "C", IF(POLYGON AREA<1, "D"))))

ABSOLUTE_SIZE_RANK_I	GIS, IF(POLYGON AREA>405, "A", IF(POLYGON AREA>40, "B", IF(POLYGON AREA>0.5, "C", IF(POLYGON AREA<0.5, "D"))))
ABSOLUTE_SIZE_RANK_J	GIS, IF(POLYGON AREA>450, "A", IF(POLYGON AREA>45, "B", IF(POLYGON AREA>4.5, "C", IF(POLYGON AREA<4.5, "D"))))
ABSOLUTE_SIZE_RANK_K	GIS, IF(POLYGON AREA>405, "A", IF(POLYGON AREA>40, "B", IF(POLYGON AREA>20, "C", IF(POLYGON AREA<20, "D"))))
ABSOLUTE_SIZE_RANK_L	GIS, IF(POLYGON AREA>225, "A", IF(POLYGON AREA>20, "B", IF(POLYGON AREA>10, "C", IF(POLYGON AREA<10, "D"))))
ABSOLUTE_SIZE_RANK_M	GIS, IF(POLYGON AREA>160, "A", IF(POLYGON AREA>40, "B", IF(POLYGON AREA>8, "C", IF(POLYGON AREA<8, "D"))))
ABSOLUTE_SIZE_RANK_N	GIS, IF(POLYGON AREA>125, "A", IF(POLYGON AREA>25, "B", IF(POLYGON AREA>5, "C", IF(POLYGON AREA<5, "D"))))
ABSOLUTE_SIZE_RANK_O	GIS, IF(POLYGON AREA>120, "A", IF(POLYGON AREA>40, "B", IF(POLYGON AREA>15, "C", IF(POLYGON AREA<15, "D"))))
ABSOLUTE_SIZE_RANK_P	GIS, IF(POLYGON AREA>80, "A", IF(POLYGON AREA>30, "B", IF(POLYGON AREA>2, "C", IF(POLYGON AREA<2, "D"))))
ABSOLUTE_SIZE_RANK_P1	Typical occurrences of ecological system smaller than polygons requires photo-interpretation or site visit.
ABSOLUTE_SIZE_RANK_Q	GIS, IF(POLYGON AREA>100, "A", IF(POLYGON AREA>50, "B", IF(POLYGON AREA>10, "C", IF(POLYGON AREA<10, "D"))))
ABSOLUTE_SIZE_RANK_R	GIS, IF(POLYGON AREA>60, "A", IF(POLYGON AREA>20, "B", IF(POLYGON AREA>2, "C", IF(POLYGON AREA<2, "D"))))
ABSOLUTE_SIZE_RANK_S	GIS, IF(POLYGON AREA>40, "A", IF(POLYGON AREA>4, "B", IF(POLYGON AREA>0.5, "C", IF(POLYGON AREA<0.5, "D"))))
ABSOLUTE_SIZE_RANK_T	GIS, IF(POLYGON AREA>30, "A", IF(POLYGON AREA>8, "B", IF(POLYGON AREA>0.5, "C", IF(POLYGON AREA<0.5, "D"))))
ABSOLUTE_SIZE_RANK_U	GIS, IF(POLYGON AREA>8, "A", IF(POLYGON AREA>4, "B", IF(POLYGON AREA>0.8, "C", IF(POLYGON AREA<0.8, "D"))))
ABSOLUTE_SIZE_RANK_V	GIS, IF(POLYGON AREA>20, "A", IF(POLYGON AREA>4, "B", IF(POLYGON AREA>0.4, "C", IF(POLYGON AREA<0.4, "D"))))
ABSOLUTE_SIZE_RANK_W	GIS, IF(POLYGON AREA>0.16, "A", IF(POLYGON AREA>1.6, "B", IF(POLYGON AREA>0.4, "C", IF(POLYGON AREA<0.4, "D"))))
ABSOLUTE_SIZE_RANK_X	GIS, IF(POLYGON AREA>4, "A", IF(POLYGON AREA>0.08, "BC", IF(POLYGON AREA<0.08, "D")))
ABSOLUTE_SIZE_RANK_Y	Typical occurrences of ecological system smaller than polygons requires photo-interpretation or site visit.
ABSOLUTE_SIZE_RANK_Z	Typical occurrences of ecological system smaller than polygons requires photo-interpretation or site visit.

Summary Rank Calculations

PRIORITY
Numeric field, Standardized values.
NOT CALCULATED. Priority areas for protection and restoration are determined by combining conservation rank (G-rank and S-Rank) and overall EIA Rank. Protection priority is suggested for rare associations and/or high integrity occurrences while a restoration focus is recommended for less rare elements and occurrences which have been degraded. PROTECTION is assigned to polygons with high integrity sites and high conservation ranked plant associations; RESTORTATION is assigned to polygons with mid-integrity sites weighted by conservation rank; NO ACTION is assigned to polygons with low integrity and lower conservation rank; FIELD VERIFY is assigned to polygon with ranked plant association with enough information to calculate an integrity score. Priority can be estimated in ARCMAP using a selection query such as "eia_input.G_RANK" = 'G2' AND "eia_input.S_RANK" = 'S2' AND "eia_output.CONDITION_RANK" >3.5, selects a subset of possible “PROTECTION” polygons.

TIER	EIA_RANK	EIA_RANK_TEXT	PRIORITY
1	4.5-5.0	A	PROTECTION
1	3.5-4.4	B	PROTECTION
1	2.5-3.4	C	PROTECTION & RESTORATION
1	1.0-2.4	D	PROTECTION & RESTORATION
1	NULL	NULL	PROTECTION FIELD VERIFY
2	4.5-5.0	A	PROTECTION
2	3.5-4.4	B	PROTECTION
2	2.5-3.4	C	RESTORATION
2	1.0-2.4	D	RESTORATION
2	NULL	NULL	FIELD VERIFY
3	4.5-5.0	A	PROTECTION
3	3.5-4.4	B	RESTORATION
3	2.5-3.4	C	RESTORATION
3	1.0-2.4	D	NO ACTION
3	NULL	NULL	FIELD VERIFY
4	4.5-5.0	A	PROTECTION
4	3.5-4.4	B	RESTORATION
4	2.5-3.4	C	RESTORATION
4	1.0-2.4	D	NO ACTION
4	NULL	NULL	FIELD VERIFY
NULL	4.5-5.0	A	PROTECTION
NULL	3.5-4.4	B	FIELD VERIFY
NULL	2.5-3.4	C	FIELD VERIFY
NULL	1.0-2.4	D	FIELD VERIFY

TIER
Numeric field, Standardized values.
NOT CALCULATED. An additional filter or Tier can be used to differentiate priorities within the PRIORITY Protection and Restoration categories. TIER groups association conservation G- and S-ranks into 4 categories of rarity or risk of extirpation. The conservation ranking systems developed by NatureServe and Natural Heritage programs is used to estimate conservation priorities (Faber-Langendoen et al 2009b). Plant associations are assigned conservation ranks by NatureServe across their full distribution (Global or G-Rank) and individual Natural Heritage Programs determine ranks at the state level (State or S-Rank). Both a global and state rank appear on a scale of 1 (high risk of extirpation) to 5 (low risk of extirpation). “NR” rank or “not ranked” is assigned to new plant associations not recognized by NatureServe (GNR) and/or by WNHP (SNR). Tier can be estimated in ARCMAP using a selection query such as "eia_input.G_RANK" = 'G2' AND "eia_input.S_RANK" = 'S2', selects subset of possible TIER 1 polygons.

TIER	G-RANK	S-RANK
1	G1	S1
1	G1	SNR
1	GNR	S1
1	G2	S1
1	G2	S2
1	G2	SNR
2	GNR	S2
2	G3	S1
2	G3	S2
2	G3	S3
2	G3	SNR
3	GNR	S2
3	G4	S1
3	G4	S2
4	G4	S3
4	G4	S4
4	G4	SNR
4	GNR	S4
3	G5	S1
3	G5	S2
4	G5	S3
4	G5	S4
4	G5	S5
4	G5	SNR
4	GNR	S5
4	GNR	SNR

EIA_RANK
Numeric field, Standardized values.
NOT CALCULATED. Average of LANDSCAPE_RANK + CONDITION_RANK + SIZE_RANK.
Ranks are numeric values with the ratings:

EIA_RANK SCORE	EIA_RANK TEXT
4.5-5.0	A
3.5-4.4	B
2.5-3.4	C
1.0-2.4	D

CONDITION_RANK
Numeric field, Standardized values.
Average of VEG_CONDITION_RANK + PHYSICAL_CONDITION_RANK + HYDRO_CONDITION_RANK.
Ranks are numeric values with the ratings are listed in EIA_RANK.

VEG_CONDITION_RANK
Numeric field, Standardized values.
This is the average of VEGETATION attributes of each ecological system. Not all attributes are measureable with available data but still occur in appropriate statement if need or opportunity arises to acquire new information.

VEG_CONDITION_RANK_1	average(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+NATIVE_BUNCHGRASS_RANK)
VEG_CONDITION_RANK_2	average(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+NATIVE_BUNCHGRASS_RANK+CANOPY_STRUCTURE)
VEG_CONDITION_RANK_3	average(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+NATIVE_BUNCHGRASS_RANK+SPECIES_COMPOSITION_RANK)
VEG_CONDITION_RANK_4	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK)
VEG_CONDITION_RANK_5	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+SPECIES_COMPOSITION_RANK+CANOPY_COMPOSITION_RANK)
VEG_CONDITION_RANK_6	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+LATE_SERAL_TREE_SIZE_AND_AGE+OAK_COVER)
VEG_CONDITION_RANK_8	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+FIRE_SENSITIVE_SHRUBS_RANK+NATIVE_BUNCHGRASS_RANK)
VEG_CONDITION_RANK_10	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SHRUB_COVER)
VEG_CONDITION_RANK_11	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK)
VEG_CONDITION_RANK_12	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+LARGE_LIVE_TREES_RANK)

VEG_CONDITION_RANK_13	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+CANOPY_COMPOSITION_RANK)
VEG_CONDITION_RANK_14	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+CONIFER_ENCROACHMENT+RELATIVE_SHRUB_COVER)
VEG_CONDITION_RANK_16	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+NATURAL_TREE_REGENERATION)
VEG_CONDITION_RANK_17	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+LARGE_LIVE_TREES_RANK+NATURAL_TREE_REGENERATION)
VEG_CONDITION_RANK_19	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+CANOPY_STRUCTURE)
VEG_CONDITION_RANK_22	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+LARGE_LIVE_TREES_RANK)
VEG_CONDITION_RANK_23	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+LATE_SERAL_TREE_SIZE_AND_AGE)
VEG_CONDITION_RANK_26	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+SPECIES_COMPOSITION_RANK+TREE_ABUNDANCE)
VEG_CONDITION_RANK_28	AVERAGE(COVER_NATIVE_UNDERSTORY_RANK+EXOTIC_INVASIVE_RANK+CANOPY_DOMINANT_AGE_RANK+LARGE_LIVE_TREES_RANK+NATURAL_TREE_REGENERATION)

PHYSICAL_CONDITION_ RANK
Numeric field, Standardized values.
This is the average of PHYISOCHEMICAL attributes of each ecological system. Not all attributes are measureable with available data but still occur in appropriate statement.

PHYSICAL_CONDITION_RANK_1	AVERAGE(SOIL_SURFACE_CONDITION_RANK)
PHYSICAL_CONDITION_RANK	AVERAGE(SOIL_SURFACE_CONDITION_RANK+SLOPE_ALTERATION)

HYDRO_CONDITION_ RANK
Numeric field, Standardized values.
This is the average of HYDROLOGICAL attributes of each ecological system. Not all attributes are measureable with available data but still occur in appropriate statement if need or opportunity arises to acquire new information.

HYDRO_CONDITION_RANK	AVERAGE(HYDROPERIOD_RANK)
HYDRO_CONDITION_RANK_1	AVERAGE(HYDROPERIOD_RANK+CHANNEL_STABILITY)

SIZE_ RANK
Numeric field, Standardized values.
NOT CALCULATED. This is the average of RELATIVE_SIZE and ABSOLUTE_SIZE attributes of each ecological system. Due to time constraints, RELATIVE_SIZE was not estimated because it requires photo-interpretation of each polygon.

LANDSCAPE Attributes

Due time constraints Landscape variable were not included in GIS script or analysis.

BUFFER_LENGTH_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the percent of a polygon's perimeter is adjacent to natural ecological systems.

BUFFER_WIDTH_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the average width of a buffered area surrounding a polygon that is a natural ecological system.

BUFFER_CONDITION_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the ecological condition estimated by CONDITION_RANK of a polygon's surrounding polygons

CONNECTIVITY_RANK, CONNECTIVITY_RIPARIAN_RANK,
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as the percent of a surrounding area that provides natural habitat.

EDGE_CONDITION_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the ecological condition of surrounding polygons estimated by CONDITION_RANK or other condition rating information.

EDGE_LENGTH_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the percent of a polygons perimeter in adjacent to natural ecological systems.

EDGE_WIDTH_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the average width of a area surrounding a polygon that is a natural ecological system.

FRCC_DEPARTURE
Numeric field, Standardized values.
Unassessed GIS approach would estimate the Landscape Fire Condition attribute. Mixed to high severity fire is vital to maintaining ecological integrity (Fire Regime Condition Class 2008). Intersection of existing polygons with FRCC map layer with FRCC 1 rate as "A", FRCC 2 rate as "BC" and FRCC 3 rate as "D".

LANDSCAPE_CONDITION_MODEL_INDEX_RANK PROXIMITY
Numeric field, Standardized values.
Unassessed GIS approach would estimate this LANDSCAPE metric as a GIS field that assesses the intensity and types of land uses within a 50 ha circle around the occurrence can affect ecological integrity developed by NatureServe.

OLD_GROWTH_PROPORTION_60_WITHIN_1_KM_RANK
OLD_GROWTH_PROPORTION_75_WITHIN_1_KM_RANK
OLD_GROWTH_PROPORTION_80_WITHIN_1_KM_RANK
Numeric field, Standardized values.
Unassessed GIS approach would estimate these LANDSCAPE metrics as a GIS or photo-interpretation field that assess the amount of old-growth forest within 1 km surrounding a polygon. Patch diversity reflects natural dynamics of mixed or high severity fire and gap replacement processes that proportionally varies with ecological system (Landfire 2007a).

LANDSCAPE_ RANK
Numeric field, Standardized values.
NOT CALCULATED. This is the average of LANDSCAPE attributes of each ecological system. Not all attributes are measureable with available data but still occur in appropriate statement if need or opportunity arises to acquire new information.

LANDSCAPE_RANK_1	AVERAGE(BUFFER_WIDTH_RANK+BUFFER_CONDITION_RANK+BUFFER_LENGTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+HYDRO_CONNECTIVITY_RANK)
LANDSCAPE_RANK_2	AVERAGE(BUFFER_WIDTH_RANK+BUFFER_CONDITION_RANK+BUFFER_LENGTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK)
LANDSCAPE_RANK_3	AVERAGE(BUFFER_WIDTH_RANK+BUFFER_CONDITION_RANK+BUFFER_LENGTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+HYDRO_CONNECTIVITY_RANK+FRCC_DEPARTURE)
LANDSCAPE_RANK_4	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+FRCC_DEPARTURE)
LANDSCAPE_RANK_5	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+FRCC_DEPARTURE+FINE_SCALE_MOSAIC)
LANDSCAPE_RANK_6	AVERAGE(BUFFER_WIDTH_RANK+BUFFER_CONDITION_RANK+BUFFER_LENGTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+FRCC_DEPARTURE)
LANDSCAPE_RANK_7	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+OLD_GROWTH_PROPORTION_60_WITHIN_1_KM_RANK+PATCH_DIVERSITY_ORIGIN_WITHIN_1_KM_RANK)
LANDSCAPE_RANK_8	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+OLD_GROWTH_PROPORTION_75_WITHIN_1_KM_RANK+PATCH_DIVERSITY_ORIGIN_WITHIN_1_KM_RANK)
LANDSCAPE_RANK_9	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+OLD_GROWTH_PROPORTION_80_WITHIN_1_KM_RANK+PATCH_DIVERSITY_ORIGIN_WITHIN_1_KM_RANK)
LANDSCAPE_RANK_10	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+PATCH_DIVERSITY_ORIGIN_WITHIN_1_KM_RANK)

LANDSCAPE_RANK_11	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK+FRCC_DEPARTURE+GRASSLAND_PROXIMITY)
LANDSCAPE_RANK	AVERAGE(EDGE_CONDITION_RANK+EDGE_LENGTH_RANK+EDGE_WIDTH_RANK+LANDSCAPE_CONDITION_MODEL_INDEX_RANK+CONNECTIVITY_RANK)

Supplementary Layers for Planning

These are placeholder fields without values in the geodatabase.

CLIMATE_VULNERABILITY
Unassessed GIS approach would estimate the vulnerability of each polygon by intersection with a Climate Vulnerability GIS layer or with vulnerability scores of ecological system per polygon.

PRIORITY_HABITAT
Unassessed GIS approach would estimate the wildlife habitat value of each polygon through intersection with the Washington Dept. of Fish and Wildlife Priority Habitat System GIS layer.

RARE_PRIORITY_SPECIES
Unassessed GIS approach would estimate the potential value of each polygon to rare species through intersection with WNHP and Washington Dept. of Fish and Wildlife heritage GIS layers.

Appendix D. Report Table Excel Spreadsheet

This excel file, **ReportTables.xlsx**, includes a set of tables summarizing information in the June 15, 2011 geodatabase.

AllFields is the crosswalk among attribute field labels for all State Park mapping projects. This was necessary to create a single set of values to apply Ecological Integrity Assessments across all parks. Standard field names appear in row 1 and map project/original shape file name in Column B. See Appendix SSS for final field definitions.

AllValues is the MAIN and INPUT tables in the geodatabase plus plant association and ecological system fields. Row 1 is the GIS table in which the field appears in the June 15, 2011 geodatabase. Row 2 lists field or attribute names. (See Appendix A. Main Metadata for column (field or attribute names) definitions)

EIAs is a compilation of all EIA tables for Ecological Systems in mapped Ste Parks. Row 1 lists the NatureServe Ecological System code, Row 2 column titles from EIA tables and a list of abbreviated names of ecological systems. Column A "EIA datasource" lists the relationship between State Park mapping attributes and EIA attributes and values. Column B through J EIA attributes, rating factors, and justification, Column K through BF Ecological System and EIA attribute relationship designated by "Y".

EIA_OUTPUT displays EIA calculations and attributes. Column A lists the field names in the June 15, 2011 geodatabase EIA_OUTPUT file. Column B "QUERY Statement or potential data source" displays the relationships among EIA_INPUT and MAIN table fields and EIA_OUTPUT calculated fields or Rank factors. For example, EIA_OUTPUT field CANOPY_DOMINANT_AGE_RANK is calculated by IF(STAND_STRUCTURE_EIA=3 OR 4 OR 6 OR 8 OR 9), "A", IF(STAND_STRUCTURE_EIA=2 OR 5 OR 7, "BC", IF(STAND_STRUCTURE_EIA=1, "D"))). The logic statement is translated into PYTHON script in GIS. Column B "QUERY Statement or potential data source also indicates the status and possible means to estimate EIA_OUTPUT field not calculated for this project. (See Appendix C. EIA_OUTPUT Metadata for column (field or attribute names) definitions.)

EcolSysMetrics show the relationship between Ecological System (Column B) and EIA_OUTPUT (Row 2) designated by "Y". Row 1 duplicates information in **EIA_OUTPUT.**

TIER_PRIORITY lists all Plant associations in the project, their G_Rank, S_Rank, and TIER. It also illustrates the relationship between Tier, EIA_Rank score, and Priority for conservation.