An Evaluation of Ecological Integrity Assessments (EIAs) as a Tool for Non-Profit Land Conservancies, with Forterra NW as a Case Study

Forterra's Hazel Wolf Wetlands Preserve (photo by Collette MacLean)

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ABSTRACT

Ecological Impact Assessments (EIAs) are tools for assessing the composition, structure, and function of ecosystems relative to intact reference systems. EIAs are being used by state agencies across the United States, and Washington State's Department of Natural Resources has recently adapted the EIA methodology for use in Washington. Nonprofit land trusts, in contrast, often do not utilize any consistent method of assessing their lands. In order to determine whether EIAs are a useful assessment tool for land trusts, 10 EIAs were conducted on properties owned by Forterra NW, a nonprofit land conservancy in Washington. Factors evaluated included the time, effort, and botanical expertise required to complete the EIAs, as well as the perceived value of the assessments by Forterra's land manager. Land managers from several other land trusts in Washington were interviewed about their impressions of EIAs, as were state land managers from environmental agencies in Washington and several other states that use this type of assessment. While EIAs provided valuable ecological information for land managers, many land trust managers reported that they do not have the capacity in terms of staff time and expertise to perform this type of intense assessment. Increasing funding for stewardship in general, and ecological assessments specifically, would provide more opportunities for this type of assessment. Modifications to the protocols to reduce the time and expertise needed can also make the EIA methodology more appealing to nonprofit land trusts.

Contents

Tables

Figure

Acknowledgments

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Introduction

Accurately assessing the ecological condition of land is critical for land managers. An ecological assessment allows managers to obtain a baseline of site conditions, track changes, identify and monitor invasive or rare species, and prioritize restoration or other management activities. The concept of ecological integrity is increasingly being used by land managers as a framework for assessing and monitoring land (Wurtzebach and Schultz 2016). In ecological integrity assessments, the structure, function, and composition of an ecosystem are assessed using a set of metrics that are relatively easy to measure, robust, and repeatable. These metrics are used to compare the area being assessed to appropriate reference habitats, within a natural range of variation. NatureServe's Ecological Integrity Assessment (EIA) methodology is a system that has been developed for use in state Natural Heritage Programs. In states such as Washington, state land management agencies have recently adopted this methodology, sometimes modifying it to fit agency needs.

Land conservancies (also known as land trusts) are growing in number and acreage managed in the United States. According to the Land Trust Alliance's latest census, 56 million acres of land were preserved by land conservancies as of 2015, an increase of 9 million acres since the 2010 census (Land Trust Alliance 2015). Of these lands, approximately 8 million acres are owned and managed by land trusts, with the rest conserved through transfer to agencies, conservation easements, or other mechanisms. In Washington state, over 126,000 acres of land are owned by land trusts, with much more protected through conservation easements and other mechanisms (Land Trust Alliance 2015). However, very few land trusts have systems in place to assess the ecological condition of their lands. Some Washington land trust managers have begun implementing or exploring using EIAs as a way to assess and monitor their lands.

Forterra NW (Forterra) is one of the largest land conservancies in Washington, owning or holding conservation easements on over 15,000 acres of land. Land managers at Forterra have been considering assessment methodologies for their increasing natural land base acreage. In order to test the efficacy of using EIAs for this purpose, ten EIAs were conducted on Forterra lands. Results from these EIAs were evaluated by the lands manager for possible adoption of the EIA methodology across Forterra lands.

In addition to evaluating using EIAs on Forterra lands, interviews were conducted with managers from other Washington land conservancies as well as state agencies in Washington and several other states to gain a broader perspective on whether this methodology is a practical way to assess diverse land holdings. Alternatives and modifications to the EIA methodology were also considered.

Background

The concept of ecological integrity has been utilized as a useful standard by which to assess and report the health of ecosystems (Harwell et al 1999, Parrish et al 2003, Tierney et al 2009). A working definition of ecological integrity is "an assessment of the structure, composition, function, and connectivity of an ecosystem as compared to reference ecosystems operating within the bounds of natural or historical disturbance regimes" (Faber-Langendoen et al 2016). Assessing ecological integrity has been incorporated into legislation such as the 1972 federal Clean Water Act and is currently being used by many federal and state agencies, including the US National Park Service (Tierney et al 2009, Mitchell et al 2014, Unnasch et al 2018), US Bureau of Land Management (Carter et al 2019), US Forest Service (Forest Service Planning Rule 36 CFR 219

2012), US Fish and Wildlife Service (Fish and Wildlife Service Manual 602 FW 1 2000), and Parks Canada (Theau et al 2018, Wurtzebach and Schultz 2016).

Methodologies for assessing ecological integrity utilize several common elements: (1) the use of indicators that can serve as proxy for more complex and hard to measure attributes of an ecosystem; (2) the use of a specific set of metrics that can be easily measured; (3) identification of reference sites to compare to the ecosystem being assessed, and; (4) a composite score or rating that can be communicated to the public (Carignan and Villard 2002, Faber-Langendoen et al 2006, Harwell 1999, Niemi and McDonald 2004, Parrish et al 2003, Tierney et al 2009). NatureServe's EIA methodology, developed in collaboration with several state Natural Heritage Program managers over approximately 15 years, incorporates the above elements into systems for analyzing wetland and upland ecosystems (Faber-Langendoen et al 2016). An EIA is "an index of ecological integrity based on metrics of biotic and abiotic condition, size, and landscape context intended to measure current ecological condition as compared to the reference standard" (Rocchio and Crawford 2011).

The EIA methodology is designed so that it can be applied at multiple levels, including landscape-level assessment based on remote sensing (Level 1), rapid field-based assessment based on semi-quantitative or quantitative metrics (Level 2), and intensive field measurements using detailed quantitative metrics (Level 3) (Table 1). Level-based metrics are used to assess Major Environmental Factors (MEFs), which are descriptors of ecosystem characteristics such as landscape connectivity, native species composition, and soil condition. These factors are rated as compared to reference conditions, incorporating knowledge of natural range of variation, and some are weighted depending on several factors such as the rarity of a particular ecosystem. MEFs are consolidated into Primary Rank Factors: Landscape Context, Condition, and Size, using weights based on the importance of the factor to the overall score (Faber-Langendoen et al 2006). Numerical scores are then aggregated into a composite score that is converted to a grade (A+ - D).

Table 1: Three-level Approach to EIA Methodology, adapted from Rocchio and Crawford 2011.

	Level 1: Remote Assessment	**Level 2: Rapid Assessment**	**Level 3: Intensive Assessment**
Evaluation methodology:	Remote sensing indicators	Remote sensing indicators, Simple field indicators	Detailed field indicators
Based on:	GIS and remotely sensed data such as land use/cover	Remotely sensed data for landscape metrics. In field, condition metrics such as species composition	Indicators calibrated to measure response to disturbance such as indices of biotic integrity
Potential uses:	Identifies priority sites, vegetative status and trends across the landscape, and condition of ecological types across the landscape	Promotes integrated scorecard reporting, informs monitoring for management or restoration projects, Supports watershed planning	Identifies status and trends of specific occurrences or indicators, promotes integrated scorecard reporting, informs monitoring
Example metrics:	Land use, road density, percent impervious surface	Contiguous natural land cover, invasive nonnative plant species cover, hydrologic connectivity	Invasive nonnative plant species cover, Floristic Quality Index

Several state agencies have utilized NatureServe's EIA methodology, often with modifications. New Hampshire, Michigan, Wisconsin, Colorado, Florida, Alabama, and Washington all use EIA methodology to assess state lands (Lemly et al 2016, Nichols and Faber-Langendoen 2015, O'Connor et al 2019, Faber-Langendoen, personal communication, October 25, 2019). In Washington State, the Department of Natural Resources (DNR) Washington Natural Heritage Program (WNHP) has adapted the EIA methodology to be used in conjunction with Washington's Ecological Systems (Rocchio and Crawford 2011, Rocchio and Ramm-Granberg 2017, Rocchio et al 2018). In addition to using this methodology on DNR lands, DNR is promoting its use on other state lands, including Washington State Parks and Washington Department of Fish and Wildlife lands (Schroeder et al 2011, Rocchio personal communication, October 19, 2019).

Land conservancies are private, non-profit organizations that conserve land with ecological value, among other goals. Washington state has 35 active land conservancies that collectively owned over 126,165 acres of land as of 2015 (Land Trust Alliance 2016). However, there is no standardized methodology for assessing the lands that are owned and managed by these trusts. The type and rigor of assessment methods used by these land managers varies from visual assessments based on land manager knowledge to semi-quantitative methods such as permanent plots or photo points. Without a standardized way to conduct ecological inventories or monitor biological parameters, land conservancies may not be able to tell whether their conservation goals are being met (Alexander and Hess 2012). EIAs provide one method of assessing land that may provide a way for land trusts to monitor progress toward conservation goals.

Forterra is one of the largest land trusts in Washington state, with fee ownership of over 8,900 acres of land as of the end of 2019, in addition to holding over 7,700 acres in conservation easements. Forterra's natural lands are located primarily in western and central Washington and include mostly second-growth forests, with some old-growth forests as well as wetlands, sagebrush-steppe, remnant prairies, and shoreline/estuarine habitats. Forterra does not currently have a standardized method for assessing their lands and is considering adopting EIA methodology for this purpose.

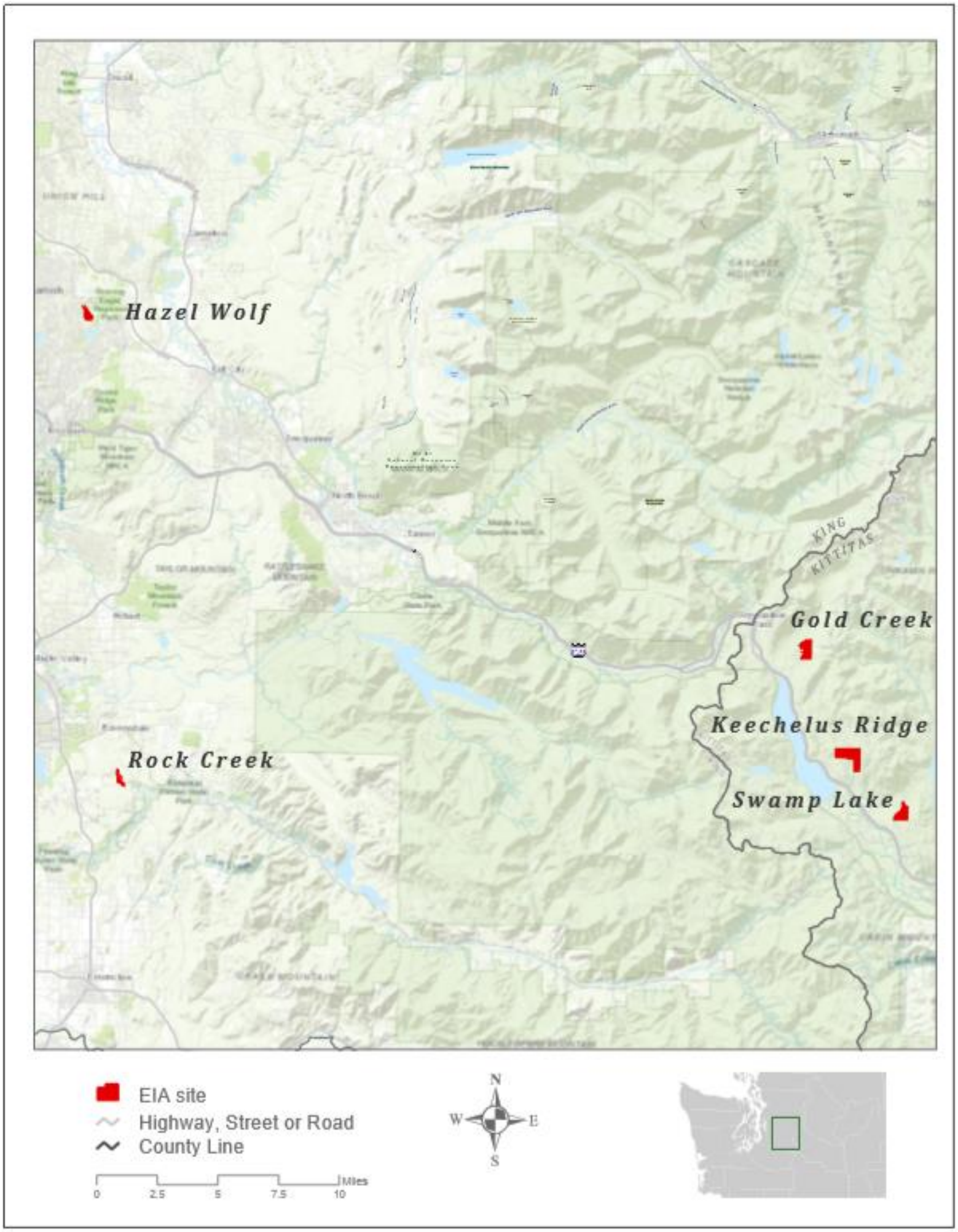
Methodology

Ten Level 2 EIAs were performed on five Forterra properties as a "proof of concept" of the EIA methodology. Washington DNR's EIA assessment protocols for upland or wetland/riparian ecosystems were followed for all EIAs (Rocchio and Ramm-Granberg 2017, Rocchio et al 2018; Appendices E and F). The latest versions of these protocols are publicly available at https://www.dnr.wa.gov/NHP-EIA. Level 2 (“rapid”) assessments were used in order to attain the most useful information within a relatively rapid timeframe. Level 1 monitoring was considered to be too general to provide adequate information for the assessment needs of most land conservancies, and Level 3 monitoring is generally not an option for land conservancies due to the cost and time commitment necessary to perform these intensive assessments.

Ten EIA sites were chosen from Forterra’s fee-owned properties in consultation with the Forterra Lands Manager. For the purposes of direct comparison, EIA sites were chosen from similar types of ecosystems, all west of or near the crest of the Cascade Mountains (Figure 1). Six of the EIA sites were second growth forests and three sites were wetland or riparian habitats. One site was a non-forested shrubland near the Cascade crest, chosen for its proximity to other sites and therefore ease of sampling.

The size of each EIA site was calculated using Arc-GIS. Property boundaries were overlaid on a shapefile of Washington Ecological Systems (Washington DNR 2019) to delineate likely EIA site boundaries. This shapefile provides a coarse level map of Ecological Systems found in Washington State. Ecological Systems are terrestrial plant communities that recur in landscapes with similar environmental conditions (Comer et al 2003). They serve as reference conditions and inform what metrics to measure in upland EIA analyses (Rocchio and Crawford 2011). For the purposes of upland EIAs, Ecological Systems are grouped into EIA Modules, which are aggregations of ecosystems that share ecological processes such as climate, soils, and broad disturbance regimes. For wetlands or riparian areas, United States National Vegetation Classification (USNVC) formations are used rather than EIA modules.

Figure 1: EIA Site Locations



Each EIA site was assigned an Ecological System using the above mapping method; DNR's Ecological Systems of Washington publication (Rocchio and Crawford 2015) was then used to verify the specific Ecological System and module or USNVC formation for each EIA site. A separate EIA must be performed for each Ecological System, so a property that contains multiple Ecological Systems requires multiple EIAs; there is no system to aggregate EIAs over different Ecological Systems (Faber-Langendoen et al 2019).

One of the first steps in all EIAs is determining the assessment area (AA). The size of the assessment area determines the sampling protocol. Large AAs (sites larger than 125 acres) are evaluated using a combined polygon/point-based approach, where randomly distributed plots are assessed within the AA. For sites smaller than 125 acres (small AAs), a polygon-based assessment is used, with a site walkthrough used to make observations that are synthesized into metric ratings. AA size in conjunction with EIA module or USNVC formation determines which metrics to apply.

Minimum AA size requirements also apply, depending on the patch type. Patch types describe the typical spatial pattern on the landscape of Ecological Systems; patch types include Matrix, Large Patch, Small Patch, and Linear (Comer et al. 2003). Matrix patches are ecosystems with extensive cover on the landscape, typically 5,000 to 25,000 acres in size in undisturbed conditions. An example of a matrix patch is a conifer-dominated forest west of the Cascade Mountains. The minimum AA size within a matrix patch type is 5 acres. Large patches are ecosystems that form large areas of cover, often interrupted (125 to 5,000 acres in undisturbed conditions), such as subalpine parkland in the Cascade Mountains. The minimum AA size within a large patch is 1 acre. Small patches form small areas of cover (<125 acres), limited by environmental conditions. This patch type includes many wetlands. Minimum AA size is 5000 square feet. Linear patches occur in linear strips, such as riparian zones, and are typically 1- 60 miles in length. Minimum AA size within linear patches is 100 linear feet (Rocchio and Crawford 2015).

EIAs were performed from June through August 2019, with each site receiving one field visit. For remote sites, two people conducted field visits for safety purposes. Sites that were easily accessible were evaluated by one person. GIS mapping and analysis was performed in an office setting, either before or after the site visits. Table 2 lists the EIA sites.

Table 2: EIA Sites on Forterra Lands

Site Name	Ecological System	EIA module or USNVC formation	Size (acres)	Assessment Protocol	Date of field visit
Keechelus Ridge Forest	North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest	Mesic/Hypermaritime Forests	327	randomly distributed plots	June 21, 2019
Gold Creek Forest	North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest	Mesic/Hypermaritime Forests	186	randomly distributed plots	June 28, 2019
Swamp Lake Forest	North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest	Mesic/Hypermaritime Forests	211	randomly distributed plots	July 19, 2019
Hazel Wolf Forest	North Pacific Maritime Mesic-Wet Douglas Fir - Western Hemlock Forest	Mesic/Hypermaritime Forests	72	site walkthrough	June 27, 2019
Rock Creek Forest	North Pacific Maritime Mesic-Wet Douglas Fir– Western Hemlock Forest	Mesic/Hypermaritime Forests	24	site walkthrough	July 25, 2019
Gold Creek Shrubland	North Pacific Avalanche Chute Shrubland	Shrublands	47	site walkthrough	June 28, 2019
Gold Creek Riparian	North Pacific Lowland Riparian Forest and Shrubland	Freshwater Marsh, Wet Meadow, and Shrubland	0.5	site walkthrough	June 28, 2019
Rock Creek Forested Wetland	North Pacific Hardwood-Conifer Swamp	Flooded and Swamp Forest	76	site walkthrough	July 25, 2019
Hazel Wolf Aquatic Bed Wetland	Temperate Pacific Freshwater Aquatic Bed	Freshwater Aquatic Vegetation	19	site walkthrough	June 27, 2019
Hazel Wolf Scrub Shrub Wetland	North Pacific Shrub Swamp	Freshwater Marsh, Wet Meadow, and Shrubland	3	site walkthrough	August 23, 2019

Assessment Protocols

DNR's WNHP Level 2 EIA upland or wetland/riparian assessment protocols were followed at each site (Rocchio and Ramm-Granberg 2017, Rocchio et al 2018). Metrics differ slightly between upland and wetland assessments. For upland assessments, data are collected for 11 - 13 metrics, depending on the type and size of system being assessed (some metrics such as woody regeneration are only used for forested EIAs, for example). These metrics are combined into five Major Ecological Factors: Landscape, Edge, Vegetation, Soils, and Size. The MEFs are then consolidated into three Primary Rank Factors: Landscape Context, Condition, and Size. The Landscape Context and Condition scores are differentially weighted and combined to calculate the EIA score, which is then assigned a rank between A+ and D (Rocchio et al 2018). Table 3 illustrates the metrics scored and weights used to determine MEF scores from the WNHP upland EIA assessment field form.

For wetland or riparian assessments, 14 - 16 metrics are scored, depending on the type of wetland, and combined into 6 MEFs: Landscape, Buffer, Vegetation, Hydrology, Soils, and Size. MEFs are combined to determine the same Primary Rank Factors as used in upland assessments (Landscape Context, Condition, and Size), and EIA scores and ranks are calculated as in the upland protocol (Rocchio and Ramm-Granberg 2017).

The Size Primary Factor score is not used for the EIA score but is used to determine if the site being assessed may qualify as an Element Occurrence (EO). EOs are rare ecosystems, or common ones with excellent ecological integrity, that are designated by state natural heritage programs (Rocchio et al 2018). Determining whether sites may rank as EOs is an optional additional step that uses EIA data as well as Global / State Conservation Status Ranks (predetermined for ecosystem types by NatureServe and state Natural Heritage Programs).

<u>Table 3: Score Metrics and Weights from WNHP Upland EIA Field Form</u>

Roll-up Calculations	Rating	Score (TABLE 1)
LAN1. Contiguous Natural Land Cover		
LAN2. Land Use Index		
LAN MEF Score = (LAN1+LAN2)/2 (TABLE 2)		
EDG1. Perimeter with Natural Edge		
EDG2. Width of Natural Edge		
EDG3. Condition of Natural Edge (do not include in calculation if not scored)		
EDG MEF Score = (((EDGF1*EDG2)$^{1/2}$)*EDG3)$^{1/2}$ [Note: ½ exponent = square root] **(TABLE 2)**		
LANDSCAPE CONTEXT PRIMARY FACTOR SCORE = (EDG Score*0.67)+(LAN Score*0.33) (TABLE 2)		
Matrix = (EDG Score*0.33)+(LAN Score*0.67) **Large-Patch = (EDG Score*0.50)+(LAN Score*0.50)** **Small-Patch = (EDG Score*0.67)+(LAN Score*0.33)**		
VEG1. Native Plant Species Cover		
VEG2. Invasive Nonnative Plant Species Cover		
VEG3. Native Plant Species Composition		
VEG4. Vegetation Structure		
VEG5. Woody Regeneration		
VEG6. Coarse Woody Debris		
(FORESTED) VEG MEF Score = [((VEG1+VEG2+VEG3)*0.4)+((VEG4+VEG5+VEG6)*0.6)/6 (Table 2)		
(NONFORESTED) VEG MEF Score = (VEG1+VEG2+VEG3+VEG4+VEG5+VEG6)/6 (Table 2)		
[Note: Divide by number of metrics scored (i.e. divide by four if VEG1-VEG4 scored)]		
SOI1. Soil Condition		
SOI MEF Score = SOI1		
CONDITION PRIMARY FACTOR SCORE = (VEG Score*0.85)+(SOI Score*0.15) (TABLE 2)		
ECOLOGICAL INTEGRITY (EIA) SCORE (TABLE 2) **Matrix/Large-Patch = (CONDITION SCORE*0.55)+(LANDSCAPE CONTEXT SCORE*0.45)** **Small-Patch = (CONDITION SCORE*0.7)+(LANDSCAPE CONTEXT SCORE*0.3)**		
SIZ1. Comparative Size		
SIZ2. Change in Size (optional)		
SIZ MEF Score = SIZ1 OR (SIZ1+SIZ2)/2 (TABLE 2)		
SIZE Points (TABLE 3)		
ELEMENT OCCURRENCE RANK (EORANK) = EIA Score + SIZE Points (TABLE 2)		

Table 1. Metric Rank / Score Conversions

Rank	A	A-	B	BC	C	C-	D
Score	4	3.5	3	2.5	2	1.5	1

Table 2. Score / Rank Conversions for MEF, EIA and EORANK calculations

Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Table 3. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	**Very Small/Small Patch**	**Large Patch**	**Matrix**
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

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One of the key elements of EIA methodology is the identification of all plant species present in an area. Percent cover of native and non-native or invasive species and native plant species composition are calculated from these comprehensive species lists and factored into the Vegetation MEFs. Other vegetative metrics include number of native “increaser” species (species that increase due to disturbance) and native “decreaser” species (species that decline rapidly with disturbance). These metrics related to vegetation are the most heavily weighted in EIAs.

The appropriate EIA protocol was followed for each of the 10 sites on Forterra lands. EIA metrics were scored on WNHP’s upland or wetland Level 2 EIA field forms (Appendices A and B). EO ranks and preliminary determinations were also calculated for the sites assessed. EIA and EO scores for the 10 sites were summarized in a spreadsheet and a short report was written for each site summarizing EIA metrics (Appendix C).

Interviews

After the EIAs were complete, an in-person interview was conducted with the Forterra lands manager to report results and discuss the protocol. The lands manager was asked to discuss his impressions of the EIA assessments as well as any concerns about the methodology, and to provide his opinion of the potential for using this methodology for assessment of Forterra lands in the future.

Phone or email interviews were conducted with land managers from four other land trusts in Washington as well as from state agencies in Washington and several other states, and with the director of NatureServe (Table 4). Managers were questioned as to whether they or not use EIAs. Those that use EIAs were asked what they thought of the methodology, what concerns they had, and what modifications they made to the protocols, if any. Managers of organizations that do not use EIAs were asked what assessment tool they use and if they have considered EIAs. Any organizations contacted that have decided against using EIAs were asked their reasoning for this decision.

Table 4: Land Managers/ecologists Interviewed

Organization Name	**Organization Type**	**Location**	**Name and Title**	**Date of Interview**
Forterra NW	Nonprofit Land Conservancy	Seattle, WA	Stuart Watson, Lands Manager	October 9, 2019
Columbia Land Trust	Nonprofit Land Conservancy	Vancouver, WA	Ian Sinks, Stewardship Director	October 7, 2019; February 11, 2020
The Nature Conservancy	Nonprofit Land Conservancy	Mt. Vernon, WA	Randi Shaw, Stewardship Manager	November 25, 2019
Chelan-Douglas Land Trust	Nonprofit Land Conservancy	Wenatchee, WA	Neal Hedges, Stewardship Director	October 28, 2019
Whatcom Land Trust	Nonprofit Land Conservancy	Bellingham, WA	Jennifer Mackey, Stewardship Director	November 13, 2019
NatureServe	Nonprofit Science and Conservation Organization	Arlington, VA	Don Faber-Langendoen, Senior Ecologist/ Conservation Methods Coordinator	October 25, 2019
Washington Department of Natural Resources	State Agency	Olympia, WA	Joe Rocchio, Senior Vegetation Ecologist	June 12, 2019; September 10, 2019; September 30, 2019; October 19, 2019
Washington Department of Fish and Wildlife	State Agency	Olympia, WA	Matt Vander Haugen, Senior Research Scientist	October 29, 2019
Missouri Department of Conservation	State Agency	Jefferson City, MO	Mike Leahy, Natural Community Ecologist	October 31, 2019
New Hampshire Natural Heritage Bureau	State Agency	Concord, NH	Bill Nichols, Senior Ecologist/ State Botanist	October 30, 2019
Wisconsin Department of Natural Resources	State Agency	Madison, WI	Ryan O’Connor, Ecologist/Inventory Coordinator	October 29, 2019

Results

Forterra EIAs

Ten EIAs were successfully completed on five Forterra properties. EIA scores ranged from a low of 2.44 (C+) to a high of 3.71 (A-). One site (Rock Creek Forested Wetland) may qualify as an EO (Table 5). Submetric details are reported in Table 6.

Field time for each EIA averaged 5 hours per person (including driving time). In-office GIS work, data summary, and report writing averaged 3 hours per EIA. Examples of detailed EIA scores for upland and wetland sites are provided in Appendices A and B, and reports for each site are in Appendix C.

Table 5: Forterra Sites EIA Scores

Site Name	EIA Score	EIA Rank	EO Rank	Possible EO?
Keechelus Ridge Forest	3.11	B+	B-	No
Gold Creek Forest	2.86	B-	D	No
Swamp Lake Forest	2.75	B-	D	No
Hazel Wolf Forest	2.44	C+	D	No
Rock Creek Forest	3.41	B+	B+	No
Gold Creek Shrubland	3.71	A-	B+	No
Gold Creek Riparian	3.55	A-	B+	No
Rock Creek Forested Wetland	3.63	A-	A+	Yes
Hazel Wolf Aquatic Bed Wetland	2.99	B-	B+	No
Hazel Wolf Scrub Shrub Wetland	2.52	B-	C+	No

Table 6: Forterra Sites EIA Submetrics

Site Name	Landscape MEF	Buffer MEF	Vegetation MEF	Hydrology MEF	Soil/ Substrate MEF	Landscape Context Score	Condition Score	Landscape Context Rank	Condition Rank	EIA Score	EIA Rank
Keechelus Ridge Forest	3.00	3.72	3.00	n/a	3.00	3.24	3.00	B	B	**3.11**	**B+**
Gold Creek Forest	3.00	3.72	2.47	n/a	3.00	3.24	2.55	B	B	**2.86**	**B-**
Swamp Lake Forest	3.00	3.00	2.47	n/a	3.00	3.00	2.55	B	B	**2.75**	**B-**
Hazel Wolf Forest	2.00	2.28	2.67	n/a	3.00	2.09	2.72	C	B	**2.44**	**C+**
Rock Creek Forest	2.50	4.00	3.47	n/a	4.00	3.25	3.55	B	A	**3.41**	**B+**
Gold Creek Shrubland	3.00	3.72	4.00	n/a	4.00	3.36	4.00	B	A	**3.71**	**A-**
Gold Creek Riparian	3.00	3.72	3.88	3.00	4.00	3.48	3.58	B	A	**3.55**	**A-**
Rock Creek Forested Wetland	2.50	3.22	3.67	4.00	4.00	2.98	3.82	B	A	**3.57**	**A-**
Hazel Wolf AB Wetland	2.00	3.22	3.13	3.00	3.00	2.82	3.07	B	B	**2.99**	**B-**
Hazel Wolf SS Wetland	2.00	3.00	2.00	3.00	3.00	2.67	2.45	B	C	**2.52**	**B-**

Interviews

Table 7 summarizes interviews with land managers from Forterra, other Washington land trusts, and state agencies that responded to interview requests about their use of EIAs. Although NatureServe's director was interviewed about the history of EIA development and to identify users, this organization does not actively manage land and so is not included in Table 7.

Interview with Forterra lands manager

Forterra currently uses a combination of professional judgment by the lands manager and, in some cases, input from partners to assess their lands. Partners may include individuals or organizations that perform biological surveys or other ecological assessments on Forterra land for a variety of reasons specific to the properties. For example, the acquisition of Forterra's Hazel Wolf Wetlands Preserve was driven by a years-long effort by concerned citizens to permanently protect this property. As part of their efforts, these citizens performed botanical, bird, and amphibian surveys to document the biodiversity at this site. For most Forterra properties, however, any ecological assessment done is incidental to required site monitoring and maintenance activities.

The Forterra lands manager was favorably impressed with the information provided by the EIAs done on Forterra lands. He commented that some of the metrics collected for EIAs were not factors that would be monitored in a routine site visit but were useful to consider in terms of site integrity (for example, the number of snags seen in a forest). He also noted that the necessity of sampling at random plots in large EIA sites meant that the sites were more thoroughly surveyed than during routine monitoring, which is often conducted from roads and trails. He considered these to be benefits of using a systematic protocol like EIAs rather than an assessment based on purely professional judgment. He found the summary reports to be useful for the purpose of comparison between sites for use in management decisions such as where to focus restoration activities.

Although the lands manager thought the information from EIAs would be useful for assessing Forterra lands, he was unsure how this effort could be funded. Another concern was that the skills needed to identify all the plants at a site might not always be available, i.e., a person with those skills might not be always be employed at Forterra. Overall, he concluded that while EIAs provided valuable information, the uncertainty as to the availability of funds and botanical skills available in-house in order to perform the work consistently into the future made him hesitant to fully adopt the methodology. However, he was interested in modifications to the methodology that might make it easier, quicker, and/or less expensive to employ.

Table 7: Summary of Land Manager Interviews

Organization Name	EIAs used? If yes, modifications? If no, other systems of land assessment?	Future EIA use?	Perceived benefits	Perceived limitations
Forterra NW	No; professional judgement, partnerships.	Possibly	Good quality data collected.	Cost, time, skills requirements may be prohibitive.
Columbia Land Trust	Yes, as written. May modify in future to reduce time/skills requirements.	Yes, as funding allows.	Methodology adds useful structure to assessments. They use the information to guide management decisions.	Cost, time, skills; choosing scale can be challenging
The Nature Conservancy	No; professional judgment, photo points.	Possibly, are exploring the possibility.	None mentioned.	None mentioned.
Chelan-Douglas Land Trust	No; professional judgment, photo points, simple plots.	Possibly	None mentioned.	None mentioned.
Whatcom Land Trust	No; professional judgment, partnerships.	Unlikely	None mentioned	Cost, time to do EIAs is a barrier.
Washington Department of Natural Resources	Yes, as written.	Yes	Standardization, consistency, repeatability.	None mentioned.
Washington Department of Fish and Wildlife	Yes, as written. May modify to allow volunteers to take photos or estimate cover of a limited number of plant species.	Yes	Standardized, repeatable indicator-based approach.	Steep learning curve for staff.
Missouri Department of Conservation	Yes, modified version using more coarse-level monitoring	Yes (modified version)	Good for assessing, monitoring large areas.	EIA requirement to identify all plant species was prohibitive (so use modified method)
New Hampshire Natural Heritage Bureau	Yes, for certain wetlands. Use Change in Size metric, include wetland rank specifications.	Yes (modified version)	Good for management and conservation, make Natural Heritage ranks more accurate.	None mentioned
Wisconsin Department of Natural Resources	Partial, use EIA concepts in coarse-level monitoring	Yes (EIA concepts)	Combining metrics into grades helps reduce variability among users.	EIA requirement to identify all plant species was prohibitive (so use modified method)

Interviews with other Washington State land conservancy managers

Land managers at Columbia Land Trust (CLT), located in Vancouver, WA, have been using EIAs for 2 years and were involved in helping DNR refine the upland methodology for use in Washington State for a year before that. They have contracted DNR to do most of the EIAs on approximately 12 of their 150 stewardship units but have also done some in-house. CLT land managers reported that they value the structured approach of the EIA methodology for assessing lands and are happy with the results. CLT land managers use EIAs to guide management decisions such as restoration and reforestation. Potential problems with EIAs mentioned by CLT land managers include the need for high-level botanical skills in-house, the financial investment required, and the time required. Hiring a consultant to do EIAs reduced the in-house skills and time requirements but added to the financial burden. CLT land managers also mentioned that choosing the scale for an EIA can be a challenge.

The stewardship manager of The Nature Conservancy (TNC) Washington office reported that this organization does not currently use EIAs, but that management was starting to explore this methodology. TNC Washington does not currently have a comprehensive system for land assessment but utilizes qualitative annual photo monitoring at their properties to assess change over time.

Two other Washington land conservancy managers surveyed stated that they do not use EIAs, but rather use professional judgment, photo points, or other methodology to assess and rank lands. The land manager of Whatcom Land Trust stated that while they have considered using EIAs, they decided that they do not have the capacity, either in staff time or funding, to institute this type of methodology. The stewardship director of the Chelan-Douglas Land Trust was open to using EIAs but currently relies on more qualitative methods such as professional judgment and photo points.

They occasionally also use simple sampling methods such as percent cover, point intercept, and nested frequency plots to monitor changes in vegetation.

Interviews with Washington State agencies

Washington DNR land managers have been heavily involved in developing and promoting EIA use in Washington State by both state agencies and land trusts. They are currently assessing DNR lands using this methodology and are in the initial stages of a Washington State Parks EIA assessment project with the goal of completing EIAs on 20 state parks in the next two years.

The Washington Department of Fish and Wildlife (WDFW) initiated a pilot study in 2012 to use EIAs to survey their lands (Schroeder et al 2011). As part of this effort, they tested using citizen science to help gather data. However, they found that the citizen monitoring was unsuccessful, as the volunteers did not always have the required botanical skills. They are pursuing funding to assess all WDFW lands using EIAs but will use professional staff rather than citizen scientists. They are considering modifications to the EIA methodology that would allow volunteers to be involved, such as taking photos at predetermined plots that could be interpreted by professionals or gathering data on invasive species.

Interviews with other state agencies

NatureServe has assisted Natural Heritage Program ecologists in developing EIA assessments for state natural areas in several states including Arkansas, Florida, Missouri, Michigan, New Hampshire, and Wisconsin. Managers from three states (Missouri, New Hampshire, and Wisconsin) responded to emails requesting information on their use of EIAs.

The Missouri Department of Conservation (MDC) has been using a variation on EIAs, called Community Health Indices, to assess state lands since 2014. These indices are a more coarse-level monitoring than EIAs, differing from EIAs primarily by the absence of conducting full botanical species surveys. Rather, surveys focus on presence or absence of a limited subset of plant species that are readily identifiable to resource managers and field staff. Other vegetation characteristics measured include native tree cover, percent cover of native increaser shrubs, percent cover of native graminoids, and percent cover of native forbs. MDC has found that using Community Health Indices allows them to assess and monitor larger areas than would be possible with more intensive monitoring, and that more resource managers and staff are equipped to perform the assessments using this methodology.

The New Hampshire Natural Heritage Bureau has adopted NatureServe's EIA protocols for evaluating wetlands that may be classified as "exemplary" natural communities. EIAs are used as a tool for management and conservation. The NH Natural Heritage Bureau uses two additional metrics from the standard EIA protocols. One is the addition of a Change in Size metric, used when an artificial change in size of the wetland is detectable from historical size (this is currently an optional metric in the standard wetland EIA protocol). Another change is the use of wetland system rank specifications, which are predetermined ranks assigned to specific wetland types in the state. Ecologists at the NH Natural Heritage Bureau have found that the use of wetland rank specifications reduces the variation in evaluations among different users and better informs the EIA evaluations. The Senior Ecologist stated that using EIAs makes their EO ranks more accurate.

Wisconsin Department of Natural Resources managers have not adopted full EIA protocols, but have integrated EIA concepts into coarse-level monitoring for their lands. This coarse-level monitoring does not require extensive botanical expertise, as full species plant species lists are not required. Instead, metrics assessed include relative percent cover of all native plants, percent cover of specific invasive species, percent cover of native increasers, number of native indicator species, and percent cover of different structural groups (i.e., medium and large shrubs, overstory trees, etc.). Since monitoring is currently limited to specific ecosystems (ie., oak barrens), the numbers of common native and invasive species are relatively limited. Native indicator species are specifically chosen for ease of identification in the summer months with minimal botanical expertise, and monitors are provided with a checklist of these species with photographs (O'Connor et al 2019). The Wisconsin DNR ecologist reported that while different field technicians' estimates of percent cover can vary greatly, the EIA protocol of combining metrics into grades greatly reduces variability in the final scores. Overall, the Wisconsin DNR staff considers using coarse-level monitoring within the EIA framework to be a successful strategy to attain valuable assessment information without requiring high-level botanical expertise.

Discussion

Many land trust managers, including most Washington managers interviewed for this study, do not have assessment systems in place to measure the quality of ecosystems on their lands, relying instead on professional judgment by staff members or other subjective factors. EIAs are one assessment methodology with potential to help land managers assess and better steward their lands.

EIAs are a relatively new method for applying the concept of ecological integrity to land assessment. Although the methodology has been developed and refined over the past 15 years, the requirement for states to first characterize the Ecological Systems in each state has delayed the widespread adoption of this method. In Washington state, the guide to Ecological Systems was published in 2015, the wetlands protocol was published in 2017, and the uplands protocol was still in draft form in 2019. Only one land trust in Washington has been an early adopter of EIAs, with most other trust managers interviewed expressing interest in the methodology along with reservations about the perceived costs and time involved.

The 10 EIAs performed on Forterra lands were relatively easy to perform by staff with botanical knowledge and identification skills and an understanding of ecological concepts relevant to the areas assessed. The EIAs provided a more thorough ecological assessment of these properties than could be obtained using the land manager's professional judgment. They also provided more quantitative information than is obtained during regular annual monitoring visits. Forterra's lands manager found the grading system and the associated brief reports for each EIA to be a useful way to compare sites for the purposes of management decisions.

A common concern among land conservancy managers interviewed, including Forterra's, was the time and botanical expertise required to perform EIAs. As nonprofit entities, land conservancies generally do not have adequate funding for basic stewardship activities, much less for completing extensive biological surveys on their lands. Land conservancies often only have one or two staff members in charge of land management and or stewardship; these staff members may not have the high-level botanical skills needed to perform EIAs, particularly if the properties to be assessed incorporate a wide variety of ecosystems. A critical part of assessing the efficacy of using EIAs for land conservancies was to determine the time and skills required for this type of assessment.

In the case of the 10 EIAs completed on Forterra lands, the average time for each EIA was approximately 8 hours. The time to complete each EIA decreased as those doing the EIAs became more familiar with the metrics and is likely to decrease further with continued practice; however, travel time to sites and within sites, particularly sites with no roads or trails, was relatively fixed. As for botanical skills required, the EIAs performed for this study required extensive botanical knowledge. A total of 160 different plant species were identified. The number of species encountered was limited by the decision to focus on sites in western Washington and near the Cascade Crest, for a total of seven Ecological Systems. The number of plant species would have been greatly increased by inclusion of sites in a wider variety of ecosystems.

One solution to the problem of lack of time and/or botanical expertise at a land trust would be to hire a consultant to perform EIAs. Columbia Land Trust hired Washington DNR to perform EIAs on their lands, for example, with good results. However, hiring out this work could be more expensive than doing it in-house, and the fundamental lack of funding for land assessment among most land trusts remains a barrier.

In the absence of additional funding to pay for staff or outside consultants to perform EIAs, one possible action land trusts could take is to incorporate EIAs into regular monitoring visits. Land conservancies that are accredited by the Land Trust Alliance are required to monitor each property at least once a year (Land Trust Alliance 2017). Level 2 EIAs, or a modified version of them, could be performed during these annual site visits. Repeat EIAs could be performed after 5 years to assess changes over this time period. Repeat visits would require less time and effort, as the majority of the plants would have been identified during the initial assessment and could be reviewed ahead of time by monitors to hasten plant identification in the field.

Many land conservancies utilize volunteer land stewards to help with "on the ground" monitoring activities. These volunteers could be trained to collect some metrics that could be incorporated into EIAs or could take photographs of unknown plant species to be sent to land managers for identification.

Land conservancies could adopt some of the modifications being used by state land managers in other states interviewed for this project, to reduce both the time and botanical expertise required for performing EIAs. Coarse-level monitoring does not require compilation of exhaustive plant species lists. Instead, staff or volunteers could be taught to identify a limited number of plant species or to estimate cover of native vs. non-native plants for a particular ecosystem. Land conservancy staff or volunteers could also be taught to accurately assess other metrics such as ecological structural features (i.e., number of snags or downed woody debris).

One way to reduce the level of botanical expertise and field time required for EIAs would be to include only plants over a certain cover threshold on field forms. For instance, in the Keechelus forest example (Appendix A) if only plants with greater than 15% cover were included on the plant species list, percent cover of only 9 plants would be listed instead of 35 (Appendix D; changes from original form are highlighted). When this reduced number of species was used in this example, the outcome of the VEG1 and VEG2 metrics did not appreciably change. However, the outcome of VEG3 was affected as the increaser and decreaser species at the site all had less than 15% cover in this instance and therefore were considered to be absent from the site. While this led to a change in the EIA score from 3.11 to 3.04, the grade of B+ remains the same. There was a corresponding decrease in EO Rank Score, but the EO rank also remained constant (Appendix D). In this case, reducing the number of species listed to those over a certain cover threshold would result in the same EIA ranking, but potentially valuable information about low-cover species (including species richness and presence of low-cover non-native species) would be lost.

Even with modifications, EIA methodologies could not be easily used on some land conservancy properties due to the artificial boundaries and disturbance history of these lands. EIA assessment areas are required to contain only one type of ecosystem (Rocchio and Ramm-Granberg 2017, Rocchio et al 2018). However, land conservancy properties often follow parcel lines or other artificial boundaries rather than ecological boundaries. A land conservancy's property may thus contain several types of ecosystems within its boundary, each requiring a separate EIA. Although not part of the EIA methodology, land trusts could calculate an average EIA grade for a particular property by utilizing a weighting system based on the area of the individual EIAs.

Since AAs have minimum size requirements, some AAs on land trust properties will be too small to assess, even though the larger, contiguous ecosystem may be of high quality. Relatedly, EIA scores are used by state natural heritage programs to identify Element Occurrences (EOs), and land conservancies may be interested in identifying EOs on their lands. Since the size of the occurrence is an important factor in determining if it ranks as an EO, the artificial boundaries and small size of many land conservancy properties can limit the opportunity for identifying EOs. Collaborations between land trusts and neighboring landowners could provide a cost-effective way to address the problem of artificial boundaries delineating ownership.

Another potential issue for assessing land conservancy properties is that of sites with a history of disturbance. EIAs are easiest to perform and most robust on large, relatively homogenous sites. Sites that have been highly disturbed in the past may contain a wide range of integrity indicators within a small area or may even contain fragments of different ecosystem types. For instance, one Forterra property that was considered for EIAs was a forested parcel that had experienced various amounts of disturbance in the past, including bulldozing and trenching in some areas. Due to the altered hydrology in the area, the site currently contains upland forest punctuated by small patches of scrub-shrub, emergent or forested wetlands. However, none of the patch types was bigger than the minimum size for an EIA. This scenario highlighted the problem of fitting the EIA protocols to sites with a history of disturbance.

Conclusions

EIAs have great potential for use by land conservancies such as Forterra. They provide a standardized, repeatable, and science-based way to assess land for baseline inventories, identify and track changes in populations of native, invasive, or rare plant species, and guide management decisions. If land conservancy staff have the botanical expertise and time to complete EIAs, the information gained will greatly benefit land managers.

The funding of EIA assessments will likely be a challenge for most nonprofit land conservancies. Land conservancies funding models most often rely on grant funding and philanthropy, and land acquisition is often prioritized over long-term land stewardship. Grant funding, for example, is commonly earmarked specifically for acquisition. Columbia Land Trust, the only land conservancy in Washington to implement wide-spread use of EIAs so far, is unusual among land conservancies in that its funding model directs a generous percentage of philanthropic funds to land stewardship. If other land trusts can find ways to prioritize funding of land stewardship, it would greatly increase their capacity to perform EIAs.

Modifications of the EIA protocols to reduce the time and botanical expertise required may make them more practical for use by land conservancies. Although it is unlikely that EIAs could be performed on all of a land conservancy's properties due to artificial boundaries and historic site disturbances, incorporating this assessment methodology into regular stewardship activities such as annual monitoring visits could provide invaluable information for land managers. Subsequent EIAs performed at existing EIA sites will provide invaluable information about changes in site conditions and rankings over time and will require less time and resources than initial EIAs. Additional research focusing on specific modifications to the EIA protocols that make them easier, quicker, or cheaper to do could make this methodology more accessible to nonprofit land trusts.

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Appendices

Appendix A

WNHP Upland EIA Form Example

Note: *All fields and metrics are strongly encouraged to be assessed. However, fields and metrics with* * *are the minimum required for element occurrence (EO) submission to WNHP. When doing the minimum, do not complete the 'Roll-up Calculation' table on page 12. Contact joe.rocchio@dnr.wa.gov or tynan.ramm-granberg@dnr.wa.gov for questions.*

***Site Name:** Keechelus Ridge *__AA Name (if >1 AAs)__________________________

Classification (pg. 28) Ecological System (S Rank): North Pacific Dry-Mesic Silver Fir- Western Hemlock-Douglas Fir forest

*NVC Plant Association (G/S Rank): *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* (G4/S4)

*NVC Group: North Pacific Maritime Silver Fir – Western Hemlock Forest Group

*Observer(s): Collette MacLean, Scott Davis *Date: 6/21/19 *County: Kittitas

VegPlot(s):______________ *TRS: 21N, 12E, 3 Photos:______________

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
*Spatial Coordinates	47.33796	47.33956	47.34214	47.34716	47.34604					
System:________	-121 .32044	-121 .32034	-121 .31822	-121 .31867	-121 .31686					

*Sampling Strategy:	☐ Polygon AA (< 50 ha / 125 ac; site walkthrough)	☐ Polygon AA (< 50 ha / 125 ac; systematic relevés)	Other:
	☐ Point-Based AA	X Combined Point/Polygon AA (> 50 ha / 125 ac)	

*Plot Type:	X Relevé	☐ Site-Walkthrough	Plot Size / Dimensions: 400 m2
	☐ Transect	☐ Other:	

*AA size (ac/ha): 327ac/132 ha. *AA Description:

Site was previously logged and thinned. It currently contains good-sized silver firs and Douglas firs (12" dbh) as well as noble firs and subalpine firs. A few Western white pines were seen near the Forest Service road. Trees are well spaced with a thriving understory of VAME, XETE, ACTR, with inclusions of RHAL and many other species. Many seedlings and small conifers were seen.

Streams are present on site with ALSI, SASI, OPHO, etc. (not sampled). Old logging roads throughout site are colonized by ALRU. Soils are good, formerly compacted in places.

Environmental (pg 25 in upland EIA manual) Soil Type: sandy loam

***Topographic Position**: *1=Interfluve (crest, summit, ridge),2= High slope (shoulder, upper), 3=Midslope, 4=Low slope (lower, colluvial foot), 5=Toeslope (alluvial foot/toe), 6=High level (mesa/plateau), 7=Step in slope (ledge; rock wall, cliff), 8=Low level (lake/river terrace), 9=Channel wall (sloping side of channel), 10=Channel bed (channel bottom), 11=Basin floor (depression), Other

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Slope (deg/%)	18	22	18	16	24					
Aspect (downslope)	S	SW	W	SW	SW					
Topographic Position*	3	3	3	3	3					
Comments:										

Natural Disturbance Comments:

No evidence of fire. Some scat (elk?), some grazing on XETE.

Anthropogenic Disturbance Comments:

Decaying stumps, occasional flagging, old trash.

Geology Comments:

Environmental Comments:

EIA Module: Mesic/Hypermaritime forests

***Species Cover** (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes**: **C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				
PSME	C	37.5	17.5		37.5	17.5						22		Y	
ABAM	C	7.5	85	62.5	37.5	62.5						51		Y	
TSHE	SC	3.5										0.7		Y	
ABAM	SC	1.5	3.5	7.5	3.5	17.5						6.7		Y	
ACCI	SH	37.5	3.5									8.2			
VAME	SH	37.5	37.5	62.5	85	85						61.5		Y	
SYMO	SH	17.5										3.5			
ALSI	SH	1.5										0.3			
ROGY	SH	3.5										0.7			
XETE	H	7.5	17.5	37.5	17.5	37.5						23.5		Y	
MANE	SH	3.5	7.5									5.5			
PTAQ	H	7.5										1.5			I
LIBO	H	17.5	1.5									3.8			
MAST	H	7.5		1.5								1.8			

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				
LUAR	H	1.5		1.5	0.5							0.7			
LICO	H	0.5										0.1			
HOLA	H	0.25										0.05	E		
RULA	H	3.5	3.5	3.5	1.5	1.5						2.7			
ACTR	H	3.5	7.5									2.2			D
PAMY	SH	1.5	3.5									1			
CHUM	H		3.5									0.7			
PYAS	H		3.5									0.7			
CHME	H		3.5									0.7			
ORSE	H		3.5		3.5	3.5						2.1			
CLUN	H		1.5									0.3			
ABPR	C		17.5	7.5	7.5							6.5			
COMA	H		1.5									0.3			
ABLA	SC			7.5	7.5							3			
VIGL	H			0.5	1.5							0.4			
SOSI	SH			1.5	7.5	7.5						3.3			
RHAL	SH				7.5	7.5						3			D
PIMO	SC				0.5							0.1			
ABPR	SC				3.5							0.7			
ARLA	H				3.5	7.5						2.2			
GOOB	H				0.25							0.05			

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

Landscape Context (pg 31)

LAN1 Contiguous Natural Land Cover

Metric Rating	Percent Contiguous NLC (0 - 500 m)	Comments
EXCELLENT (A)	0.95	Contiguous land is 2nd growth forest or natural openings with ~5% dirt roads, cabins.
GOOD (B)		
FAIR (C)		
POOR (D)		

LAN2 Land Use Index (use table below to calculate score, then check rank)

Worksheet : Land Use Categories	Weight	% Area (0 to 1.0)	Score
Paved roads / parking lots	0		
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0	0.01	0.01
Gravel pit / quarry / open pit / strip mining	0		
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1	0.04	0.04
Agriculture: tilled crop production	2		
Intensively developed vegetation (golf courses, lawns, etc.)	2		
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3		
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4		
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4		
Military training areas (armor, mechanized)	4		
Heavy grazing by livestock on pastures or native rangeland	4		
Heavy logging or tree removal (50-75% of trees >30 cm DBH removed)	5	0.37	1.85
Commercial tree plantations / holiday tree farms	5		
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5		
Dam sites and flood disturbed shorelines around water storage reservoirs and boating	5		
Moderate grazing of native grassland	6		
Moderate recreation (high-use trail)	7		
Mature old fields and other fallow lands with natural composition	7		
Selective logging or tree removal (<50% of trees >30 cm DBH removed)	8	0.51	4.08
Light grazing or haying of native rangeland	9		
Light recreation (low-use trail)	9		
Natural area / land managed for native vegetation	10	0.15	1.50
		Total Land Use Index	7.48

⌋ EXCELLENT (A) Avg. LU score = 9.5 – 10	⌋ GOOD (B) Avg. LU score = 8.0 – 9.4	X⌋ FAIR (C) Avg. LU score = 4.0 – 7.9	⌋ POOR (D) Avg. LU score = < 4.0

EDGE (pg 38)

EDG1 Perimeter with Natural Edge

⌋ EXCELLENT (A) 100% 4 pts	X⌋ GOOD (B) 75-99% 3 pts	⌋ FAIR (C) 25-75% 2 pts	⌋ POOR (D) <25% 1 pt

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Metric Rating										

EDGE1 Comments

1	A few dirt roads intersect perimeter.
2	
3	
4	
5	
6	
7	
8	
9	

EDG2 Width of Natural Edge

X EXCELLENT (A) 4 pts; ≥ 100m	⌋ GOOD (B) 3 pts; 75-99m	⌋ FAIR (C) 2 pts; 25-75m	⌋ POOR (D) 1 pt; <25m

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Segment 1	100									
Segment 2	100									
Segment 3	100									
Segment 4	100									
Segment 5	100									
Segment 6	100									
Segment 7	100									
Segment 8	100									
Average	100									
Metric Rating	4									

*EDG3 Condition of Natural Edge (Small AAs ONLY; if surveying lines used for EDG2, score each line and then average)

X EXCELLENT (A) 4 pts	⌋ GOOD (B) 3 pts	⌋ FAIR (C) 2 pts	⌋ POOR (D) 1 pt

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Metric Rating										

BUF3 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Vegetation (pg 45)

*VEG1 Native Plant Species Cover (Relative)

(calculate **relative** cover of each stratum at each sample point/sub-AA, then average across sample points; Use lower relative cover of either stratum for metric rating). Relative cover = (native cover / native+nonnative cover)*100; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area)

X⌋ EXCELLENT (A) 4 pts; >99%	⌋ VERY GOOD (A-) 3.5 pts; 95-99%	⌋ GOOD (B) 3 pts; 85-94%	⌋ FAIR (C) 2 pts; 60-84%	⌋ POOR (D) 1 pt; <60%

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Trees *Native*	50	123.5	90	97.5	97.5						
Nonnative	0	0	0	0	0						
Total Cover	50	123.5	90	97.5	97.5						
VEG1a. Native Tree Relative Cover	100	100	100	100	100						
Shrub/Herb *Native*	151.5	116.5	108.5	128.25	150						
Nonnative	0.25	0	0	0	0						
Total Cover	151.75	116.5	108.5	128.25	150						
VEG1b. Native Shrub/Herb Relative Cover	99.8	100	100	100	100						
Metric Rating	4	4	4	4	4						

Veg1 Comments:

1	Very few non-natives seen. Few HOLA, CIAR on old roads, clearings.
2	
3	
4	
5	
6	
7	
8	
9	
10	

***VEG2 Invasive Nonnative Plant Species Cover** (absolute cover; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

X EXCELLENT (A) 4 pts; <1%	⌋ GOOD (B) 3 pts; 1-4%	⌋ FAIR (C) 2 pts; 4-10%	⌋ FAIR/POOR (C-) 1.5 pts; 10-30%	⌋ POOR (D) 1 pt; >30%

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	4	4	4	4	4						

Veg2 Comments:

1	No invasive nonnatives seen.
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG3 Native Plant Species Composition (based on vegetation table above; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

X EXCELLENT (A; 4 pts)	⌋ GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Submetrics: 3a Diagnostic Species	4	4	4	4	4						4
3b Species diversity	4	4	3	4	3						4
3c Native Increasers	3	4	4	4	4						4
3d Native Decreasers	3	3	1	3	3						3
Metric Rating	3.5	4	3	4	3.5						4

Veg3 Comments

1	
2	
3	

4	
5	
6	
7	
8	
9	
10	

***VEG4 Vegetation Structure** (varies by EIA module; For Forest types, indicate the Stand Development Stage; then record a metric rank/score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score).

<u>Stand development stage codes</u>: cohort establishment (1); canopy closure (2); biomass accumulation/stem exclusion (3); maturation-eastside (4); maturation 1-westside (5); maturation 2-westside (6); vertical diversification-old growth (7); horizontal diversification-old growth (8); pioneer cohort loss-old growth (9).

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Stand Development Stage (Van Pelt)	5	5	5	5	5					

⌡ EXCELLENT (A; 4 pts) ⌡ GOOD (B; 3 pts) X FAIR (C; 2 pts) ⌡ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
v7 Dry Forests & Woodlands; v8 Mesic / Hypermaritime Forests											
Submetrics: 7/8a Canopy Structure (age class diversity)	2	2	3	3	2						2
7/8b Old/Large Live Trees	2	1	2	2	2						2
Metric Rating	2	1.5	2.5	2.5	2						2
v9 Shrublands											
Submetrics: 9a Shrub Cover											
9b Tree Encroachment											
Metric Rating											
v10 Shrub-Steppe; v11 Grasslands / Meadows											
Submetrics: 10/11a Woody Vegetation Cover											
10/11b Bunchgrass Cover											
10/11c Biological Soil Crust											
Metric Rating											
v12 Bedrock / Cliffs (no submetrics)											
Metric Rating											

Veg4 Comments:

1	
2	
3	
4	
5	

6	
7	
8	
9	
10	

VEG5 Woody Regeneration *(v2 Dry Forests & Woodlands; v3 Mesic / Hypermaritime Forests)* (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌡ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	⌡ FAIR (C; 2 pts)	⌡ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V4 Dry Forests & Woodlands; V5 Mesic/Hypermaritime Forests & Woodlands											
Metric Rating	3	3	3	3	3						
V6 Shrublands; Grassland / Meadows; Shrub-steppe											
Metric Rating											

Veg5 Comments:

1	Most trees are planted but many regenerating naturally.
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG6 Coarse Woody Debris and Snags (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌡ EXCELLENT (A; 4 pts)	⌡ GOOD (B; 3 pts)	X FAIR (C; 2 pts)	⌡ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V3 Dry Forests & Woodlands; V4 Mesic/Hypermaritime Forests & Woodlands											
Submetrics: V6v3/4a CWD Size Diversity	3	3	3	3	3						3
V6v3/4b. CWD Decay Class Diversity	3	3	3	3	3						3
V6v3/4c. Snag Size Diversity	1	1	1	1	1						1
V6v3/4d. Snag Decay Diversity	1	1	1	1	1						1
Metric Rating	2	2	2	2	2						2
V5 Shrublands; Grassland / Meadows; Shrub-steppe											
Submetrics: V6v5a Litter Source											
V6v5b. Litter Accumulation											

Metric Rating											

Veg6 Comments:

1	Little CWD seen, no snags seen.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Soil / Substrate (pg 72)

***SOI1 Soil Condition v3** (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

☐ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	☐ FAIR (C; 2 pts)	☐ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	3	3	3	3	3						

SOI1 Comments

1	Some evidence of former logging (ie., roads), but soils in good shape otherwise.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Size (pg 74)

SIZ1 Comparative Size (Patch Type)

☐ EXCELLENT (A)	☐ GOOD (B)	X FAIR (C)	☐ POOR (D)

Spatial Pattern Type: Matrix Estimated Size (ac/ha): 327/132

Comments: Relatively small patch for matrix (within property boundary)

SIZ2 Change in Size (optional)

☐ EXCELLENT (A)	☐ GOOD (B)	☐ FAIR (C)	☐ POOR (D)

Comments:

Calculate EIA Scores

Roll-up Calculations	Rating	Score (TABLE 1)
LAN1. Contiguous Natural Land Cover	A	4
LAN2. Land Use Index	C	2
LAN MEF Score = (LAN1+LAN2)/2 (TABLE 2)	B	3
EDG1. Perimeter with Natural Edge	B	3

EDG2. Width of Natural Edge	A	4
EDG3. Condition of Natural Edge (do not include in calculation if not scored)	A	4
EDG MEF Score = $(((EDGF1*EDG2)^{1/2})*EDG3)^{1/2}$ [Note: ½ exponent = square root] **(TABLE 2)**		3.72
LANDSCAPE CONTEXT PRIMARY FACTOR SCORE = (EDG Score*0.67)+(LAN Score*0.33) (TABLE 2)		3.48
Matrix = (EDG Score*0.33)+(LAN Score*0.67) **Large-Patch = (EDG Score*0.50)+(LAN Score*0.50)** **Small-Patch = (EDG Score*0.67)+(LAN Score*0.33)**		3.24
VEG1. Native Plant Species Cover	A	4
VEG2. Invasive Nonnative Plant Species Cover	A	4
VEG3. Native Plant Species Composition	A	4
VEG4. Vegetation Structure	C	2
VEG5. Woody Regeneration	B	3
VEG6. Coarse Woody Debris	C	2
(FORESTED) VEG MEF Score = [((VEG1+VEG2+VEG3)*0.4)+((VEG4+VEG5+VEG6)*0.6)/6 (Table 2)		3.00
(NONFORESTED) VEG MEF Score = (VEG1+VEG2+VEG3+VEG4+VEG5+VEG6)/6 (Table 2)		
[Note: Divide by number of metrics scored (i.e. divide by four if VEG1-VEG4 scored)]		
SOI1. Soil Condition	B	3
SOI MEF Score = SOI1		3
CONDITION PRIMARY FACTOR SCORE = (VEG Score*0.85)+(SOI Score*0.15) (TABLE 2)		3.00
ECOLOGICAL INTEGRITY (EIA) SCORE (TABLE 2) **Matrix/Large-Patch = (CONDITION SCORE*0.55)+(LANDSCAPE CONTEXT SCORE*0.45)** **Small-Patch = (CONDITION SCORE*0.7)+(LANDSCAPE CONTEXT SCORE*0.3)**	**B+**	**3.11**
SIZ1. Comparative Size	C	2
SIZ2. Change in Size (optional)		
SIZ MEF Score = SIZ1 OR (SIZ1+SIZ2)/2 (TABLE 2)		2
SIZE Points (TABLE 3)		-0.5
ELEMENT OCCURRENCE RANK (EORANK) = EIA Score + SIZE Points (TABLE 2)	**B-**	**2.61**

Table 1. Metric Rank / Score Conversions

Rank	A	A-	B	BC	C	C-	D
Score	4	3.5	3	2.5	2	1.5	1

Table 2. Score / Rank Conversions for MEF, EIA and EORANK calculations

Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Table 3. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	**Very Small/Small Patch**	**Large Patch**	**Matrix**
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Determine Whether AA Meets EO Criteria

EORANK	**Global Rank** **State Rank**	G1S1, G2S1, GNRS1, GUS1	G2S2, GNRS2, G3S1, G3S2, GUS2	GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR	G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5
A+ (3.8 to 4.0)		EO	EO	EO	EO
A- (3.5 to 3.79)		EO	EO	EO	EO
B+ (3.0 to 3.49)		EO	EO	EO	Not an Element Occurrence
B- (2.5 to 2.99)		EO	EO	EO	
C+ (2.0 to 2.49)		EO	EO	Not an Element Occurrence	
C- (1.5 to 1.99)		EO	Not an Element Occurrence		
D (1.0 to 1.49)		EO			

Appendix B

WNHP Wetland/Riparian EIA Form Example

Note: *All fields and metrics are strongly encouraged to be assessed. However, fields and metrics with* ***** *are the minimum required to propose a new WHCV. If only doing the minimum do not complete the 'Roll-up Calculation' table on page 9.*
Contact joe.rocchio@dnr.wa.gov for questions.

***Site Name** Hazel Wolf ***AA Name (if >1 AAs)** AA2 - SS

Classification (page 18 in EIA manual) *HGM Class: Depressional

Cowardin:

System	Subsystem	Class	Subclass	Water Regime	Water chemistry	Soil	Special
Palustrine	----	Scrub-Shrub	3	O	t	g	

*NVC Formation: Freshwater Marsh, Wet Meadow, and Shrubland

*NVC Subgroup (S Rank): Vancouverian Wet Shrubland Group

*NVC Plant Association (G/S Rank): *Spiraea douglasii* Wet Shrubland (G5/S5)

*Observer(s): Collette MacLean *Date: 8/23/19 *County: King

VegPlot(s):______ *TRS: 25N, 06E, 35 Photos:______

EOID:______ Source FeatureID:______ Owner(s): Forterra

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
*Spatial Coordinates	47.60477									
System:______	-121.32044									

*Sampling Strategy:	X Polygon AA (< 50 ha / 125 ac; site walkthrough)	☐ Polygon AA (< 50 ha / 125 ac; systematic relevés)	Other:
	☐ Point-Based AA	☐ Combined Point/Polygon AA (> 50 ha / 125 ac)	
*Plot Type:	☐ Relevé	X Site-Walkthrough	Plot Size / Dimensions:
	☐ Transect	☐ Other:	

*AA size (ac/ha): 3 ac./1.2 ha. *AA Description (see back page for additional space):

Scrub-shrub wetland north of aquatic bed/pond and boardwalk. Lots of PHAR interspersed with SPDO, Salix species, wetland herbs. Edge has SODU; buffer has RUAR, RULAC, ILAQ.

Environmental (page 13 in EIA manual) Slope (deg/%):__0_______Aspect (downslope):_N/A______

*Topographic Position (check):

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Slope (deg/%)	0									
Aspect (downslope)	--									
Topographic Position*	Basin floor									

*Interfluve (crest, summit, ridge), High slope (shoulder, upper), Midslope, Low slope (lower, colluvial foot), Toeslope (alluvial foot/toe), High level (mesa/plateau), Step in slope (ledge; rock wall, cliff), Low level (lake/river terrace), Channel wall (sloping side of channel), Channel bed (channel bottom), Basin floor (depression), Other

Comments:

***Water Source** (enter numeric codes along with "P" for primary and "S" for secondary); 1=precipitation; 2=groundwater; 3=overbank flooding; 4=natural surface flow; 5=snowmelt; 6=tidal; 7=alluvial aquifer; 8= irrigation seepage; 9=point discharge (pipe); 10=irrigation runoff; 11=irrigation direct application; 12=urban run-off/culverts

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Water Source	4									

Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Hydrodynamics: 1=stagnant; 2=sluggish; 3=mobile; 4=dynamic; 5=very dynamic

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Hydrodynamics	1									

Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

***Soil Type:** ☐ Mineral ☐ Organic (sapric – von Post 7-10) X Organic (hemic – von Post 4-6) ☐ Organic (fibric – von Post 1-3)

Mineral Soil Texture:_________________________ pH:_______ Conductivity:________Temp:________

Instrument:_________________________________ Sample source:__________________________________

*von Post index (peatlands only):___________

Natural Disturbance Comments:

Anthropogenic Disturbance Comments:

Little disturbance considering proximity to boardwalk. However, buffer is disturbed.

Geology Comments:

Environmental Comments:

*Species Cover(pg 28)

Cover (midpt): Trace (**0.25)**, 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**);
Strata Codes: **C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cover	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				
SPDO	SH	37.5												Y	
COST	SH	3.5													
SALA	SH	17.5												Y	
SASI	SH	7.5												Y	
POTR	C	3.5													
PHAR	H	62.5											I		
PEHY	H	7.5													
VESC	H	3.5													
SCLA	H	3.5													
LUPA	H	17.5													I
JUEF	H	7.5													I
LYAM	H	1.5													
BICE	H	0.5													
JUAC	H	0.5													
LOIN	SH	0.5													
CAVE	H	0.5													
SODU	H	0.5											E		

*Species Cover(pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**);
Strata Codes: **C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cover	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

*Species Cover(pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**);
Strata Codes: **C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cover	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

*Species Cover(pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**);
Strata Codes: **C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cover	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

Landscape Context

LAN1 Contiguous Natural Land Cover (page 21 in EIA manual)

Metric Rating	Overall NLC (0 - 500 m	*Subzones*		Comments
		Inner Landscape: 0-100 m	*Outer Landscape (100-500m)*	
EXCELLENT (A)				Some paved roads within 100 m zone; some paved roads, houses, golf courses within 500 m zone.
GOOD (B)				
FAIR (C)	43%	85%	39%	
POOR (D)				

LAN2 Land Use Index (page 23 in EIA manual) (use table below to calculate score then check rank)

⎦ EXCELLENT (A) Avg. LU score = 9.5-10	⎦ GOOD (B) Avg. LU score = 8.0-9.4	X FAIR (C) Avg. LU score = 4.0-7.9	⎦ POOR (D) Avg. LU score = < 4.0

Worksheet : Land Use Categories	**Weight**	**Inner Landscape (0-100 m)**		**Outer Landscape (100-500m)**	
		% Area (0 to 1.0)	Score	% Area (0 to 1.0)	Score
Paved roads / parking lots	0	0.05	0	0.9	0
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0				
Gravel pit / quarry / open pit / strip mining	0				
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1				
Agriculture: tilled crop production	2				
Intensively developed vegetation (golf courses, lawns, etc.)	2			0.52	1.04
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3				
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4				
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4				
Military training areas (armor, mechanized)	4				
Heavy grazing by livestock on pastures or native rangeland	4				
Heavy logging or tree removal (50-75% of trees >30 cm dbh removed)	5				
Commercial tree plantations / holiday tree farms	5				
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5				
Dam sites and flood disturbed shorelines around water storage reservoirs and boating	5				
Moderate grazing of native grassland	6				
Moderate recreation (high-use trail)	7				
Mature old fields and other fallow lands with natural composition	7				
Selective logging or tree removal (<50% of trees >30 cm dbh removed)	8			0.18	1.6
Light grazing or haying of native rangeland	9				
Light recreation (low-use trail)	9	0.01	0.09	0.02	0.18
Natural area / land managed for native vegetation	10	0.94	9.49	0.19	1.9
Total Land Use Score		9.58		4.72	
Score/rating conversion: A = >9.5, **B** = 8.0-9.4, **C** = 4.0-7.9, **D** = <4.0 — **Multiple by Weight**		x 0.6		X 0.4	
Weighted Score		5.75		1.89	
Total Score (Inner + Outer score)		7.6			

Comments:

Buffer

BUF1 Perimeter with Natural Buffer (page 26 in EIA manual)

⎦ EXCELLENT (A) 100% 4 pts	X GOOD (B) 75-99% 3 pts	⎦ FAIR (C) 25-75% 2 pts	⎦ POOR (D) <25% 1 pt

Assessment Pt. / Sub-AA	**1**	2	3	4	5	6	7	8	9	10
Metric Rating	3									

BUF1 Comments

1	95% of perimeter has natural buffer
2	
3	
4	

5	
6	
7	
8	
9	
10	

BUF2 Width of Natural Buffer (page 27 in EIA manual)

⎦ EXCELLENT (A) 4 pts; ≥ 100m	X GOOD (B) 3 pts; 75-99m	⎦ FAIR (C) 2 pts; 25-75m	⎦ POOR (D) 1 pt; <25m

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Segment 1	100									
Segment 2	100									
Segment 3	100									
Segment 4	100									
Segment 5	100									
Segment 6	100									
Segment 7	50									
Segment 8	100									
Average	94									
Metric Rating	3									

*BUF3 Condition of Natural Buffer (page 33 in EIA manual)

⎦ EXCELLENT (A) 4 pts	X GOOD (B) 3 pts	⎦ FAIR (C) 2 pts	⎦ POOR (D) 1 pt

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Rank	3									

BUF3 Comments:

1	Some development, PHAR in buffer, but not >25%.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Vegetation

*VEG1 Native Plant Species Cover (Relative)

(calculate **relative** cover of each stratum at each sample point/sub-AA, then average across sample points; Use lower relative cover of either stratum for metric rating). Relative cover = (native cover / native+nonnative cover)*100; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area)

⎦ EXCELLENT (A) 4 pts; >99%	⎦ VERY GOOD (A-) 3.5 pts; 95-99%	⎦ GOOD (B) 3 pts; 85-94%	⎦ FAIR (C) 2 pts; 60-84%	X⎦ POOR (D) 1 pt; <60%

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Trees *Native*	3.5										
Nonnative	0										
Total Cover	3.5										

VEG1a. Native Tree Relative Cover	100										
Shrub/Herb *Native*	110										
Nonnative	63										
Total Cover	173										
VEG1b. Native Shrub/Herb Relative Cover	58										
Metric Rating	1										

Veg1 Comments:

1	Lots of PHAR throughout
2	
3	
4	
5	
6	
7	
8	
9	
10	

***VEG2 Invasive Nonnative Plant Species Cover (Absolute)** (page 35 in EIA manual; absolute cover; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⎦ EXCELLENT (A) 4 pts; <1%	⎦ GOOD (B) 3 pts; 1-4%	⎦ FAIR (C) 2 pts; 4-10%	⎦ FAIR/POOR (C-) 1.5 pts; 10-30%	X POOR (D) 1 pt; >30%

Assessment Pt. / Sub-AA	**1**	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	1										

Veg2 Comments:

1	Lots of PHAR
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG3 Native Plant Species Composition (page 37 in EIA manual; based on vegetation table above; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⎦ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	⎦ FAIR (C; 2 pts)	⎦ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	**1**	2	3	4	5	6	7	8	9	10	Avg
Submetrics: 3a Diagnostic Species	4										
3b Species diversity	3										

3c Native Increasers	2										
3d Native Decreasers	2										
Metric Rating	3										

Veg3 Comments

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

***VEG4 Vegetation Structure** (page 39 in EIA manual; varies by USNVC Formation; record a metric rank/score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score).

⌋ EXCELLENT (A; 4 pts)	⌋ X GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Avg**
V1 Flooded & Swamp Forest											
Submetric: 1a. Canopy Structure											
1b. Large / Old Live Trees											
Metric Rating											
V2 Freshwater Marsh, Wet Meadow & Shrubland (no submetrics)											
Metric Rating	3										
V4 Salt Marsh (no submetrics)											
Metric Rating											
V5 Bog & Fen											
Submetric: 5a. Tree Cover											
5b. Shrub Cover											
5c.Micro-topographic Diversity											
Metric Rating											
V6 Aquatic Vegetation and Mudflats(no submetrics)											
Metric Rating											

Veg4 Comments:

1	
2	
3	
4	
5	
6	

7	
8	
9	
10	

VEG5 Woody Regeneration (page 42 in EIA manual; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌋ EXCELLENT (A; 4 pts)	⌋ GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V1 Flooded & Swamp Forest											
Metric Rating											
V2 Freshwater Marsh, Wet Meadow & Shrubland											
Metric Rating											
V3 Bog & Fen											
Metric Rating											

Veg5 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG6 Coarse Woody Debris, Snags, & Litter (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌋ EXCELLENT (A; 4 pts)	⌋ GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V1 Flooded & Swamp Forest											
Submetrics: V6v1a. CWD Size Diversity											
V6v1b. CWD Decay Class Diversity											
V6v1c. Snag Size Diversity											
V6v1d. Snag Decay Diversity											
Metric Rating											
V2 Nonforested Wetlands											
Submetrics: V6v2a. Litter Source											
V6v2b. Litter Accumulation											
Metric Rating											

Veg6 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Hydrology

***HYD1 Water Source** (page 46 in EIA manual) **Metric Version**:________

⌋ EXCELLENT (A; 4 pts)	X⌋ GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	3										

HYD1 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

***HYD2 Hydroperiod** (page 49 in EIA manual; see worksheets on next page) **Metric Version**:________

X⌋ EXCELLENT (A; 4 pts)	⌋ GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	4										

HYD2 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

***HYD3 Hydrological Connectivity** (page 56 in EIA manual) **Metric Version**:________

⌋ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	3										

HYD3 Comments:

1	Some banks are limiting natural water flow.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Soil / Substrate

*SOI1 Soil Condition (page 58 in EIA manual)   Metric Version:________

☐ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	☐ FAIR (C; 2 pts)	☐ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	3										

SOI1 Comments:

1	Soils typical for submerged/wetlands.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Size

SIZ1 Comparative Size (Patch Type)

☐ EXCELLENT (A)	☐ GOOD (B)	X FAIR (C)	☐ POOR (D)

Spatial Pattern Type: Small Patch   Estimated Size (ac/ha): 3/1.2

Comments:

SIZ2 Change in Size (optional)

☐ EXCELLENT (A)	☐ GOOD (B)	☐ FAIR (C)	☐ POOR (D)

Comments:

Condition	Field Indicator of Hydrological Alteration	1	2	3	4	5	6	7	8	9	10
Condition	**Hydroperiod Field Indicators for Evaluating Tidal Wetlands (Estuarine)** (check all that apply)										
Tidal Prism	Changes in the relative abundance of plants indicative of either high or low marsh.										
	A preponderance of shrink cracks or dried pannes is indicative of decreased hydroperiod.										
	Inadequate tidal flushing may be indicated by algal blooms or by encroachment of freshwater vegetation.										
	Dikes, levees, ponds, ditches, and tide control structures are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, boating, etc.										
Condition	**Hydroperiod Field Indicators for Evaluating Riverine Wetlands** (check all that apply)										
Channel Equilibrium	The channel (or multiple channels in braided systems) has a well-defined usual high water line, or bankfull stage that is clearly indicated by an obvious floodplain, topographic bench that represents an abrupt change in the cross-sectional profile of the channel throughout most of the site.										
	The usual high water line or bankfull stage corresponds to the lower limit of riparian vascular vegetation.										
	The channel contains embedded woody debris of the size and amount consistent with what is available in the riparian area.										
	There is little or no active undercutting or burial of riparian vegetation.										
Active Degradation (Erosion)	Portions of the channel are characterized by deeply undercut banks with exposed living roots of trees or shrubs. There are abundant bank slides or slumps, or the banks are uniformly scoured and unvegetated.										
	Riparian vegetation may be declining in stature or vigor, and/or riparian trees and shrubs may be falling into the channel.										
	The channel bed lacks any fine-grained sediment.										
	Recently active flow pathways appear to have coalesced into one channel (i.e., a previously braided system is no longer braided).										
Active Aggradation (Sedimentation)	The channel through the site lacks a well-defined usual high water line.										
	There is an active floodplain with. fresh splays of sediment covering older soils or recent vegetation										
	There are partially buried tree trunks or shrubs.										
	Cobbles and/or coarse gravels have recently been deposited on the floodplain										
	There are partially buried, or sediment-choked, culverts.										
Condition	**Hydroperiod Field Indicators for Evaluating Non-Riverine, Non-tidal Freshwater Wetlands** (check all that apply)										
Reduced Extent and Duration of Inundation or Saturation	Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland.										
	Evidence of aquatic wildlife mortality.										
	Encroachment of terrestrial (upland) vegetation										
	Stress or mortality of hydrophytes.										
	Compressed or reduced plant zonation										
	Organic soils occurring well above contemporary water tables.										
	Water withdrawal (regional or local wells)										
	Encroachment of young, tall, vigorous trees										
	Drying or mortality of non-vascular species (e.g. *Sphagnum*)										
Increased Extent and Duration of Inundation or Saturation	Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps)										
	Diversions, ditching, or draining into the wetland.										
	Late-season vitality of annual vegetation.										
	Recently drowned riparian or terrestrial vegetation.										
	Extensive fine-grain deposits on the wetland margins.										

Roll-up Calculations	Rating	Score (TABLE 1)
LAN1. Contiguous Natural Land Cover	C	2
LAN2. Land Use Index	C	2
LAN MEF Score = (LAN1+LAN2)/2 (TABLE 2)		2
BUF1. Perimeter with Natural Buffer	B	3
BUF2. Width of Natural Buffer	B	3
BUF3. Condition of Natural Buffer	B	3
BUF MEF Score = $(((BUF1*BUF2)^{1/2})*BUF3)^{1/2}$ [Note: ½ exponent = square root] **(TABLE 2)**		3
LANDSCAPE CONTEXT FACTOR SCORE = (BUF Score*0.67)+(LAN Score*0.33) (TABLE 2)		2.67
VEG1. Native Plant Species Cover	D	1
VEG2. Invasive Nonnative Plant Species Cover	D	1
VEG3. Native Plant Species Composition	B	3
VEG4. Vegetation Structure	B	3
VEG5. Woody Regeneration	B	3
VEG6. Coarse Woody Debris	-	-
VEG (non-forested) MEF Score = (VEG1+VEG2+VEG3+VEG4)/4 (TABLE 2)		2.00
VEG (forested) MEF Score = (VEG1+VEG2+VEG3+VEG4+VEG5+VEG6)/6 (TABLE 2)		
HYD1. Water Source	B	3
HYD2. Hydroperiod	B	3
HYD3. Hydrological Connectivity	B	3
HYD MEF Score = (HYD1+HYD2+HYD3)/3 (TABLE 2)		3.00
SOI1. Soil Condition	B	3
SOI MEF Score = SOI1		3
CONDITION FACTOR SCORE = (VEG Score*0.55)+(HYD Score*0.35)+(SOI Score*0.1) (TABLE 2)		2.45
EIA SCORE = (Condition Factor Score*0.7)+(Landscape Context Factor Score*0.3) (TABLE 2)	**B-**	**2.52**
SIZ1. Comparative Size	C	2
SIZ2. Change in Size (optional)		
SIZ MEF Score = SIZ1 OR (SIZ1+SIZ2)/2 (TABLE 2)		2
SIZE Points (TABLE 3)		-0.25
ELEMENT OCCURRENCE RANK (EORANK) = EIA Score + SIZE Points (TABLE 2)	**C+**	**2.27**

Table 1. Metric Rank / Score Conversions

Rank	A	A-	B	C	C-	D
Score	4	3.5	3	2	1.5	1

Table 2. Score / Rank Conversions for MEF, EIA and EORANK calculations

Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Table 3. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	**Very Small/Small Patch**	**Large Patch**	**Matrix**
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Determine Whether AA Meets WHCV Criteria

EORANK — **Global Rank** / **State Rank**	G1S1, G2S1, GNRS1, GUS1	G2S2, GNRS2, G3S1, G3S2, GUS2	GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR	G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5
A+ (3.8 to 4.0)	EO	EO	EO	EO
A- (3.5 to 3.79)	EO	EO	EO	EO
B+ (3.0 to 3.49)	EO	EO	EO	Not an Element Occurrence
B- (2.5 to 2.99)	EO	EO	EO	
C+ (2.0 to 2.49)	EO	EO	Not an Element Occurrence	
C- (1.5 to 1.99)	EO	Not an Element Occurrence		
D (1.0 to 1.49)	EO			

Appendix C

EIA Reports

Keechelus Ridge

EIA score: 3.11 (B+)

Assessment date: June 21, 2019
EIA completed and summary report prepared by Collette MacLean

The Keechelus Ridge property contains second growth forest near the Cascade crest in Kittitas County. It is within the North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest Ecological System.

Metrics:

Landscape Context Score (land use and edge): 3.24

Contiguous land is 2nd growth of various ages with some natural openings and a small amount of dirt roads.

Condition Score (vegetation and soils): 3.00

Site has good sized, well-spaced second growth silver firs and Douglas firs with smaller amounts of western hemlock, noble fir, and subalpine fir. Understory vegetation is lush and contains good diversity of native plants and no invasive or non-native plants. Logging legacy includes reduced amounts of snags and large, old trees (living or dead). Soils are generally good with some compaction along former logging roads.

Size Score -0.5

Size is small for patch type.

EO Rank: 2.61 (B-)

G/S Rank is **G4/S4**; with a B- rank, not an EO.

Management recommendations:

None at this time. The forest is in good shape and should continue to improve with age as more snags and CWD naturally develop.

Gold Creek Riparian

EIA score: 3.55 (A-)

Assessment date: June 28, 2019
EIA completed and summary report prepared by Collette MacLean

The Gold Creek Riparian AA contains approximately 0.5 acres of linear riparian habitat on the south side of Gold Creek. It is within the Freshwater Marsh, Wet Meadow, and Shrubland USNVC formation.

Metrics:

Landscape Context Score (land use and buffer): 3.48

Contiguous land is additional riparian vegetation and riverbed, 2nd growth of various ages, and some dirt roads and parking lots.

Condition Score (vegetation, soils, and hydrology): 3.58

Site has typical riparian shrub and herbaceous vegetation, as well as some good sized Western red cedar, Douglas firs, and black cottonwoods. No invasive or non-natives seen. Soils are generally typical for the system. Hydrology scored well for water source and connectivity but poorly for hydroperiod as the creek dewaters later in the year in dry years.

Size Score -0.25

Size is small for patch type.

EO Rank: 3.30 (B+)

G/S Rank is **G4/S3?**; with a B+ rank, not an EO.

Management recommendations:

The riparian area appears to be in good shape currently; however, continued creek dewatering could have adverse effects in the long term. Basin-level efforts to maintain water flow should continue, particularly for the sake of the bull trout that inhabit this creek.

Gold Creek Forest

EIA score: 2.86 (B-)

Assessment date: June 28, 2019
EIA completed and summary report prepared by Collette MacLean

The Gold Creek Forest AA contains approximately 186 acres of second growth forest of various ages (50 - 100 years) interspersed with shrubby avalanche chutes near the Cascade crest in Kittitas County. It is within the North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest Ecological System.

Metrics:

Landscape Context Score (land use and edge): 3.24

Contiguous land is riparian vegetation and riverbed, 2nd growth of various ages, and some dirt roads and cabins.

Condition Score (vegetation and soils): 2.55

Site has medium to large-sized second growth silver firs and smaller amounts of western hemlock. Understory vegetation is sparse in many areas due to stem exclusion stage of 2nd growth, but openings contain shrubby and herbaceous understory vegetation. No invasive or non-native plants were seen. Logging legacy includes reduced amounts of snags and large, old trees (living or dead). Soils are generally good with some compaction along former logging roads. Plastic sheeting was observed covering the ground in a few places.

Size Score -1.5

Size is small for patch type.

EO Rank: 1.36 (D)

G/S Rank is **G4G5/S4S5**; with a D rank, not an EO.

Management recommendations:

The forest is in decent shape for the stand age and should continue to improve with age as more snags, CWD, and openings naturally develop and understory vegetation increases. The plastic sheeting on the forest floor should be removed.

Gold Creek Shrubland

EIA score: 3.71 (A-)

Assessment date: June 28, 2019
EIA completed and summary report prepared by Collette MacLean

The Gold Creek Shrubland AA consists of approximately 47 acres of shrubby avalanche chutes interspersed with forests on the slopes on the east side of the Gold Creek property near the Cascade crest in Kittitas County. It is within the North Pacific Avalanche Chute Shrubland Ecological System.

Metrics:

Landscape Context Score (land use and edge): 3.36

Contiguous land is 2nd growth forest of various ages, and some dirt roads and cabins.

Condition Score (vegetation and soils): 4.00

Site has typical avalanche chute shrubby and herbaceous vegetation, with no non-native plants observed. Soils are in good shape.

Size Score -0.33

Size is somewhat small for patch type.

EO Rank: 3.38 (B+)

G/S Rank is **G4/S4**; with a B+ rank, not an EO.

Management recommendations:

None. These shrubby avalanche chutes are typical of the mountains in the Cascade Crest and are in good condition.

Swamp Lake Forest

EIA score: 2.75 (B-)

Assessment date: July 19, 2019
EIA completed and summary report prepared by Collette MacLean

The Swamp Lake Forest AA contains approximately 211 acres of second growth near the Cascade crest in Kittitas County. It is within the North Pacific Dry-Mesic Silver Fir – Western Hemlock – Douglas Fir Forest Ecological System.

Metrics:

Landscape Context Score (land use and edge): 3.00

Contiguous land includes Swamp Lake and 2nd growth of various ages, as well as some dirt and paved roads and cabins.

Condition Score (vegetation and soils): 2.55

Site has small to medium-sized second growth silver firs, Douglas firs, western red cedars, and western hemlock, as well as a good amount of western yew in the subcanopy. Understory vegetation is sparse in many areas due to stem exclusion stage of 2nd growth, but occasional openings contain shrubby and herbaceous understory vegetation. An insignificant amount of non-native plants was seen. Logging legacy includes poor age class diversity, reduced amounts of snags, CWD, and large, old living trees. Soils are generally good with some compaction along former logging roads. Bear scat was observed in several places.

Size Score -1.5

Size is small for patch type.

EO Rank: 1.25 (D)

G/S Rank is **G4G5/S4S5**; with a D rank, not an EO.

Management recommendations:

The majority of the forest is in the stand exclusion stage of development and contains primarily small- to medium-diameter trees. Thinning would help speed up the process of stand development to reach maturation, but even without thinning, the stand would be expected to continue to improve with age as more snags, CWD, and openings naturally develop and understory vegetation increases. Management actions are not critical at present.

Hazel Wolf AB Wetland

EIA score: 2.99 (B-)

Assessment date: June 27, 2019
EIA completed and summary report prepared by Collette MacLean

The Hazel Wolf AB Wetland AA contains approximately 19 acres of aquatic bed wetlands located in the City of Sammamish, King County. It is within the Freshwater Aquatic Vegetation USNVC formation.

Metrics:

Landscape Context Score (land use and buffer): 2.82

Contiguous land includes adjacent SS wetlands and second growth forest, golf courses, and some trails, paved roads and residences.

Condition Score (vegetation, soils, and hydrology): 3.07

This is a mostly intact wetland but has been impacted by a boardwalk and overlook on the north end and a boardwalk on the south end. Vegetation is mostly native but includes small amount of invasive reed canary grass on the margins. Hydrology is somewhat limited by raised trails and banks.

Size Score 0.25

Size is somewhat large for patch type.

EO Rank: 3.24 (B+)

G/S Rank is **G5/S4S5**; with a B+ rank, not an EO.

Management recommendations:

The wetland is in decent shape but could be adversely impacted by visitors. Check frequently for issues or work with neighbors/stewards to report any problems.

Hazel Wolf SS Wetland

EIA score: 2.52 (B-)

Assessment date: August 23, 2019
EIA completed and summary report prepared by Collette MacLean

The Hazel Wolf SS Wetland AA contains approximately 3 acres of scrub-shrub wetlands. It is located in the City of Sammamish, King County. It is within the Freshwater Marsh, Wet Meadow, and Shrubland USNVC formation.

Metrics:

Landscape Context Score (land use and buffer): 2.67

Contiguous land includes adjacent AB wetland and second growth forest, golf courses, and some trails, paved roads and residences.

Condition Score (vegetation, soils, and hydrology): 2.45

This wetland contains moderate native plant diversity but also a large amount of reed canary grass, an invasive plant. The northwest buffer is disturbed and contains Himalayan blackberry, cut-leaf blackberry and other invasive plants. Soils were typical of wetlands. Hydrologic flow is likely impacted to a small extent by the boardwalk on the southern end of the wetland.

Size Score -0.25

Size is somewhat small for patch type.

EO Rank: 2.27 (C+)

G/S Rank is **G5/S5**; with a C+ rank, not an EO.

Management recommendations:

The reed canary grass is likely limiting native species in the wetland. However, there is currently no good strategy for removing this species without having adverse impacts to the wetland, so no removal strategy is recommended. The area northwest of the wetland (within the buffer) that contains invasive plants would be a good candidate for restoration but is not within the wetland itself.

Hazel Wolf Forest

EIA score: 2.44 (C+)

Assessment date: June 27, 2019
EIA completed and summary report prepared by Collette MacLean

The Hazel Wolf Forest AA contains approximately 72 acres of second-growth forest. It is located in the City of Sammamish, King County and is within the North Pacific Maritime Mesic-Wet Douglas Fir – Western Hemlock Forest Ecological System.

Metrics:

Landscape Context Score (land use and edge): 2.09

Contiguous land includes adjacent wetlands, second growth forest, golf courses, and some trails, paved roads and residences.

Condition Score (vegetation and soils): 2.72

East of the wetland, the forest is in good shape with large Douglas firs and big-leaf maples and a lush, mostly native understory. On the west side, the forest is limited to a narrow area between the wetland and a housing development and is also bisected by a trail. The vegetation is mostly native but in some places is dominated by increasers such as bracken fern and trailing blackberry. The northwest part of the site is disturbed and contains some Himalayan blackberry, cut-leaf blackberry and other invasive plants. Non-native and invasive plants are also present in small amounts along the trails. Soils are in good shape in the less disturbed areas but compacted in disturbed areas

Size Score -1.5

Size is small for patch type.

EO Rank: 0.94 (D)

G/S Rank is **G4/SNR**; with a D rank, not an EO.

Management recommendations:

Restoration is recommended for the northwest part of the forest that contains invasive plants and is otherwise disturbed.

Rock Creek Forested Wetland

EIA score: 3.63 (A-)

Assessment date: July 25, 2019
EIA completed and summary report prepared by Collette MacLean

The Rock Creek Wetland AA contains approximately 76 acres of forested wetlands associated with the headwaters of Rock Creek and Lake 12, near Black Diamond, King County. It is within the Flooded and Swamp Forest USNVC formation.

Metrics:

Landscape Context Score (land use and buffer): 2.98

Contiguous land includes Lake 12, Rock Creek upland forest, and 2nd growth of various ages, as well as some cleared land/pastures, dirt and paved roads and residences.

Condition Score (vegetation, soils, and hydrology): 3.91

This is an intact forested wetland with western red cedar and smaller amounts of Sitka spruce and western hemlock in the overstory, and a diverse shrub and herb layer. Rock Creek runs sluggishly through the wetland (deep at spots), as it exits Lake 12. Hydrology and soils were typical of a functioning wetland. No invasive or non-native plants were seen in the wetland.

Size Score 0.75

Size is large for patch type.

EO Rank: 4.38 (A+)

G/S Rank is **GNR/S2**; with a A+ rank, this is a potential EO.

Management recommendations:

The forested wetland is in fine shape. No recommended management.

Rock Creek Forest

EIA score: 3.41 (B+)

Assessment date: July 25, 2019
EIA completed and summary report prepared by Collette MacLean

The Rock Creek Forest AA contains approximately 24 acres of older second growth near Black Diamond, King County. It is within the North Pacific Maritime Mesic-Wet Douglas Fir– Western Hemlock Forest Ecological System.

Metrics:

Landscape Context Score (land use and edge): 3.25

Contiguous land includes Lake 12, Rock Creek wetlands, and 2nd growth of various ages, as well as some cleared land/pastures, dirt and paved roads and residences.

Condition Score (vegetation and soils): 3.55

Site has large second growth Douglas firs, western red cedars, and western hemlock, as well as a good amount of big-leaf maple. Understory vegetation includes mostly sword fern with a few other shrub and herb species. An insignificant amount of non-native plants was observed. Despite having been logged, the site currently supports large trees as well as snags and CWD. Soils are in good shape.

Size Score -0.33

Size is small for patch type.

EO Rank: 3.08 (B+)

G/S Rank is **GNR/SNR**; with a B+ rank, not an EO.

Management recommendations:

The forest is in good shape. No recommended management at this time.

Appendix D

Simplified EIA Form Example

For this simplified EIA, only plants with greater than 15% cover were included on the plant species list. Changes from the original form (Appendix A) are highlighted.

***Note:** All fields and metrics are strongly encouraged to be assessed. However, fields and metrics with * are the minimum required for element occurrence (EO) submission to WNHP. When doing the minimum, do not complete the 'Roll-up Calculation' table on page 12. Contact joe.rocchio@dnr.wa.gov or tynan.ramm-granberg@dnr.wa.gov for questions.*

***Site Name:** Keechelus Ridge ***AA Name (if >1 AAs)**________________

Classification (pg. 28) Ecological System (S Rank): North Pacific Dry-Mesic Silver Fir- Western Hemlock-Douglas Fir forest

*NVC Plant Association (G/S Rank): *Abies amabilis/Vaccinium membranaceum/Xerophyllum tenax* (G4/S4)

*NVC Group: North Pacific Maritime Silver Fir – Western Hemlock Forest Group

*Observer(s): Collette MacLean, Scott Davis *Date: 6/21/19 *County: Kittitas

VegPlot(s):________ *TRS: 21N, 12E, 3 Photos:________

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
*Spatial Coordinates	47.33796	47.33956	47.34214	47.34716	47.34604					
System:______	-121 .32044	-121 .32034	-121 .31822	-121 .31867	-121 .31686					

*Sampling Strategy:			
	☐ Polygon AA (< 50 ha / 125 ac; site walkthrough)	☐ Polygon AA (< 50 ha / 125 ac; systematic relevés)	Other:
	☐ Point-Based AA	X Combined Point/Polygon AA (> 50 ha / 125 ac)	

*Plot Type:			
	X Relevé	☐ Site-Walkthrough	Plot Size / Dimensions: 400 m2
	☐ Transect	☐ Other:	

*AA size (ac/ha): 327ac/132 ha. *AA Description:

Site was previously logged and thinned. It currently contains good-sized silver firs and Douglas firs (12" dbh) as well as noble firs and subalpine firs. A few Western white pines were seen near the Forest Service road. Trees are well spaced with a thriving understory of VAME, XETE, ACTR, with inclusions of RHAL and many other species. Many seedlings and small conifers were seen.

Streams are present on site with ALSI, SASI, OPHO, etc. (not sampled). Old logging roads throughout site are colonized by ALRU. Soils are good, formerly compacted in places.

Environmental (pg 25 in upland EIA manual) Soil Type: sandy loam

***Topographic Position**: *1=Interfluve (crest, summit, ridge),2= High slope (shoulder, upper), 3=Midslope, 4=Low slope (lower, colluvial foot), 5=Toeslope (alluvial foot/toe), 6=High level (mesa/plateau), 7=Step in slope (ledge; rock wall, cliff), 8=Low level (lake/river terrace), 9=Channel wall (sloping side of channel), 10=Channel bed (channel bottom), 11=Basin floor (depression), Other

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Slope (deg/%)	18	22	18	16	24					
Aspect (downslope)	S	SW	W	SW	SW					
Topographic Position*	3	3	3	3	3					
Comments:										

Natural Disturbance Comments:

No evidence of fire. Some scat (elk?), some grazing on XETE.

Anthropogenic Disturbance Comments:

Decaying stumps, occasional flagging, old trash.

Geology Comments:

Environmental Comments:

EIA Module: Mesic/Hypermaritime forests

***Species Cover** (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				
PSME	C	37.5	17.5		37.5	17.5						22		Y	
ABAM	C	7.5	85	62.5	37.5	62.5						51		Y	
ABAM	SC	1.5	3.5	7.5	3.5	17.5						6.7		Y	
ACCI	SH	37.5	3.5									8.2			
VAME	SH	37.5	37.5	62.5	85	85						61.5		Y	
SYMO	SH	17.5										3.5			
XETE	H	7.5	17.5	37.5	17.5	37.5						23.5		Y	
LIBO	H	17.5	1.5									3.8			
ABPR	C		17.5	7.5	7.5							6.5			

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

*Species Cover (pg 28)

Cover (midpt): Trace (**0.25**), 0-1% (**0.5**), 1-2% (**1.5**), 2-5% (**3.5**), 5-10% (**7.5**), 10-25% (**17.5**), 25-50% (**37.5**), 50-75% (**62.5**), 75-95% (**85**), >95% (**97.5**); **Strata Codes: C** (tree canopy); **SC** (tree subcanopy > 5m); **SH** (shrub or tree 0.5 to 5m); **H** (herb or shrub < 0.5m); **G** (moss/lichen on soil surface)

Species	Stratum Code	Cover Class Midpoint Plots/Assessment Points/Sub-AAs 1-10										Avg. Cov.	Exo / Inv (E/I)	Diag (Y)	Incr / Decr (I/D)
		1	2	3	4	5	6	7	8	9	10				

Landscape Context (pg 31)

LAN1 Contiguous Natural Land Cover

Metric Rating	Percent Contiguous NLC (0 - 500 m)	Comments
EXCELLENT (A)	0.95	Contiguous land is 2nd growth forest or natural openings with ~5% dirt roads, cabins.
GOOD (B)		
FAIR (C)		
POOR (D)		

LAN2 Land Use Index (use table below to calculate score, then check rank)

Worksheet : Land Use Categories	Weight	% Area (0 to 1.0)	Score
Paved roads / parking lots	0		
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0	0.01	0.01
Gravel pit / quarry / open pit / strip mining	0		
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1	0.04	0.04
Agriculture: tilled crop production	2		
Intensively developed vegetation (golf courses, lawns, etc.)	2		
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3		
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4		
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4		
Military training areas (armor, mechanized)	4		
Heavy grazing by livestock on pastures or native rangeland	4		
Heavy logging or tree removal (50-75% of trees >30 cm DBH removed)	5	0.37	1.85
Commercial tree plantations / holiday tree farms	5		
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5		
Dam sites and flood disturbed shorelines around water storage reservoirs and boating	5		
Moderate grazing of native grassland	6		
Moderate recreation (high-use trail)	7		
Mature old fields and other fallow lands with natural composition	7		
Selective logging or tree removal (<50% of trees >30 cm DBH removed)	8	0.51	4.08
Light grazing or haying of native rangeland	9		
Light recreation (low-use trail)	9		
Natural area / land managed for native vegetation	10	0.15	1.50
		Total Land Use Index	7.48

⌋ EXCELLENT (A) Avg. LU score = 9.5 – 10	⌋ GOOD (B) Avg. LU score = 8.0 – 9.4	X⌋ FAIR (C) Avg. LU score = 4.0 – 7.9	⌋ POOR (D) Avg. LU score = < 4.0

EDGE (pg 38)

EDG1 Perimeter with Natural Edge

X

⌋ EXCELLENT (A) 100% 4 pts	⌋ GOOD (B) 75-99% 3 pts	⌋ FAIR (C) 25-75% 2 pts	⌋ POOR (D) <25% 1 pt

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Metric Rating										

EDGE1 Comments

1	A few dirt roads intersect perimeter.
2	
3	
4	
5	
6	
7	
8	

EDG2 Width of Natural Edge

X EXCELLENT (A) 4 pts; ≥ 100m	⌋ GOOD (B) 3 pts; 75-99m	⌋ FAIR (C) 2 pts; 25-75m	⌋ POOR (D) 1 pt; <25m

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Segment 1	100									
Segment 2	100									
Segment 3	100									
Segment 4	100									
Segment 5	100									
Segment 6	100									
Segment 7	100									
Segment 8	100									
Average	100									
Metric Rating	4									

*EDG3 Condition of Natural Edge (Small AAs ONLY; if surveying lines used for EDG2, score each line and then average)

X EXCELLENT (A) 4 pts	GOOD (B) 3 pts	FAIR (C) 2 pts	POOR (D) 1 pt

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Metric Rating										

BUF3 Comments:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Vegetation (pg 45)

*VEG1 Native Plant Species Cover (Relative) (calculate **relative** cover of each stratum at each sample point/sub-AA, then average across sample points; Use lower relative cover of either stratum for metric rating). Relative cover = (native cover / native+nonnative cover)*100; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area)

X EXCELLENT (A) 4 pts; >99%	VERY GOOD (A-) 3.5 pts; 95-99%	GOOD (B) 3 pts; 85-94%	FAIR (C) 2 pts; 60-84%	POOR (D) 1 pt; <60%

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Trees *Native*	46.5	123.5	87.5	86	97.5						
Nonnative	0	0	0	0	0						
Total Cover	46.5	123.5	87.5	86	97.5						
VEG1a. Native Tree Relative Cover	100	100	100	100	100						
Shrub/Herb *Native*	112.5	60	100	102.5	122.5						
Nonnative	0	0	0	0	0						
Total Cover	112.5	60	100	102.5	122.5						
VEG1b. Native Shrub/Herb Relative Cover	100	100	100	100	100						
Metric Rating	4	4	4	4	4						

Veg1 Comments:

1	Few non-natives seen do not show up on field form due to low cover.
2	
3	
4	
5	
6	
7	
8	
9	
10	

***VEG2 Invasive Nonnative Plant Species Cover** (absolute cover; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

X EXCELLENT (A) 4 pts; <1%	⌋ GOOD (B) 3 pts; 1-4%	⌋ FAIR (C) 2 pts; 4-10%	⌋ FAIR/POOR (C-) 1.5 pts; 10-30%	⌋ POOR (D) 1 pt; >30%

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	4	4	4	4	4						

Veg2 Comments:

1	No invasive nonnatives seen.
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG3 Native Plant Species Composition (based on vegetation table above; score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
Submetrics: 3a Diagnostic Species	4	4	4	4	4						4
3b Species diversity	2	2	2	2	2						2
3c Native Increasers	4	4	4	4	4						4
3d Native Decreasers	1	1	1	1	1						1
Metric Rating	3	3	3	3	3						3

Veg3 Comments

1	Removing low cover species from consideration lowers species diversity, removes visibility of increasers, decreasers and lowers the metric rating
2	
3	

4	
5	
6	
7	
8	
9	
10	

***VEG4 Vegetation Structure** (varies by EIA module; For Forest types, indicate the Stand Development Stage; then record a metric rank/score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score).

Stand development stage codes: cohort establishment (1); canopy closure (2); biomass accumulation/stem exclusion (3); maturation-eastside (4); maturation 1-westside (5); maturation 2-westside (6); vertical diversification-old growth (7); horizontal diversification-old growth (8); pioneer cohort loss-old growth (9).

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10
Stand Development Stage (Van Pelt)	5	5	5	5	5					

☐ EXCELLENT (A; 4 pts)	☐ GOOD (B; 3 pts)	X FAIR (C; 2 pts)	☐ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
v7 Dry Forests & Woodlands; v8 Mesic / Hypermaritime Forests											
Submetrics: 7/8a Canopy Structure (age class diversity)	2	2	3	3	2						2
7/8b Old/Large Live Trees	2	1	2	2	2						2
Metric Rating	2	1.5	2.5	2.5	2						2
v9 Shrublands											
Submetrics: 9a Shrub Cover											
9b Tree Encroachment											
Metric Rating											
v10 Shrub-Steppe; v11 Grasslands / Meadows											
Submetrics: 10/11a Woody Vegetation Cover											
10/11b Bunchgrass Cover											
10/11c Biological Soil Crust											
Metric Rating											
v12 Bedrock / Cliffs (no submetrics)											
Metric Rating											

Veg4 Comments:

1	
2	
3	
4	
5	

6	
7	
8	
9	
10	

VEG5 Woody Regeneration *(v2 Dry Forests & Woodlands; v3 Mesic / Hypermaritime Forests)* (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌋ EXCELLENT (A; 4 pts)	X GOOD (B; 3 pts)	⌋ FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V4 Dry Forests & Woodlands; V5 Mesic/Hypermaritime Forests & Woodlands											
Metric Rating	3	3	3	3	3						
V6 Shrublands; Grassland / Meadows; Shrub-steppe											
Metric Rating											

Veg5 Comments:

1	Most trees are planted but many regenerating naturally.
2	
3	
4	
5	
6	
7	
8	
9	
10	

VEG6 Coarse Woody Debris and Snags (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌋ EXCELLENT (A; 4 pts)	⌋ GOOD (B; 3 pts)	X FAIR (C; 2 pts)	⌋ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	1	2	3	4	5	6	7	8	9	10	Avg
V3 Dry Forests & Woodlands; V4 Mesic/Hypermaritime Forests & Woodlands											
Submetrics: V6v3/4a CWD Size Diversity	3	3	3	3	3						3
V6v3/4b. CWD Decay Class Diversity	3	3	3	3	3						3
V6v3/4c. Snag Size Diversity	1	1	1	1	1						1
V6v3/4d. Snag Decay Diversity	1	1	1	1	1						1
Metric Rating	2	2	2	2	2						2
V5 Shrublands; Grassland / Meadows; Shrub-steppe											
Submetrics: V6v5a Litter Source											
V6v5b. Litter Accumulation											

Metric Rating											

Veg6 Comments:

1	Little CWD seen, no snags seen.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Soil / Substrate (pg 72)

***SOI1 Soil Condition v3** (Score at each sample point/sub-AA and enter numeric value (e.g. A = 4 pts), then average scores across sample points; roll-up of sub-AA scores should consider relative area of sub-AA to total AA area; check appropriate box for overall score)

⌡ EXCELLENT (A; 4 pts)	X⌡ GOOD (B; 3 pts)	⌡ FAIR (C; 2 pts)	⌡ POOR (D; 1 pt)

Assessment Pt. / Sub-AA	**1**	2	3	4	5	6	7	8	9	10	Avg
Metric Rating	3	3	3	3	3						

SOI1 Comments

1	Some evidence of former logging (ie., roads), but soils in good shape otherwise.
2	
3	
4	
5	
6	
7	
8	
9	
10	

Size (pg 74)

SIZ1 Comparative Size (Patch Type)

⌡ EXCELLENT (A)	⌡ GOOD (B)	X FAIR (C)	⌡ POOR (D)

Spatial Pattern Type: Matrix Estimated Size (ac/ha): 327/132

Comments: Relatively small patch for matrix (within property boundary)

SIZ2 Change in Size (optional)

⌡ EXCELLENT (A)	⌡ GOOD (B)	⌡ FAIR (C)	⌡ POOR (D)

Comments:

Calculate EIA Scores

Roll-up Calculations	Rating	Score (TABLE 1)
LAN1. Contiguous Natural Land Cover	A	4
LAN2. Land Use Index	C	2
LAN MEF Score = (LAN1+LAN2)/2 (TABLE 2)	B	3
EDG1. Perimeter with Natural Edge	B	3

EDG2. Width of Natural Edge	A	4
EDG3. Condition of Natural Edge (do not include in calculation if not scored)	A	4
EDG MEF Score = (((EDGF1*EDG2)$^{1/2}$)*EDG3)$^{1/2}$ [Note: ½ exponent = square root] **(TABLE 2)**	A	3.72
LANDSCAPE CONTEXT PRIMARY FACTOR SCORE = (EDG Score*0.67)+(LAN Score*0.33) (TABLE 2)	B	3.48
Matrix = (EDG Score*0.33)+(LAN Score*0.67) **Large-Patch = (EDG Score*0.50)+(LAN Score*0.50)** **Small-Patch = (EDG Score*0.67)+(LAN Score*0.33)**	B	3.24
VEG1. Native Plant Species Cover	A	4
VEG2. Invasive Nonnative Plant Species Cover	A	4
VEG3. Native Plant Species Composition	B	3
VEG4. Vegetation Structure	C	2
VEG5. Woody Regeneration	B	3
VEG6. Coarse Woody Debris	C	2
(FORESTED) VEG MEF Score = [((VEG1+VEG2+VEG3)*0.4)+((VEG4+VEG5+VEG6)*0.6)/6 (Table 2)		2.87
(NONFORESTED) VEG MEF Score = (VEG1+VEG2+VEG3+VEG4+VEG5+VEG6)/6 (Table 2)		
[Note: Divide by number of metrics scored (i.e. divide by four if VEG1-VEG4 scored)]		
SOI1. Soil Condition	B	3
SOI MEF Score = SOI1		3
CONDITION PRIMARY FACTOR SCORE = (VEG Score*0.85)+(SOI Score*0.15) (TABLE 2)		2.89
ECOLOGICAL INTEGRITY (EIA) SCORE (TABLE 2) **Matrix/Large-Patch = (CONDITION SCORE*0.55)+(LANDSCAPE CONTEXT SCORE*0.45)** **Small-Patch = (CONDITION SCORE*0.7)+(LANDSCAPE CONTEXT SCORE*0.3)**	**B+**	**3.04**
SIZ1. Comparative Size	C	2
SIZ2. Change in Size (optional)		
SIZ MEF Score = SIZ1 OR (SIZ1+SIZ2)/2 (TABLE 2)		2
SIZE Points (TABLE 3)		-0.5
ELEMENT OCCURRENCE RANK (EORANK) = EIA Score + SIZE Points (TABLE 2)	**B-**	**2.54**

Table 1. Metric Rank / Score Conversions

Rank	A	A-	B	BC	C	C-	D
Score	4	3.5	3	2.5	2	1.5	1

Table 2. Score / Rank Conversions for MEF, EIA and EORANK calculations

Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Table 3. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	**Very Small/Small Patch**	**Large Patch**	**Matrix**
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Determine Whether AA Meets EO Criteria

EORANK / **Global Rank** / **State Rank**	G1S1, G2S1, GNRS1, GUS1	G2S2, GNRS2, G3S1, G3S2, GUS2	GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR	G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5
A+ (3.8 to 4.0)	EO	EO	EO	EO
A- (3.5 to 3.79)	EO	EO	EO	EO
B+ (3.0 to 3.49)	EO	EO	EO	Not an Element Occurrence
B- (2.5 to 2.99)	EO	EO	EO	
C+ (2.0 to 2.49)	EO	EO	Not an Element Occurrence	
C- (1.5 to 1.99)	EO	Not an Element Occurrence		
D (1.0 to 1.49)	EO			

Appendix E

Field manual for applying rapid Ecological Integrity Assessments in Upland Plant Communities of Washington State (DRAFT)

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Field Manual for Applying Rapid Ecological Integrity Assessments in Upland Plant Communities of Washington State (DRAFT)

November 27, 2018

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ON THE COVER

Photograph of Judy's Tamarack Park, Naneum Ridge, near Ellensburg, WA. Photograph by: Tynan Ramm-Granberg

TABLE OF CONTENTS

Figures

Tables

ACKNOWLEDGEMENTS

This document builds upon the upland Ecological Integrity Assessments (EIAs) for Ecological Systems developed by Crawford (2011a-aj; Crawford & Rocchio, 2011; Rocchio, 2011a-e). In addition, many of the methods and metrics presented here are adaptations of those originally developed for wetlands in Faber-Langendoen et al. (2016a, 2016b, 2016c) and Rocchio et al. (2016). Nordman et al. (2016) and Foti (2016) provided additional context for upland applications of EIA.

1.0 INTRODUCTION

Ecological Integrity Assessments (EIA) summarize the condition/integrity of individual occurrences of ecosystems through consideration of composition, structure, and ecological processes. The method can be applied to occurrences as small as 0.05 ha and as large as thousands of hectares. EIAs can be conducted at three different sampling intensities: Level 1 (entirely GIS-based), Level 2 (rapid, mostly qualitative, field-based), and Level 3 (intensive, quantitative, field-based).

This document describes the protocols for applying rapid, field-based Ecological Integrity Assessments (Level 2 EIA) to upland ecosystems in Washington State. For wetland ecosystems, reference Rocchio et al. (2016). Additional overviews of ecological integrity assessments are found in Rocchio & Crawford (2011), Faber-Langendoen et al. (2016a,b,c).

In 2011, the Washington Natural Heritage Program (WNHP) developed EIA scorecards for 67 of the 99 Ecological Systems which occur in Washington State (Crawford, 2011a-aj; Crawford & Rocchio, 2011; Rocchio, 2011a-e). This publication is the result of efforts to simplify those Ecological System-specific EIA scorecards into one document. After years of employing the system-specific scorecards, it became obvious there were more similarities across systems than differences. This effort also matches a similar approach taken for wetland and riparian EIAs (Faber-Langendoen et al., 2016b,c; Rocchio et al., 2016).

While the rapid nature of Level 2 assessments necessitates primarily qualitative metrics, the procedures delineated here provide a repeatable structure that will aid in evaluation of baseline ecological integrity of occurrences, as well as repeat-monitoring to establish trends. The EIA assessment target is defined by classification criteria. For upland ecosystems, we use "Ecological Systems of Washington State: A Guide to Identification" (Rocchio & Crawford, 2015). Specific project objectives may result in further adjustments to the assessment target. The process for establishing assessment target boundaries (i.e., the assessment area) and protocols for collecting data necessary to apply the EIA metrics are provided in this document. Section 2 focuses on the steps needed to employ the Level 2 EIA, including which metrics to apply based on ecosystem type. Section 3 provides protocols for measuring each metric.

Once metrics are scored, they are rolled up into five Major Ecological Factors: Landscape, Edge, Vegetation, Soils, and Size. These Major Ecological Factor scores are in turn rolled up into three Primary Rank Factors: Landscape Context, Condition, and size. These three factors are then combined to calculate an overall EIA score/rank.

Initial drafts of this protocol contained a sixth Major Ecological Factor, "Natural Disturbance Regime", which was intended to assess the degree to which natural disturbances were functioning within their natural range of variability at an ecosystem occurrence. However, in a rapid, level 2 EIA assessment, the observer does not have the luxury of witnessing disturbance events and must rely on proxy indicators—indicators that are already assessed in other metrics, such as VEG3 Native Plant Species Composition, VEG4 Vegetation Structure, VEG5 Woody Regeneration, and VEG6 Coarse Woody Debris, Snags, and Litter. For example, an occurrence of a Northern Rocky Mountain Ponderosa Pine Woodland and Savanna Ecological System may exhibit departure from its historic fire regime (frequent, low-intensity fires) via abundant tree regeneration by relatively fire-intolerant species such as *Pseudotsuga menziesii*. That indicator of altered disturbance regime is already measured in the VEG5 Woody Regeneration metric. Further testing may prove natural disturbance regime to be a useful metric for level 3 EIAs, in which more in-depth investigations of the disturbance history itself can take place (e.g. via reconstructed fire histories).

Primary and major ecological factor scores/ranks can be helpful for understanding the current status of primary ecological drivers. Whether one needs to roll up scores is dependent on the project objective. Land managers may only be interested in individual metric scores, as these provide insight into specific management needs, goals, and measures of success (e.g. a low score in the Invasive Nonnative Plant Cover metric (VEG2) may indicate the need for an herbicide treatment). On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, an overall EIA score/rank may be needed. For example, a land trust considering the purchase of one of three potential properties may want to focus on the site that has the most-intact ecological integrity.

1.1 Glossary of Frequently Used Terms

- Occurrence: An area of land where an ecosystem type is, or was, present. This can be a single patch/stand of a natural community, or a cluster of patches/stands within a given distance of one another that are considered as a single occurrence on the basis of shared ecological characteristics (NatureServe, 2002).
- Element Occurrence: An occurrence with practical conservation value as determined by a combination of Conservation Status Rank (rarity and imperilment of the ecosystem across its range) and EIA Rank (condition of the specific occurrence).
- Assessment Area (AA): The spatial area in which the EIA will be applied. The AA is “the entire area, subarea, or point of an occurrence” of an ecosystem type “with a relatively homogeneous ecology and condition” (Faber-Langendoen et al., 2016a,b,c).
- Spatial Pattern Type: Refers to the scale at which an ecosystem naturally occurs on the landscape. For example, ‘matrix’ types of vegetation are dominant across the majority of a given landscape, while ‘large-patch’, ‘small-patch’, and ‘linear’ types occur as distinctive patches within the larger ‘matrix.’
- Ecosystem: Used in a generic sense, referring to Ecological Systems, USNVC Groups, USNVC Associations, etc.—really any ecosystem classification unit.

- Ecological Systems: A mid-scale ecological classification developed by Comer et al. (2003) to aid conservation and environmental planning for uplands and wetlands. Ecological Systems represent recurring groups of terrestrial plant communities found in similar climatic and physical environments (including substrates and/or environmental gradients) and influenced by similar dynamic ecological processes, such as fire or flooding (Comer et al., 2003).
- United States Vegetation Classification (USNVC): A comprehensive, hierarchical classification of ecosystems of the United States (http://www.usnvc.org), developed in conjunction with the International Vegetation Classification (IVC) (http://www.natureserve.org/conservation-tools/projects/international-vegetation-classification). Both classifications are based on vegetation criteria (physiognomy and structure, plant species composition) and ecological characteristics, including disturbance patterns, bioclimate, and biogeography (Faber-Langendoen et al., 2009, 2014). USNVC hierarchy units mentioned in this document:
    - Group: "A vegetation classification unit that is defined by a relatively small set of diagnostic plant species (including dominants and codominants), broadly similar composition, and diagnostic growth forms that reflect regional mesoclimate, geology, substrates, hydrology, and disturbance regimes" (Faber-Langendoen et al., 2014).
    - Association: "A vegetation classification unit defined on the basis of a characteristic range of species composition, diagnostic species occurrence, habitat conditions and physiognomy. Associations reflect subregional to local topo- edaphic factors of substrates, hydrology, disturbance regimes, and climate" (Faber-Langendoen et al., 2014).
- EIA Module: For the purposes of Level 2 EIA, Washington's Ecological Systems have been aggregated into physiognomically similar "modules" that share key ecological processes, such as climate, broad disturbance regimes, soil types, etc. It is not a systematic vegetation classification unit, but a means of grouping ecosystems that can be evaluated by the same EIA metrics.

2.0 Applying Level 2 Ecological Integrity Assessments

2.1 Materials

In addition to standard footwear and attire for working in the field, the following materials and supplies are needed for applying the EIA:

- EIA field forms (http://www.dnr.wa.gov/NHPdata)
- *Ecological Systems of Washington State. A Guide to Identification* (Rocchio & Crawford, 2015) (http://www.dnr.wa.gov/NHPecoreports)
- Local plant identification keys and field guides. Users are strongly encouraged to use technical dichotomous keys such as *Flora of the Pacific Northwest* (Hitchcock & Cronquist, 1973). Color photo field guides typically list only common species. While they are an indispensable tool for identification, they do not cover the entire flora.
- *Identifying Old Trees and Forests in Eastern Washington* (Van Pelt, 2008) (http://file.dnr.wa.gov/publications/lm_hcp_west_oldgrowth_guide_full_lowres.pdf)
- *Identifying Mature and Old Forests in Western Washington* (Van Pelt, 2007) (http://file.dnr.wa.gov/publications/lm_hcp_east_old_growth_hires_part01.pdf)
- Hand lens, compass, camera, small trowel or shovel, pin flags and/or flagging, measuring tape (for plot layout)
- GIS is recommended for assessing Landscape Context and Edge metrics. However, using online map viewers could suffice. We have adapted NatureServe's Ecological System's map (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states) for assessing land use patterns and scoring EIA metrics. The GIS layer can be downloaded here: https://fortress.wa.gov/dnr/adminsa/DataWeb/dmmatrix.html#Natural Heritage.

2.2 Procedure

Below are general guidelines for applying a Level 2 EIA.

Step 1: Determine project objectives: Is your objective to estimate condition of an Ecological System (or other classification unit) across a given watershed, ecoregion, or management area, or to estimate condition of a specific occurrence?

Step 2: Assemble background information about ecological and management history of the site or project area.

Step 3: Classify the ecosystem occurrences present at the site using the Key to Washington's Ecological Systems found in Rocchio & Crawford (2015). If assessing riparian or wetland ecosystem occurrences, STOP and switch to the EIA manual for wetlands and riparian areas (Rocchio et al., 2016)

Step 4: Identify assessment area(s) of the occurrences. Each assessment area must contain only one ecosystem occurrence. In some cases, the assessment area (AA) equals the full extent of the occurrence within the project area, but it may be smaller. See Sections 2.3 and 2.4 for details.

Step 5: Estimate the size of the AA. If > 50 ha, it is a Large AA. If < 50 ha, it is a Small AA. The AA size, along with the EIA module, will determine which methodology and EIA metrics to use during the assessment.

Step 6: Make sure the AA meets the minimum size requirement (Table 2) for the spatial pattern type of the Ecological System (see Rocchio & Crawford (2015)).

Step 7: Using Table 4, determine the EIA module in which the Ecological System is classified. Along with AA size, the EIA module determines which set of ecologically specific EIA metrics to use during the assessment.

Step 8: Using GIS, establish the Landscape Context envelope for the AA by buffering a 500 m area around the outer AA boundary. Also, establish an Edge envelope for the AA by buffering an area (100 m for all AA sizes) around the outer AA boundary.

Step 9: Before implementing the assessment, consult metric protocols to ensure they are conducted systematically. Verify the appropriate season to sample in and/or other timing aspects of field assessment (Section 3.0 Level 2 EIA Protocol). If returning to a long-term monitoring site, be sure to match seasonality as much as possible with the timing of previous site visits.

Step 10: Some metrics may be entirely or partially based on office assessments. When possible, complete those prior to field work.

Step 11: Determine your sampling strategy. The assessment often follows a site walkthrough approach where metrics are scored based on visual observations. For long-term monitoring, relevé plots are recommended for collecting data necessary to score metrics. For Large AAs (> 50 ha), where the AA is too extensive to assess rapidly and confidently, employ a point-based or combined point/polygon-based sampling methodology (Figure 2), with multiple assessment points selected at random before the field visit.

Step 12: Conduct the field assessment of on-site conditions, scoring all applicable metrics and noting stressors on the AA(s). For Small AAs (< 50 ha), the entire AA should be assessed, including—as much as feasibly possible—the 100 m Edge that extends beyond the AA boundary. This is typically aided by aerial photography or other imagery. For Large AAs (> 50 ha)—where it is not feasible to observe the entire occurrence with a rapid site walkthrough approach—sample the pre-determined assessment points.

Step 13: Complete the roll-up calculations for the six Major Ecological Factors, three Primary Rank Factors, and overall EIA ranks/scores. Automated EIA calculators are available on the WNHP website (http://www.dnr.wa.gov/NHP-EIA).

Step 14: Using the conservation status rank of the Ecological System being assessed (consult Rocchio & Crawford (2015)) and the overall EIA rank of the AA, refer to Table 3 and determine whether the occurrence meets the WNHP standard for an Element Occurrence. If so, submit EIA documentation to WNHP when convenient.

2.3 Assessment Area

As mentioned above, the Assessment Area (AA) is the spatial area in which the EIA will be applied. The AA is "the entire area, subarea, or point of an occurrence" of an ecosystem type "with a relatively homogeneous ecology and condition" (Faber-Langendoen et al., 2016a,b,c). An individual AA must contain only one ecosystem type at the desired scale of classification. In other words, when using Ecological Systems as the target, the AA may contain only one Ecological System. When using United States National Vegetation Classification (USNVC) plant associations (http://usnvc.org) as the target level of classification, the AA may contain only one association. The AA may never be larger than the occurrence being assessed, but it *is* possible for the AA to be smaller than the occurrence. This may occur due to a property line, or when different portions of the occurrence have starkly different anthropogenic histories. For example, a fenceline may cross an occurrence, limiting grazing to one side and resulting in very different ecological condition on either side.

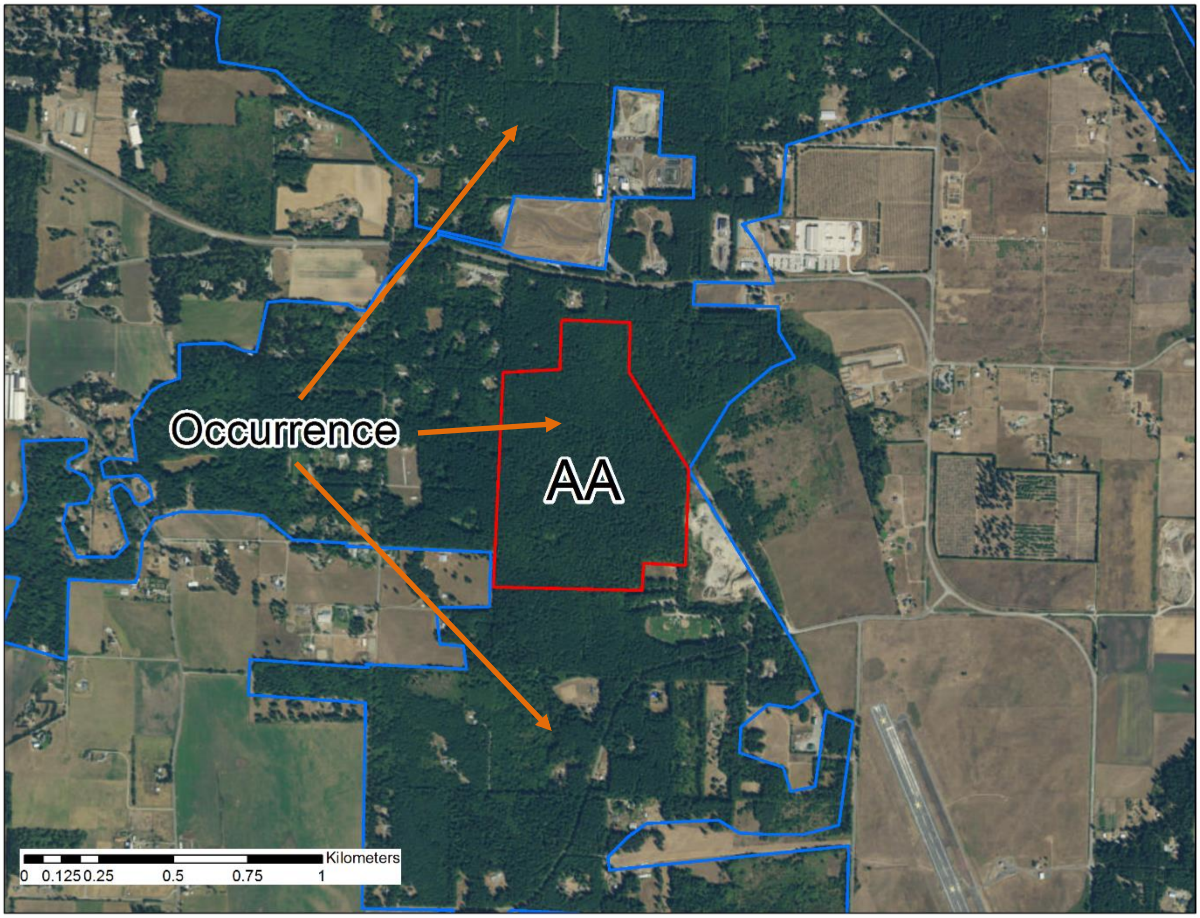

Figure 1. Example of Assessment Area (AA) v. Occurrence. The full extent of this North Pacific Maritime Dry-Mesic Douglas-Fir Western Hemlock Forest is the occurrence. The AA is the area in which the EIA will be applied. In this demonstration, the AA is smaller than the occurrence because the EIA is being applied to a county park. The area within the county park has relatively homogeneous ecology and condition, but outside its borders (throughout the rest of the occurrence) there is an amalgamation of different management histories that have resulted in a range of conditions.

There are many different approaches for determining the AA boundary, contingent on project objectives, ecosystem target, and the size of the occurrence. The approaches for AA delineation can generally be grouped into four categories: (1) point-based, (2) polygon-based, (3) combined point/polygon-based, and (3) nested polygon-based (using sub-AAs). Sections 2.3.1 through 2.3.4 outline each of these four approaches. Consult Figure 2 for guidance on the appropriate approach for your project objectives.

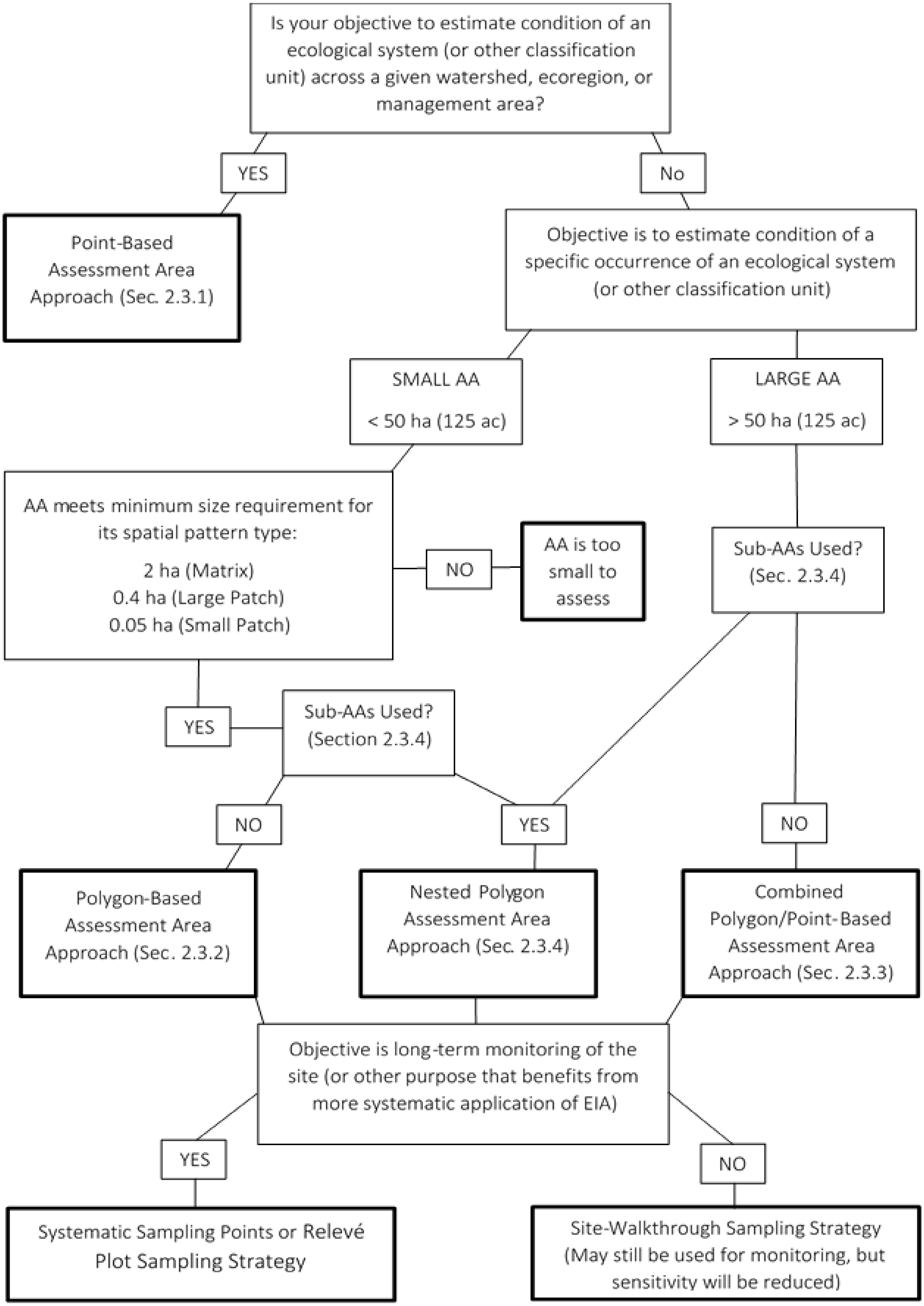

Figure 2. Decision Tree for Selection of Assessment Area Approach and Sampling Strategy

2.3.1 Point-Based Assessment Area

Point-based approaches are best suited for assessing the ecological condition of a population of occurrences, such as occurrences of a given ecosystem across an entire watershed or ecoregion (see Figure 2). These approaches typically define a relatively small area (e.g., 0.5 ha) around pre-determined points that are randomly distributed across the geographical area of interest. Assessments are then conducted within and around these points. A point-based approach offers some advantages (Fennessy et al., 2007; Stevens Jr & Jensen, 2007):

- Simple sampling design.
- Does not necessarily require a mapped boundary of the ecosystem
- Limited practical difficulties in the field for assessing the entire area, as the area is typically relatively small (0.5–2 ha).
- Long-term ambient monitoring programs often use a point-based approach because of these advantages.

For point-based AAs, some EIA metrics may not be applicable (e.g., Size metrics) or require modifications to rating criteria and/or roll-up procedures to make them logically consistent with their development. Those modifications are not within the scope of this document. Please contact WNHP for more information about using point-based sampling for EIAs in this context.

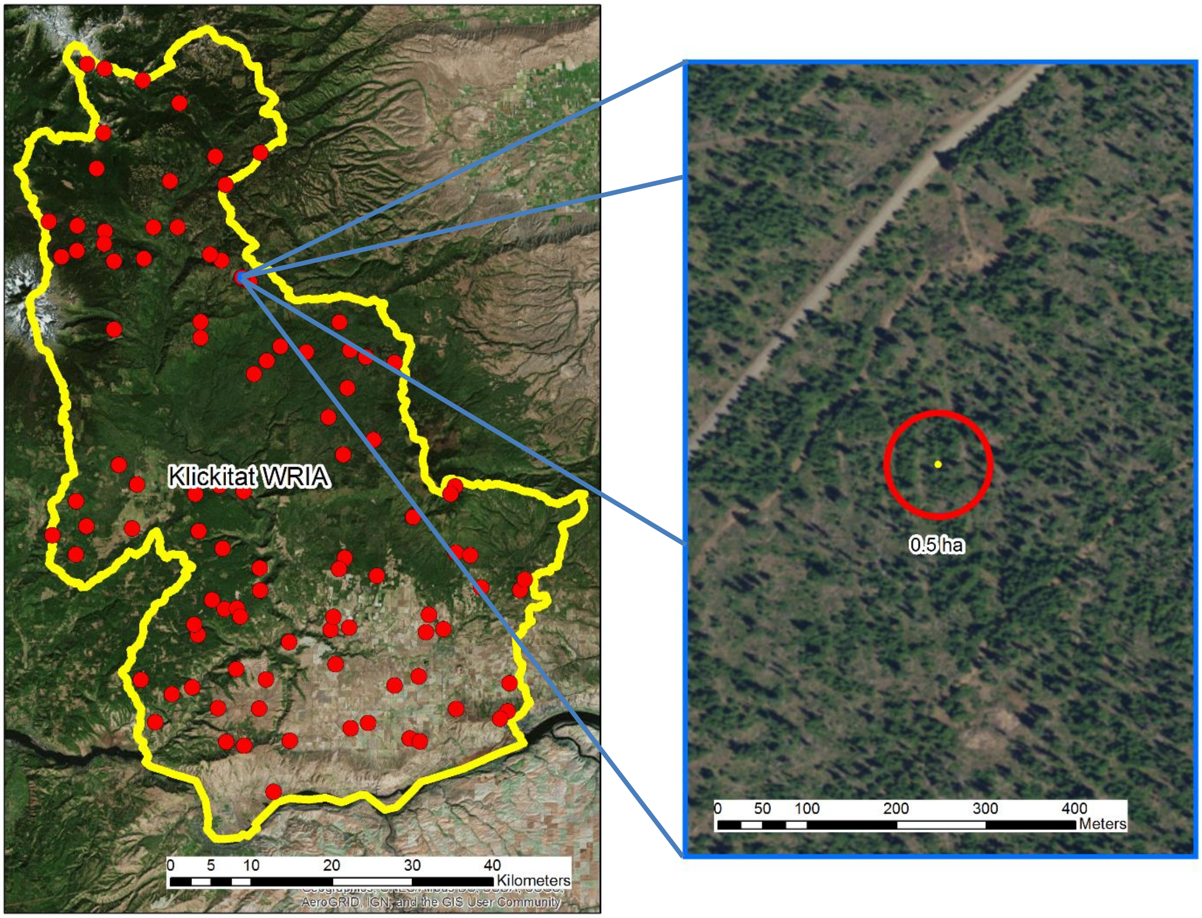

Figure 3. Point-based Assessment Areas (red circles). 40 m buffers were applied to randomly distributed points to create 0.5 ha assessment areas across an entire Water Resource Inventory Area (WRIA, http://www.ecy.wa.gov/programs/eap/wrias/Planning/). Points that fall within the ecological system of interest are then sampled.

2.3.2 Polygon-Based Assessment Area

The polygon approach is best suited for assessment of small AAs (< 50 ha) (see Figure 2). This includes nearly all occurrences of small-patch Ecological Systems, in addition to small occurrences of large-patch and matrix types (see Table 1). These AAs can be sampled using a site walkthrough approach whereby the observer walks as much of the AA as possible and makes observations that are then synthesized into metric ranks. Another option is to use a series of relevé plots or systematic sampling points within the AA where Condition metrics are assessed (similar to the combined point/polygon-based approach described in Section 2.3.3). The latter approach is useful for long-term monitoring (returning to the same plots each time) or to ensure a more systematic application of the EIA. It is *possible* to use polygon-based AAs to estimate ecological condition of larger aggregations of occurrences, or for occurrences of large-patch or matrix Ecological Systems, but the combined point/polygon method (Section 2.3.3) is typically more efficient and more conducive to those applications. Advantages of polygon-based AAs are:

- Mapping boundaries facilitate whole ecosystem and landscape interpretations.
- Decision-makers and managers are often more interested in "stands" or "occurrences," than points.
- Programs that maintain mapped occurrences of ecosystems are most interested in the status and trends of those occurrences.

Table 1. Patch Type Definitions (Comer et al., 2003).

PATCH TYPE	DEFINITION
Matrix	Ecosystems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., < 5%) of the total occurrence. In undisturbed conditions, **typical occurrences range in size from 2,000–10,000 ha (5000 – 25,000 ac) or more.**
Large Patch	Ecosystems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., > 20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions**, typical occurrences range from 50–2,000 ha (125-5,000 ac).**
Small Patch	Ecosystems that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. In undisturbed conditions, **typical occurrences < 50 ha (< 125 ac).**
Linear	Ecosystems that occur as linear strips. They often form ecotones between terrestrial and aquatic ecosystems. In undisturbed conditions**, typical occurrences range in linear distance from 0.5–100 km (1 – 60 mi).**

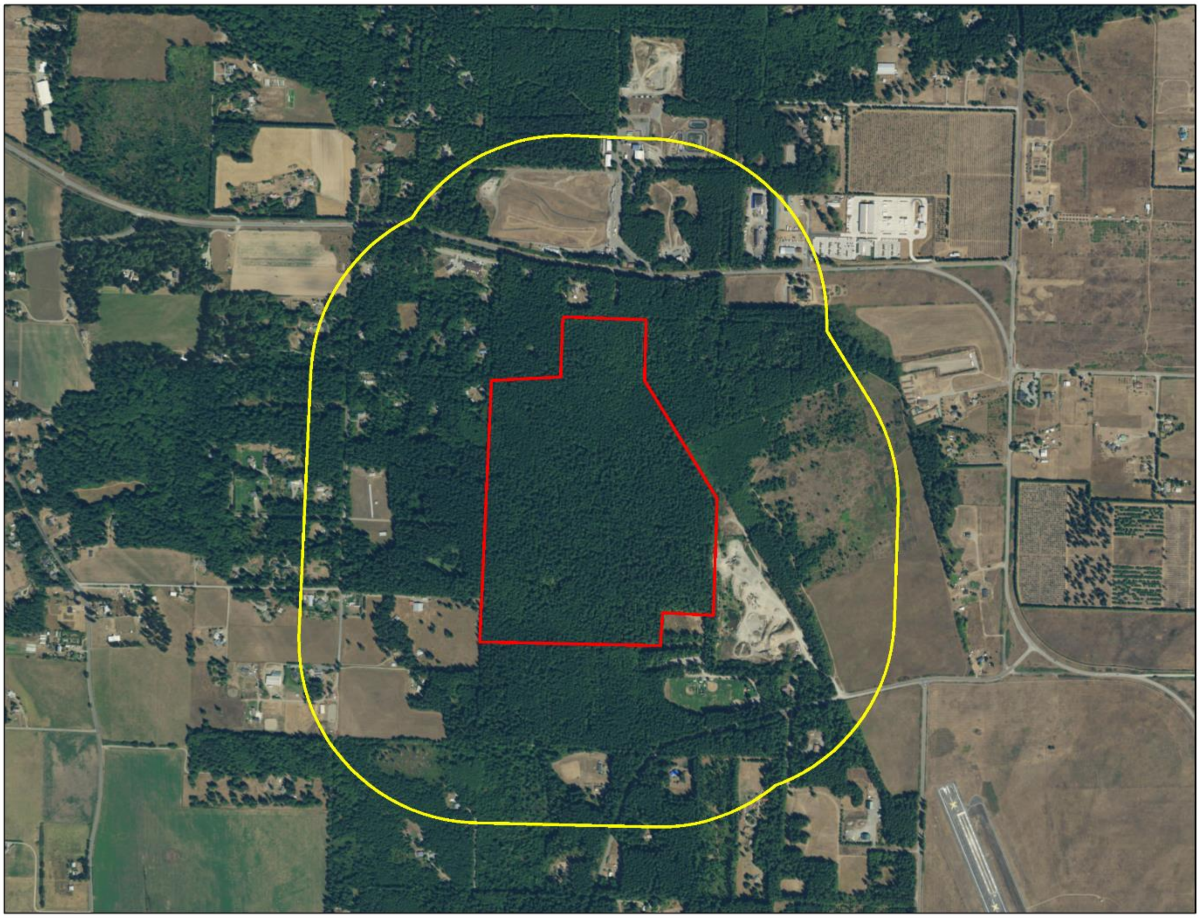

Figure 4. Polygon-based Assessment Area (red line) and 500 m Landscape Context Envelope (yellow line).

2.3.3 Combined Point/Polygon-Based Assessment Areas for Large-Patch and Matrix Ecological Systems

In this document we introduce a method for using combined point/polygon-based assessment areas for use in large AAs (> 50 ha) (see Figure 2). This method differs from the strict polygon-based approach in the following ways:

- A polygon-based assessment area boundary is mapped, but only used for Landscape Context and Size metrics.
- For Condition metrics, multiple point-based AAs are made within the larger polygon-based AA boundary. Each applicable Condition metric is rated/scored at each point-based AA. These multiple point-based AA ranks/scores are then rolled-up in order to calculate an overall score for a given metric over the entire polygon-based AA. This process ultimately provides a rank/score for each Condition metric at the polygon-based AA scale. Thereafter, Condition, Landscape Context, and Size metrics are rolled-up using the same approach as the polygon-based approach.

- Gives a structured sampling approach for assessing Ecological Systems that occur over vast areas.

Note that large AAs are used to assess most—but not all—large-patch or matrix Ecological System occurrences. Small occurrences of these systems should be assessed using the polygon-based methodology of small AAs (section 2.3.2), which allows for greater sampling efficiency. This applies to both naturally small/confined occurrences of large-patch and matrix Ecological Systems (e.g. occurring on the edge of the system's natural geographic range, or the site is restricted by soils, geology, aspect, etc.), as well as anthropogenically reduced fragments. From an ecological perspective, Size metrics for these small fragments will be scored relative to the inherent patch size of their Ecological System.

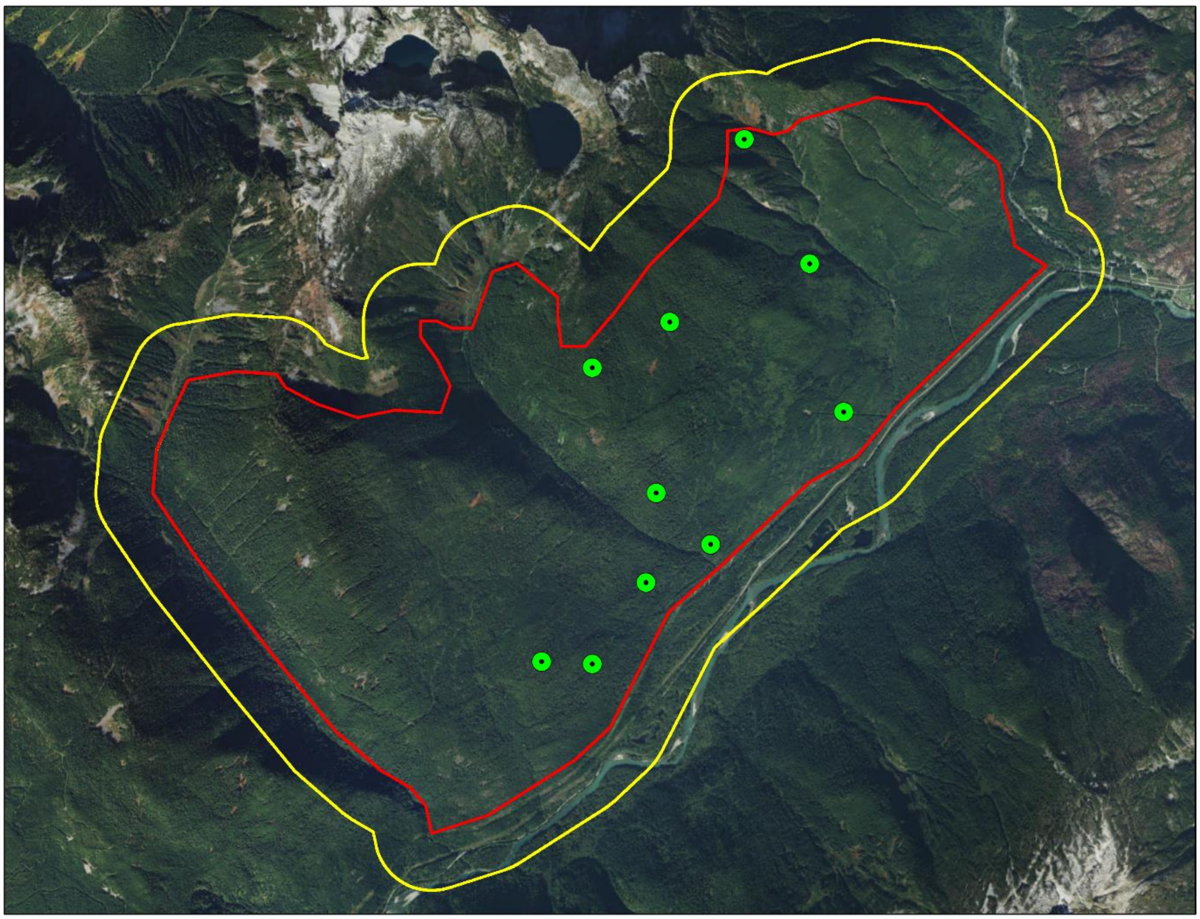

Figure 5. Combined Point/Polygon-Based Assessment Area (red line), 500 m Landscape Context Envelope (yellow line), and Randomly Distributed Assessment Points (green dots) for Large AAs.

2.3.4 Nested Polygon-Based Assessment Areas for Use with Sub-AAs

Another method for making large AAs more practicable is to divide them into multiple polygons that can be evaluated as "sub-assessment areas" (sub-AAs). Note that the entire occurrence remains one AA, because it is all one ecosystem type and the management histories of the different sections are not notably different. Sub-AAs may be delineated via numerous methods: randomly, based on observed ecological condition, using natural topographic breaks, the amount of area one can survey in a day, etc. Sub-AAs may be delineated on the ground, but are more easily determined beforehand using aerial imagery.

Besides making the sampling effort more practicable, some users may be interested in scoring individual sections within a larger AA for management purposes. For example, if a manager's goal is to restore the entirety of a forested ecosystem occurrence to old-growth conditions, they may have already digitized areas that are in early seral states in order to track progress of those sections towards old-growth. These pre-delineated sections can be considered sub-AAs for the purpose of the EIA.

This approach may be used with AAs of any size, but it will take considerable sampling effort to deploy it with large AAs. It differs from the strict polygon-based approach in the following ways:

- An outer assessment area boundary is mapped, but only used for Landscape Context and Size metrics.
- For Condition metrics, multiple sub-AAs are created within the larger AA boundary based on management units, "stands", or other user criteria. Each applicable Condition metric is rated/scored within each sub-AA, using either a site-walkthrough or systematic sampling approach. These sub-AA rank/scores are then weighted based on the area of the sub-AA relative to the full AA and rolled-up in order to calculate an overall score for a given metric over the entire polygon-based AA. This process ultimately provides a rank/score for each Condition metric at the AA scale, but the individual sub-AA ranks/scores may be used for management purposes. Thereafter, Condition, Landscape Context, and Size metrics are rolled-up using the same approach as the polygon-based approach.
- Gives a structured sampling approach for assessing the condition of smaller patches within an AA.

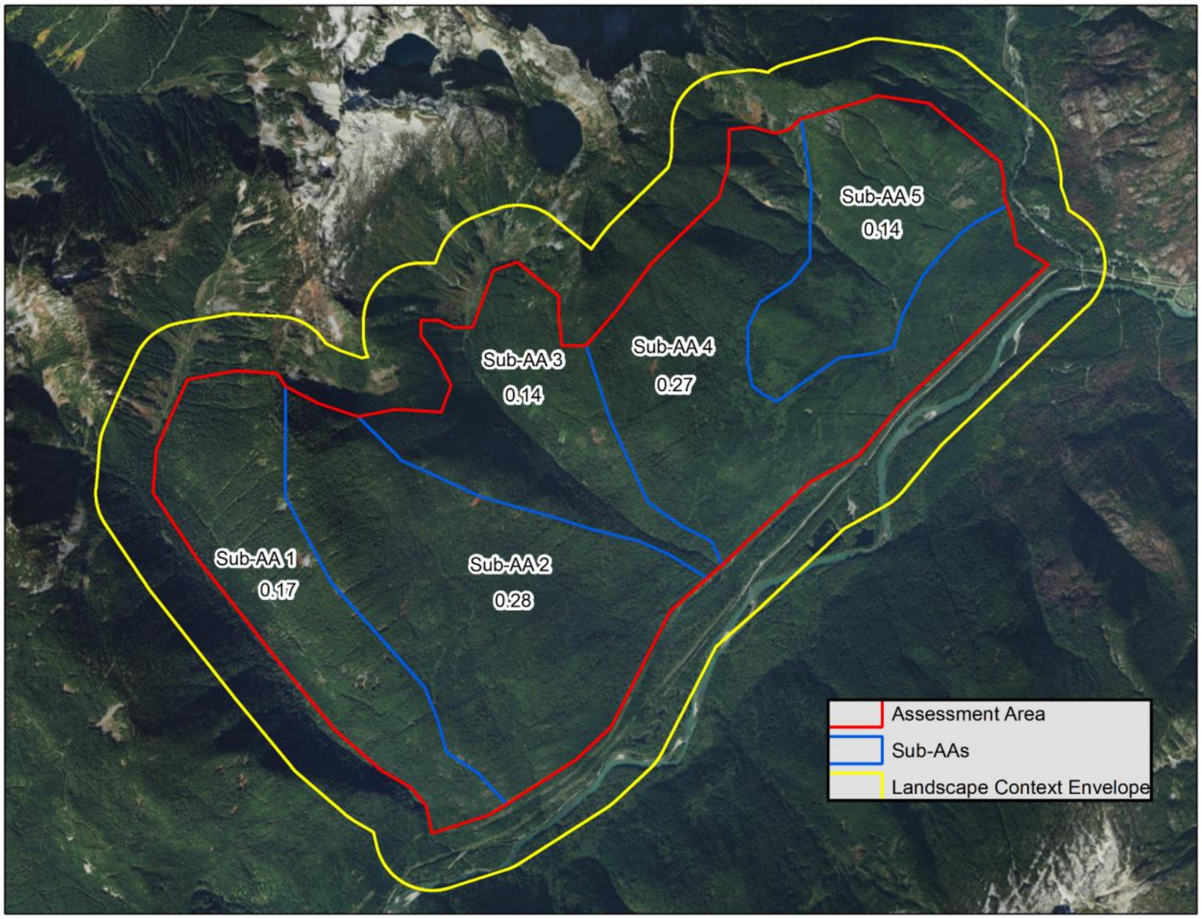

Figure 6. Nested Polygon-Based Assessment Area (red line), sub-AAs (blue line), and 500 m Landscape Context Envelope (yellow line). The numbers indicate proportion of the total AA accounted for by each sub-AA. Each sub-AA is scored for Condition metrics separately, then multiplied by its proportion of the total AA area. The sum of these weighted scores then gives the total score for that metric over the whole AA.

2.4 Determine the Assessment Area Boundaries

The steps below outline the procedure for delineating an AA boundary.

Step 1. Estimation of Ecosystem Occurrence Boundaries: Classify the ecological systems present within your project area (using Rocchio & Crawford (2015)) and then map their extent. These boundaries form the first draft of your AAs. In some cases, the extent of a given Ecological System may consist of multiple polygons that are separated from one other.

Make sure each AA meets the minimum size requirement (Table 2) for the spatial pattern type of the Ecological System (see Rocchio & Crawford (2015)). Consider an example in which you have mapped Inter-Mountain Basins Semi-Desert Shrub-Steppe (a matrix system), but the AA is only 1 ha in size. The AA does not meet the minimum size requirement for that spatial pattern type and thus is not considered to be a viable example of the ecosystem—it would not be assessed. In this case, the small remnant is considered either a) variation in the ecosystem type within which it is embedded, or b) a very small fragment of a once larger occurrence that is now too small to possess the ecological characteristics of the ecosystem in question. However, if your project objectives require such remnants to be assessed, the default score should be an overall "D" rank. Users may still use individual metrics to track specific attributes in such areas, if desirable.

Table 2. Patch Type and Minimum Size.

Patch Size of Ecological System Target	Recommended Minimum Size for Assessment Area
Matrix	2 ha (~5 acres)
Large Patch	0.4 ha (~1 acre)
Small Patch	0.05 ha (500 m^2)

If you are interested in submitting your ecological observation to WNHP for consideration as an element occurrence, proceed to step 2. Otherwise, skip to step 3.

Step 2. Preliminary Determination of the Ecological System's Conservation Significance

To merit consideration as a WNHP element occurrence (EO), the occurrence must be a rare ecosystem or a common one with excellent ecological integrity (Table 3). This is determined using the conservation status rank (Global/State rank) of the ecosystem and the EIA rank of the specific occurrence of that type. In other words, all occurrences of rare ecosystems qualify, regardless of their condition, while only good to excellent condition examples of common types are tracked as EOs.

Before proceeding further with the EIA, one should make a preliminary determination of whether the specific occurrence in question may qualify as an EO. First, determine the conservation status rank of the ecosystem target being assessed. If focusing on Ecological Systems, consult Rocchio & Crawford (2015), otherwise see the appropriate plant association field guide (http://www.dnr.wa.gov/NHPecoreports) and lists (http://file.dnr.wa.gov/publications/amp_nh_assoc_list.pdf). If it is a common ecosystem (e.g., S4 or S5), use your professional judgment regarding the ecological condition of the occurrence to determine whether it is valuable to proceed further. For example, if the ecosystem target is part of the North Pacific Mountain Hemlock Forest Ecological System (conservation status rank = S4S5) and it appears significantly degraded, further assessment is probably unnecessary, since occurrences of S4S5 ecosystems must have an A-rank or "excellent integrity" to be tracked as element occurrences (Table 3). If there is reason to believe the occurrence could have excellent ecological integrity (e.g., A-rank) then continue to Step 4. Conversely, if the occurrence is part of an ecosystem with a conservation status rank of G1 or S1, then further assessment is certainly warranted, as any occurrence with that status would warrant tracking as an EO, regardless of EIA rank (Table 3). This same logic applies to plant associations.

Table 3. Decision Matrix to Determine Ecosystem Element Occurrences.

<table>
<tr><th rowspan="2">Global / State Conservation Status Rank Combination</th><th colspan="4">Ecological Integrity Assessment Rank</th></tr>
<tr><th>A
Excellent
Integrity</th><th>B
Good
Integrity</th><th>C
Fair
Integrity</th><th>D
Poor
Integrity</th></tr>
<tr><td>G1S1, G2S1,
GNRS1, GUS1</td><td colspan="4" style="background:red"></td></tr>
<tr><td>G2S2, GNRS2,
G3S1, G3S2, GUS2</td><td colspan="3" style="background:red"></td><td></td></tr>
<tr><td>GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR</td><td colspan="2" style="background:red"></td><td colspan="2"></td></tr>
<tr><td>G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5</td><td style="background:red"></td><td colspan="3"></td></tr>
<tr><td colspan="5">Red Shading = Element Occurrence</td></tr>
</table>

<u>Step 3. Aggregate Polygons into AA Boundaries</u>: If each ecosystem target identified in Steps 1-2 has only one polygon/patch, then proceed to Step 4. Otherwise, use the key below to determine whether to aggregate multiple polygons of the same vegetation type as a single AA or to consider them as separate AAs.

1. Is the distance between two separate observation ≥ 5km?
   - Yes = they are separate AAs
   - No – GO TO 2
2. Do the observations share connected habitat?
   - Yes = GO TO 3
   - No – GO TO 4
3. Is there an area of cultural vegetation/development ≥ 2 km long (following linear habitat) between observations?
   - Yes = they are separate AAs
   - No – they are the same AA
4. Is there an area of development ≥ 100 m wide?
   - Yes = they are separate AAs
   - No – GO TO 5
5. Is there cultural vegetation / water ≥ 300 m wide?
   - Yes = they are separate AAs
   - No – GO TO 6
6. Is there contrasting wetlands / uplands ≥ 500 m wide? (i.e., if element is upland, contrast = wetland, and vice-versa)
   - Yes = they are separate AAs
   - No – they are same AA

<u>Step 4. Modifications to AA Boundaries Based on Variation in Land Use:</u> If significant changes in management or land use results in distinct ecological differences within the occurrence boundaries identified in Steps 1-3, those areas should be considered separate AAs (e.g. heavily

grazed shrub-steppe on one side of a fence line and ungrazed shrub-steppe on the other could result in separate AAs, even if they are both part of the same ecosystem target).

Step 5. Apply Level 2 EIA to AA Boundaries: For small occurrences, the extent of the AA boundary at this stage will result in a reasonably sized area (< 50 ha) allowing practical application of the EIA. If the AA exceeds a reasonable size for a rapid assessment (the AA > 50 ha), consider: (1) creating sub-AAs so that each is a practical assessment unit for a site walkthrough approach OR (2) use the combined point/polygon approach (Section 2.3.3.) to sample the AA. Our initial recommendation—pending further testing and statistical analysis—is to randomly establish 10 assessment points of 0.5 ha each (as in US Environmental Protection Agency, 2016) within the mapped boundary of the AA polygon (this can be done using GIS). These can be 40 m radius circular plots or rectangular plots of appropriate dimensions. Landscape Context and Size metrics are scored for the AA polygon as a whole, while all other metrics are scored for the individual assessment points and then averaged across the entire AA (as outlined in section 2.3.3). It is important to balance the goal of representing the inherent variability of large occurrences with the need to conduct efficient field sampling. Note that assessment points that fall within ecosystem inclusions (areas that differ from the ecosystem target being assessed) should be thrown out and new points should be selected. Note that sub-AAs may also be used as part of the nested polygon approach, in cases where managers are interested in scoring individual portions of a larger AA.

2.5 Determine Which Metrics to Apply

AA size is one key factor in determining which metrics to use in the Level 2 EIA. The other factor is the "EIA module" of the Ecological System being assessed. For the purposes of Level 2 EIA, Washington's Ecological Systems have been aggregated into physiognomically similar modules that share key ecological processes, such as climate, broad disturbance regimes, soil types, etc. Because each AA represents a single Ecological System, by definition, an AA also represents only one EIA module. Consult Table 4 to determine which EIA module your AA's Ecological System falls within. Once you've identified the EIA Module and size of your AA, consult Table 5 to determine which metrics or ratings to apply. Some metrics that cover complicated concepts have been broken down into component submetrics that allow the user to score the metric piece-by-piece. Generally, the total metric score is the average of all of its submetrics, unless stated otherwise (for example, VEG 1 Native Plant Species Cover takes the lowest value between the Tree and Shrub/Herb strata submetrics).

Table 4. Ecological System to EIA Module Crosswalk.

Ecological System	EIA Module
Columbia Basin Foothill and Canyon Dry Grassland	Grasslands / Meadows
Columbia Basin Palouse Prairie	Grasslands / Meadows
Columbia Plateau Low Sagebrush Steppe	Shrub-Steppe
Columbia Plateau Scabland Shrubland	Shrub-Steppe
Columbia Plateau Steppe and Grassland	Grasslands / Meadows
Columbia Plateau Western Juniper Woodland and Savanna	Dry Forests & Woodlands
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	Mesic / Hypermaritime Forests
East Cascades Oak-Ponderosa Pine Forest and Woodland	Dry Forests & Woodlands
Inter-Mountain Basins Active and Stabilized Dune	Grasslands / Meadows
Inter-Mountain Basins Big Sagebrush Steppe	Shrub-Steppe
Inter-Mountain Basins Cliff and Canyon	Bedrock / Cliff
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	Shrublands
Inter-Mountain Basins Montane Sagebrush Steppe	Shrub-Steppe
Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrub-Steppe
North Pacific Active Volcanic Rock and Cinder Land	Bedrock / Cliff
North Pacific Alpine and Subalpine Bedrock and Scree	Bedrock / Cliff
North Pacific Alpine and Subalpine Dry Grassland	Grasslands / Meadows
North Pacific Avalanche Chute Shrubland	Shrublands
North Pacific Broadleaf Landslide Forest and Shrubland	Mesic / Hypermaritime Forests
North Pacific Coastal Cliff and Bluff	Bedrock / Cliff
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field, or Meadow	Shrublands
North Pacific Dry Douglas-fir Forest and Woodland	Dry Forests & Woodlands
North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest	Mesic / Hypermaritime Forests
North Pacific Herbaceous Bald and Bluff	Grasslands / Meadows
North Pacific Hypermaritime Shrub and Herbaceous Headland	Bedrock / Cliff
North Pacific Hypermaritime Sitka Spruce Forest	Mesic / Hypermaritime Forests
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest	Mesic / Hypermaritime Forests

Ecological System	EIA Module
North Pacific Maritime Coastal Sand Dune	Grasslands / Meadows
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	Mesic / Hypermaritime Forests
North Pacific Maritime Mesic Subalpine Parkland	Mesic / Hypermaritime Forests
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	Mesic / Hypermaritime Forests
North Pacific Mesic Western Hemlock-Silver Fir Forest	Mesic / Hypermaritime Forests
North Pacific Montane Massive Bedrock, Cliff and Talus	Bedrock / Cliff
North Pacific Montane Shrubland	Shrublands
North Pacific Mountain Hemlock Forest	Mesic / Hypermaritime Forests
North Pacific Oak Woodland	Dry Forests & Woodlands
North Pacific Serpentine Barren	Bedrock / Cliff
North Pacific Wooded Volcanic Flowage	Dry Forests & Woodlands
Northern Rocky Mountain Avalanche Chute Shrubland	Shrublands
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	Mesic / Hypermaritime Forests
Northern Rocky Mountain Foothill Conifer Wooded Steppe	Dry Forests & Woodlands
Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland	Grasslands / Meadows
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	Mesic / Hypermaritime Forests
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	Shrublands
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	Dry Forests & Woodlands
Northern Rocky Mountain Subalpine Deciduous Shrubland	Shrublands
Northern Rocky Mountain Subalpine Woodland and Parkland	Mesic / Hypermaritime Forests
Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grasslands / Meadows
Northern Rocky Mountain Western Larch Savanna	Dry Forests & Woodlands
Rocky Mountain Alpine Bedrock and Scree	Bedrock / Cliff
Rocky Mountain Alpine Dwarf-Shrubland	Bedrock / Cliff
Rocky Mountain Fell-Field	Bedrock / Cliff
Rocky Mountain Alpine Turf	Grasslands / Meadows
Rocky Mountain Aspen Forest and Woodland	Mesic / Hypermaritime Forests
Rocky Mountain Cliff, Canyon and Massive Bedrock	Bedrock / Cliff
Rocky Mountain Lodgepole Pine Forest	Mesic / Hypermaritime Forests

Ecological System	EIA Module
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Mesic / Hypermaritime Forests
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	Mesic / Hypermaritime Forests
Rocky Mountain Subalpine-Montane Mesic Meadow	Grasslands / Meadows
Willamette Valley Upland Prairie and Savanna	Grasslands / Meadows

Table 5. EIA Metrics and Applicable EIA Modules/AA sizes.

Primary Rank Factor	Major Ecological Factor	Metric/Variant Name	Where Measured	Apply to:
LANDSCAPE CONTEXT	LANDSCAPE	LAN1 Contiguous Natural Cover	Office then field check	All EIA modules and AA sizes (for large AAs, score entire AA, not assessment points)
		LAN2 Land Use Index	Office then field check	All EIA modules and AA sizes (for large AAs, score entire AA, not assessment points)
	EDGE	EDG1 Perimeter with Natural Edge	Office then field check	All EIA modules (all sizes; for large AAs, score entire AA, not assessment points)
		EDG2 Width of Natural Edge	Office then field check	All EIA modules (all sizes; for large AAs, score entire AA, not assessment points)
		EDG3 Condition of Natural Edge	Office then field check	All EIA Modules (small AAs)
CONDITION	VEGETATION	VEG1 Native Plant Species Cover	Field	All EIA modules (all sizes); Use lowest submetric score
		<u>*Submetrics*</u>: *Tree Stratum*		Forested EIA modules (all sizes)
		Shrub/Herb Stratum		All EIA Modules (all sizes)
		VEG2 Invasive Nonnative Plant Species Cover	Field	All EIA Modules (all sizes)
		VEG3 Native Plant Species Composition	Field	All EIA Modules (all sizes)
		VEG4 Vegetation Structure	Field	All EIA Modules (all sizes; variant differs by EIA Module)
		VEG4, variant 7		Dry Forests and Woodlands (all sizes)
		VEG4, variant 8		Mesic / Hypermaritime Forests (all sizes)
		VEG4, variant 9		Shrublands (all sizes)
		VEG4, variant 10		Shrub-Steppe (all sizes)
		VEG4, variant 11		Grasslands / Meadows (all sizes)

Primary Rank Factor	Major Ecological Factor	Metric/Variant Name	Where Measured	Apply to:
		VEG4, variant 12		Bedrock/Cliff (all sizes)
		VEG5 Woody Regeneration	Field	Forested EIA modules (all sizes; variant differs by EIA Module)
		VEG5, variant 2		Dry Forests and Woodlands (all sizes)
		VEG5, variant 3		Mesic / Hypermaritime Forests (all sizes)
		VEG6 Coarse Woody Debris, Snags, and Litter	Field	Required for Forested EIA Modules; Optional for Shrubland and Herbaceous EIA Modules (all sizes; variant differs by EIA Module)
		VEG6, variant 3		Dry Forests and Woodlands (all sizes)
		VEG6, variant 4		Mesic / Hypermaritime Forests (all sizes)
		VEG6, variant 5		Grasslands / Meadows (all sizes)
	SOIL	SOL1 Soil Condition	Field	All EIA Modules (all sizes)
		SOL1, variant 3		All EIA Modules (all sizes)
SIZE	SIZE	SIZ1 Comparative Size (Patch Type)	Office then field check	All EIA Modules (for large AAs, score entire AA, not assessment points)
		SIZ2 Change in Size (Optional)	Office then field check	Required for small AAs of large-patch ecosystems; optional for other small AAs

3.0 Level 2 EIA Protocol

This section provides guidance on how to populate the field form. The first four sections address basic site-level data. Thereafter, protocols for each metric are described. They are organized by Rank Factor categories. Some of the protocols are the same as outlined by Faber-Langendoen et al. (2016b, 2016c) and implemented in the Washington wetland/riparian EIA manual (Rocchio et al., 2016). Occasionally, regional language is used for some of the metric ratings. Additionally, many of the metric ratings have been updated/combined/modified from EIA scorecard matrices previously developed by WNHP for specific Ecological Systems (Crawford, 2011a-aj; Crawford & Rocchio, 2011; Rocchio, 2011a,b,c,d,e). This publication is the result of efforts to simplify those Ecological System-specific EIA scorecards into one document. After many years of employing the system-specific scorecards, it became obvious there were more similarities across systems than differences. This effort also matches a similar approach taken for wetland and riparian EIAs (Faber-Langendoen et al., 2016b, 2016c; Rocchio et al., 2016).

3.1 Site / Assessment Area Information

The EIA field form can be used with any of the three sampling approaches: (1) point-based; (2) polygon-based AA (small, < 50 ha) or (3) combined point/polygon AA (large, > 50 ha), as described in Section 2.3. The combined point/polygon method requires surveys of multiple assessment points, the field form accommodates this approach by providing columns for up to 10 sample points for applicable metrics. When using the polygon-based AA method, the entire AA is given one value per field/metric, so only assessment point 1 should be filled out in each table.

Site Name: Provide a unique name for the survey site or project area.

AA Name (if > 1 AAs): If multiple assessment area polygons are established at the site, provide a unique name/identifier for the assessment area. For example, if there are multiple AA polygons at a site called "Pine Creek East" the individual AAs should be labeled something like "Pine Creek East-01" and "Pine Creek East-02". In this example, Pine Creek East-01 might be a high quality pine savanna occurrence, one side of a fence, while Pine Creek East-02 might be a much degraded, overgrazed pine savanna occurrence on the other side of the fence. Note that this naming convention does not apply to the multiple sample points one might establish within a single AA.

Observer: First and last name of the surveyor(s).

Date: Date(s) of the survey.

County: County in which the AA occurs.

VegPlot(s): If vegetation plots are established within the AA, list their unique plot codes.

TRS: Township, Range, and Section in which the AA occurs.

Photos: If photos are taken, please provide the photographer's name and associated file names. File names, ideally, should have the photographer's initials and a numeric code (e.g., fjr_001). A brief description of each photo's content should be documented in (1) a field notebook, (2) the file name, or (3) in the photo's metadata.

EOID: This is the "element occurrence ID" code from BIOTICS. This only applies to existing records in Washington Natural Heritage Program's BIOTICS database.

Source FeatureID: This is the "Feature ID" code from BIOTICs. Element occurrences can have more than 1 polygon. The FeatureID is used to uniquely code each polygon. This only applies to existing records in WNHP's BIOTICS database.

Owner(s): List the owners of the AA.

Spatial Coordinates: Record coordinates and indicate the system used (LAT/LONG, UTMs, etc.). Space is provided on the field form to record coordinates for up to 10 sample point locations. If using a polygon-based, site walkthrough approach, record the AA coordinates under point 1 in the table.

Sampling Strategy: Indicate the method used to delineate the AA boundary.

Plot Type: Circle the type of plot used for data collection (write it in if not listed). The plot form is tailored for relevé or site walkthrough data collection.

Plot Size/Dimension: Note the size of the plots used. Standard plot sizes for specific strata include: 100 m^2 for herbaceous and shrubland ecosystems; 400 m^2 for forested ecosystems. Note size by dimension (e.g. 10x10 m; 20x20 m; 10x40 m, etc.). If the site walkthrough method is used, estimate area walked and approximate time spent searching.

AA Size: Record the estimated size of the AA in acres or hectares.

AA Description: Please provide a written description of the AA's characteristics. Focus on the setting in which the site occurs, ecological and vegetation patterns within and adjacent to the site, notable stressors or human activity, signs of wildlife, etc. A sketched map may also be helpful.

3.2 Environmental

Soil Type: Using the key in Figure 7 determine soil texture at approximately 15 cm depth.

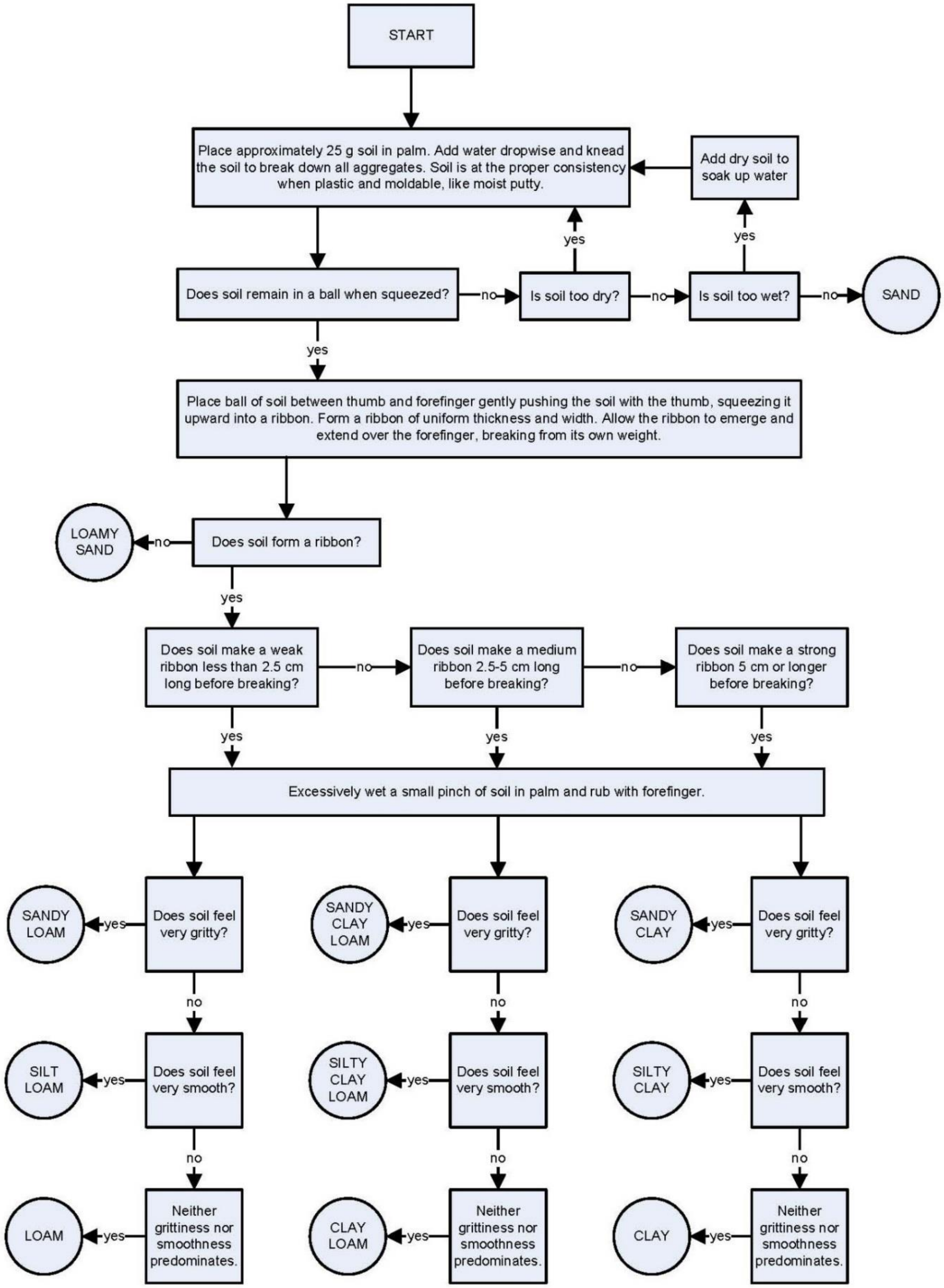

Figure 7. Soil Texture Flow Chart.

Topographic Position: Record the slope and aspect (facing downslope) and select the setting that best fits the location of the AA. If needed, use the empty boxes to enter topographic positions not represented in the table. Topographic positions are adapted from Liang (1951) and Dalrymple et al. (1968) and defined in Table 6.

Table 6. Topographic Positions.

Topographic Position	Definition
Interfluve	(Crest, summit, ridge): linear top of ridge, hill or mountain; the elevated area between two fluves (drainageways) that sheds water to the drainageways
High Slope	(Shoulder slope, upper slope, convex creep slope): geomorphic component that forms the uppermost inclined surface at the top of a slope. It comprises the transition zone from backslope to summit, and the surface is dominantly convex in profile and erosional in origin
High Level	(Mesa) level top of plateau
Midslope	(Transportational midslope, middle slope): intermediate slope position between high and low
Backslope	(Dipslope): subset of midslopes which are steep, linear and may include cliff segments (fall faces)
Step in Slope	(ledge, terracette): nearly level shelf interrupting a steep slope, rock wall, or cliff face
Low slope	(Lower slope, foot slope, colluvial footslope): inner gently inclined surface at the base of a slope. Surface profile is generally concave and a transition between midslope or backslope, and toeslope
Toeslope	(Alluvial toeslope): outermost gently inclined surface at base of a slope. Toeslopes in profile are commonly gentle and liner and characterized by alluvial deposition
Low level	(Terrace): valley floor or shoreline representing the former position of an alluvial plain, lake, or shore
Channel wall	(Bank): sloping side of a channel
Channel bed	(Narrow valley bottom, gully arroyo): bed of single or braided watercourse commonly barren of vegetation and formed of modern alluvium
Basin floor	(Depression): nearly level to gently sloping, bottom surface of an intermontane basin

Natural Disturbance Comments: Comments may include information on vegetation or ground cover disturbance (such as pit-and-mound topography created by windfall), evidence of native animal use, erosion, fire, storm debris, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided. Only comments on the natural disturbance evidence within the AA itself should be included in this field; although including information on the surrounding context cannot entirely be avoided, the focus should be on the AA. Information on disturbances to the surrounding landscape should be entered in the applicable Landscape Context metric comment fields instead.

Anthropogenic Disturbance Comments: Comments may include information on vegetation or ground cover disturbance by human activities such as logging, plowing, scraping, mowing, fire suppression, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided.

Geology Comments: Description of the geologic substrate that influences the occurrence.

Environmental Comments: Comments on other important aspects of the environment that affect this particular occurrence, including information on climate, seasonality, soil moisture, soil depth, or any other relevant environmental factors.

3.3 Classification

Ecological System: Note the Ecological System determined in Section 2.2 (using the key provided in Rocchio & Crawford (2015))

NVC Plant Association: Optional finer classification scale (Required for submission as EO).

NVC Group: Optional finer classification scale (Required for submission as EO).

Global/State Rank: Note the Global and State Conservation Status ranks for the Ecological System or NVC Plant Association.

EIA Module: Note the EIA module used (Table 4).

Stand Development Stage: In forested ecosystems, record the stand development stage using the keys in Van Pelt (2007, 2008).

3.4 Vegetation

Species Cover: List the species observed in the AA in the left hand column. For each species, enter the appropriate strata code. Columns for up to 10 relevé plots or assessment points are provided (if transect quadrats or nested subplots are used, attach the associated plot form to the EIA field form). Estimate canopy cover of the species within the plot and record the midpoint of the cover class (Table 7). For example, if *Artemisia tridentata* ssp. *vaseyana* has 10-25% cover, the midpoint value of 17.5 would be entered. Canopy cover is the “percentage of ground covered by a vertical projection downward of the outermost perimeter of the natural spread of foliage of plants” (Society for Range Management, 1989). Trace cover (0.25 midpoint) is assigned to minute plants that are found only once in the AA. If multiple plots are sampled, enter the average cover across plots for each species (this will help with metric calculations). For each species, be sure to enter the appropriate values for the Exotic/Invasive, Diagnostic, and Increaser/Decreaser columns. Example species for each of these categories, in each Ecological System, are found in Table A-1. Definitions of these categories are as follows:

Exotic species: Species not considered native to Washington.

Invasive species: Aggressive nonnative species that change or transform the character, condition, form, or nature of ecosystems (Monaco & Sheley, 2012).

Diagnostic species: The characteristic combination of native species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (Federal Geographic Data Committee, 2008). Together these species indicate specific ecological conditions--typically that of minimally disturbed sites.

Native Increaser Species: Native species that dramatically increase due to anthropogenic stressors such as grazing, nutrient enrichment, soil disturbance, etc. Examples, along with sources, are provided for each Ecological System in Appendix B. Species with a coefficient of conservatism value ≤ 3 were also reviewed as potential native "increasers". However, the mere presence of these species is not enough to indicate that they are acting as increasers. Instead, their proportion relative to what is expected triggers that designation. This concept tends to work well in occurrences exposed to conspicuous stressors such as livestock grazing where increasers tend to dominate or become monocultures (e.g. *Ericameria nauseosa* in shrub-steppe habitats, *Lupinus* species in montane grasslands). Because presence/absence is not enough to score this submetric it can be a difficult measure for many users. If that is the case, you can ignore this submetric and make a note in the Veg 3 metric comment section explaining your reasoning.

Native Decreaser Species: Native species that decline rapidly from stressors (i.e. "conservative species"). Examples, along with sources, are provided for each Ecological System in Appendix B. Species with a coefficient of conservatism value ≥ 7 were also reviewed as potential native "decreasers" (see Washington Floristic Quality databases for eastern and western Washington (http://www.dnr.wa.gov/NHP-FQA).

Table 7. Cover Classes.

Cover Class	Range	Midpoint
1	Trace	0.25%
2	0-1%	0.5%
3	1-2%	1.5%
4	2-5%	3.5%
5	5-10%	7.5%
6	10-25%	17.5%
7	25-50%	37.5%
8	50-75%	62.5%
9	75-95%	85%
10	> 95%	97.5

3.5 EIA Metric Ratings and Scores

For each metric, an "A", "B", "C", or "D" rank is selected. These ranks are informed by the following:

- Rating criteria descriptions contained within this manual
- Ecological Systems Guide (Rocchio & Crawford, 2015)
- *Identifying Old Trees and Forests in Eastern Washington* (Van Pelt, 2008) (http://file.dnr.wa.gov/publications/lm_hcp_east_old_growth_hires_part01.pdf)
- *Identifying Mature and Old Forests in Western Washington* (Van Pelt, 2007) (http://file.dnr.wa.gov/publications/lm_hcp_west_oldgrowth_guide_full_lowres.pdf)
- Relevant GIS data other data sources.

Field crews are encouraged to assign a single rating, but a range rank may be used (i.e., "AB", "BC", or "CD") in cases of uncertainty or in metrics in early stages of field-testing. The range rank does not indicate an intermediate rank, but that the metric may be one or the other. We also discourage the use of intermediate or plus/minus ranks (e.g., "A-", "B-", or "C-") at the metric level, as it may generate a sense of precision that is not present in a rapid assessment such as this. Some metrics do allow intermediate ranks and provide metric scoring language for them--these metrics are the exception. For example, when rating the "Native Plant Species Cover" metric, we find it helpful to distinguish "A" scores from "A-" scores. Metric ratings should be entered on the EIA field form. Associated scores for each rating (Table 8) are then used for roll-up calculations (Section 4.0). Users are encouraged to take notes in the comments field associated with each metric. These comments can prove invaluable in communicating the reasons underlying any given rating.

Table 8. Metric Rating and Points. Occasionally, metric ratings are further subdivided (e.g. "B" (3.0) and "B-" (2.5), or "C" (2.0) and "C-" (1.5)).

Metric Rating	Points
A	4.0
B	3.0
C	2.0
D	1.0

When multiple assessment points are used, the submetric and overall metric ratings are simply the average of all of the assessment point ratings. It does not matter if you average across each submetric and then average the submetrics together, or average across each assessment point and then average the assessment points together. In either direction, the overall metric rating for the AA will remain the same. Note that for large AAs, Landscape Context, Edge, and Size ratings are scored for the entire assessment area, not individual assessment points.

3.6 LANDSCAPE CONTEXT METRICS

LAN1 Contiguous Natural Land Cover

Definition: A measure of connectivity using the percent of natural habitat directly connected to the AA. **Note that** for large AAs (> 50 ha), this metric is assessed at the scale of the entire AA, not for individual assessment points within the AA.

Background: This metric serves as a proxy measure of the capacity for natural disturbances to occur on the landscape (e.g. fire). This metric also addresses the broader connectivity of the natural land cover by measuring the natural habitat that is directly contiguous to the AA. However, not all organisms and processes require directly contiguous habitat, and organisms perceive "connectivity" differently, so this metric may underestimate contiguous habitat for some organisms. The importance of this metric is assumed to differ between small-patch and large-patch/matrix ecosystem targets. As such, the spatial pattern of the ecosystem target determines the weight of this metric for roll-up and EIA score calculations.

Apply To: All EIA modules and AA sizes. For large AAs, this is scored for the entire assessment area, not individual assessment points.

Measurement Protocol: Identify the percent of natural land cover within 500 m that is directly connected to the AA and then score the metric using Table 10. We recommend using NatureServe's Ecological Systems map (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states) as a foundation for measurement of natural land cover. The GIS layer can be downloaded here: https://fortress.wa.gov/dnr/adminsa/DataWeb/dmmatrix.html#Natural_Heritage. The National Land Cover database (http://www.mrlc.gov/nlcd2011.php) may also be used. Ground-truthing or comparison with recent aerial photography is advised, since remotely sensed data sources may misinterpret some land cover types. Well-traveled dirt roads and major fire breaks divide occurrences, but vegetated two-track roads, hiking trails, hayfields, low fences and small ditches may be included (Table 9 provides guidance for distinguishing natural from non-natural land cover). Any cover type that "breaks" natural cover must be greater than five meters wide (or contribute to a break that is at least that wide). See Figure 8 for an example.

Table 9. Guidelines for Identifying Natural Land Cover.

Examples of Cover Types Included in Natural Land Cover	Examples of Cover Types Excluded from Natural Land Cover	Examples of Cover Types Crossing and Breaking Natural Edges[4]

Natural or ruderal[1] plant communities; open water[2] vegetated levees; old fields; naturally vegetated rights-of-way; rough meadows; natural swales and ditches; native or naturalized rangeland and non-intensive plantations[3]	Parking lots; commercial and private developments; roads (all types), intensive agriculture; intensive plantations; orchards; vineyards; dry-land farming areas; railroads; planted pastures (e.g., from low intensity to high intensity horse paddock, feedlot, or turkey ranch); planted hayfields; lawns; sports fields; traditional golf courses; Conservation Reserve Program pastures	Bike trails; horse trails; dirt, gravel or paved roads; residential areas; bridges; culverts; railroads; sound walls; fences that interfere with movements of species and processes that are critical to the overall functioning of the occurrence

[1]Ruderal plant communities: Plant communities dominated or codominated by nonnative species OR communities dominated by native species, but resulting from past human stressors and possessing no natural analog. For example, areas previously plowed may be revegetated by native vegetation, but composition may be unlike other plant communities. Novel ecosystems also fall into this category.

[2]Open Water: Some protocols exclude open water (such as lakes, large rivers, or lagoons) from natural land cover because the water quality or water disturbance regime (natural waves vs. boat traffic waves) may or may not be in good condition. Here we include open water. If desired, the condition of the open water can be assessed using the Condition of Natural Edge metric (EDG3).

[3]Plantations: Logged and replanted areas in which the overstory is allowed to mature and may regain some native component, and in which the understory of saplings, shrubs, and herbs are native or naturalized species and not strongly manipulated (i.e., they are not "row-crop tree plantings" with little to no vegetation in the understory, typical of intensive plantations).

[4]Cover Types Crossing and Breaking Natural Edges: These cover types are added to cover types excluded from natural land cover so that, collectively, they may contribute to a 5 m break in natural land cover.

Table 10. Contiguous Natural Land Cover Metric Rating.

Metric Rating	Percent Continuous Natural Land Cover
EXCELLENT (A)	**Intact:** Embedded in 90-100% natural habitat around AA. Connectivity is expected to be high; fire regime is relatively unimpeded by fragmentation; remaining natural habitat is in good condition (low modification); and a mosaic with gradients.
GOOD (B)	**Variegated:** Embedded in 60-90% natural habitat. Connectivity is generally high, but lower for species sensitive to habitat modification; remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries.
FAIR (C)	**Fragmented**: Embedded in 20-60% natural habitat. Connectivity is generally low, but varies with mobility of species and arrangement on landscape; remaining natural habitat with low to high modifications and gradients shortened.
POOR (D)	**Relict**: Embedded in < 20% natural habitat. Connectivity is essentially absent; remaining natural habitat generally highly modified and generally uniform.

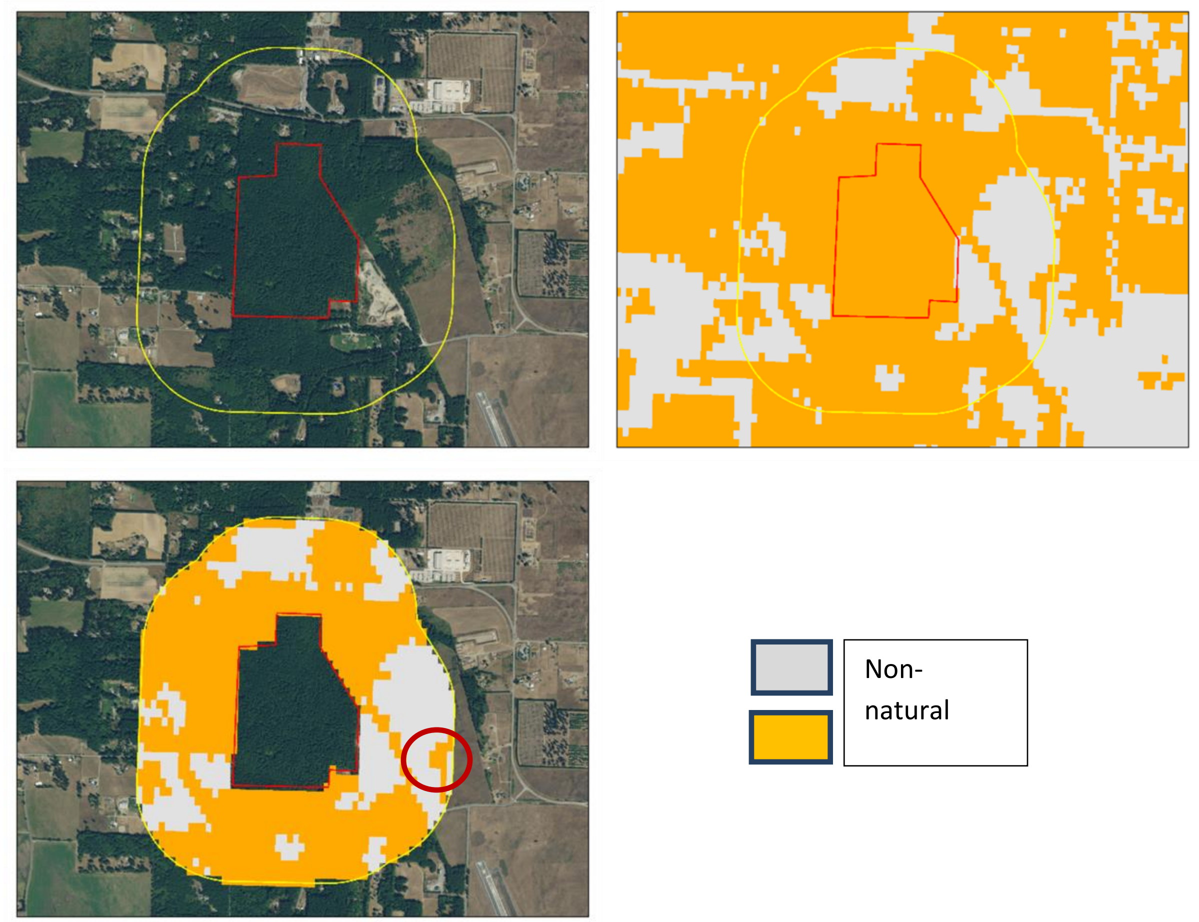

Figure 8. Contiguous Natural Land Cover Evaluation Based on Percent Natural Vegetation Directly Connected to AA. TOP LEFT: Aerial imagery showing the Assessment Area (red line) and 500 m landscape context envelope (yellow line). TOP RIGHT: The categories in NatureServe's Ecological Systems map have been cross-walked to land use categories in the GIS download available on the WNHP website. These land use categories were then lumped as 'natural' and 'non-natural' in the COVER_TYPE field. BOTTOM: After clipping the Ecological Systems raster and making adjustments based on ground-truthing and aerial photography interpretation, the percent Contiguous Natural Land Cover is calculated. This can be done using summary statistics in ArcGIS or by exporting the raster table to Excel and calculating there. In this example, 63.3% of the area counts as Contiguous Natural Land Cover (Table 11), a "B" rating (Table 10). Note that the portion of natural land cover in the southeast corner is not contiguous with the assessment area and was thus excluded from the total.

Table 11. Demonstration of Contiguous Natural Land Cover Scoring.

Count (pixels)	Area (m^2)	Ecological System	Natural / Non-Natural	Total Area (m^2)
12	360	North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland	Natural	46,050
1284	38520	North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	Natural	

148	4440	North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	Natural	
53	1590	North Pacific Lowland Riparian Forest and Shrubland	Natural	
38	1140	Temperate Pacific Freshwater Emergent Marsh	Natural	
100	3000	Cultivated Cropland	Non-Natural	26,670
34	1020	Pasture/Hay	Non-Natural	
394	11820	Harvested Forest - Grass/Forb Regeneration	Non-Natural	
32	960	Harvested Forest-Shrub Regeneration	Non-Natural	
11	330	Quarries, Mines, Gravel Pits and Oil Wells	Non-Natural	
110	3300	Developed, Open Space	Non-Natural	
153	4590	Developed, Low Intensity	Non-Natural	
55	1650	Developed, High Intensity	Non-Natural	
			% NATURAL	63.3%
			CONTIGUOUS NATURAL LAND COVER RATING	B

LAN2 Land Use Index (0-500 m)

Definition: This metric measures the intensity of human-dominated land uses in the surrounding landscape (0-500 m). Note that for large AAs this metric is assessed at the scale of the entire AA, not for individual assessment points within the AA.

Background: This metric is one aspect of landscape context. It is based on Hauer et al. (2002), Mack (2006), and Comer and Faber-Langendoen (2013). The importance of this metric is assumed to differ between small-patch and large-patch/matrix ecosystem targets. As such, the spatial pattern of the ecosystem target determines the weight of this metric for roll-up and EIA score calculations.

Apply To: All EIA modules and AA sizes. For large AAs, this is scored for the entire assessment area, not individual assessment points.

Measurement Protocol: This metric assesses the percentage of the surrounding landscape subjected to different land uses. Ideally, both field data and remote sensing tools (e.g. aerial photography or satellite imagery) are used to identify an accurate percentage of each land use within the 500m landscape envelope. For large AAs, remotely sensed data may be used on their own. To calculate a Total Land Use Score, estimate the percentage of each land use category and then plug the corresponding coefficient (found on the field form and Table 12) into the following equation:

Sub-land use score = $\sum LU \times PC/100$

LU = Land Use weight for Land Use Category

PC = % of adjacent area in Land Use Category

That score can then be rated using Table 15. See Figure 9, Table 13, and Table 14 for an example.

Table 12. Land Use Index Table.

Worksheet : Land Use Categories	Weight	% Area (0 to 1.0)	Score
Paved roads / parking lots	0		
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0		
Gravel pit / quarry / open pit / strip mining	0		
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1		
Agriculture: tilled crop production	2		
Intensively developed vegetation (golf courses, lawns, etc.)	2		
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3		
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4		
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4		
Military training areas (armor, mechanized)	4		
Heavy grazing by livestock on pastures or native rangeland	4		
Heavy logging or tree removal (50-75% of trees > 30 cm DBH removed)	5		
Commercial tree plantations / holiday tree farms	5		
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5		
Dam sites and flood disturbed shorelines around water storage reservoirs and motorized boating	5		
Moderate grazing of native grassland	6		
Moderate recreation (high-use trail)	7		
Mature old fields and other fallow lands with natural composition	7		
Selective logging or tree removal (< 50% of trees > 30 cm DBH removed)	8		
Light grazing or haying of native rangeland	9		
Light recreation (low-use trail)	9		
Natural area / land managed for native vegetation	10		
A = ≥9.5, **B** = 8.0-9.4, **C** = 4.0-7.9, **D** = < 4.0 Total Land Use Index			

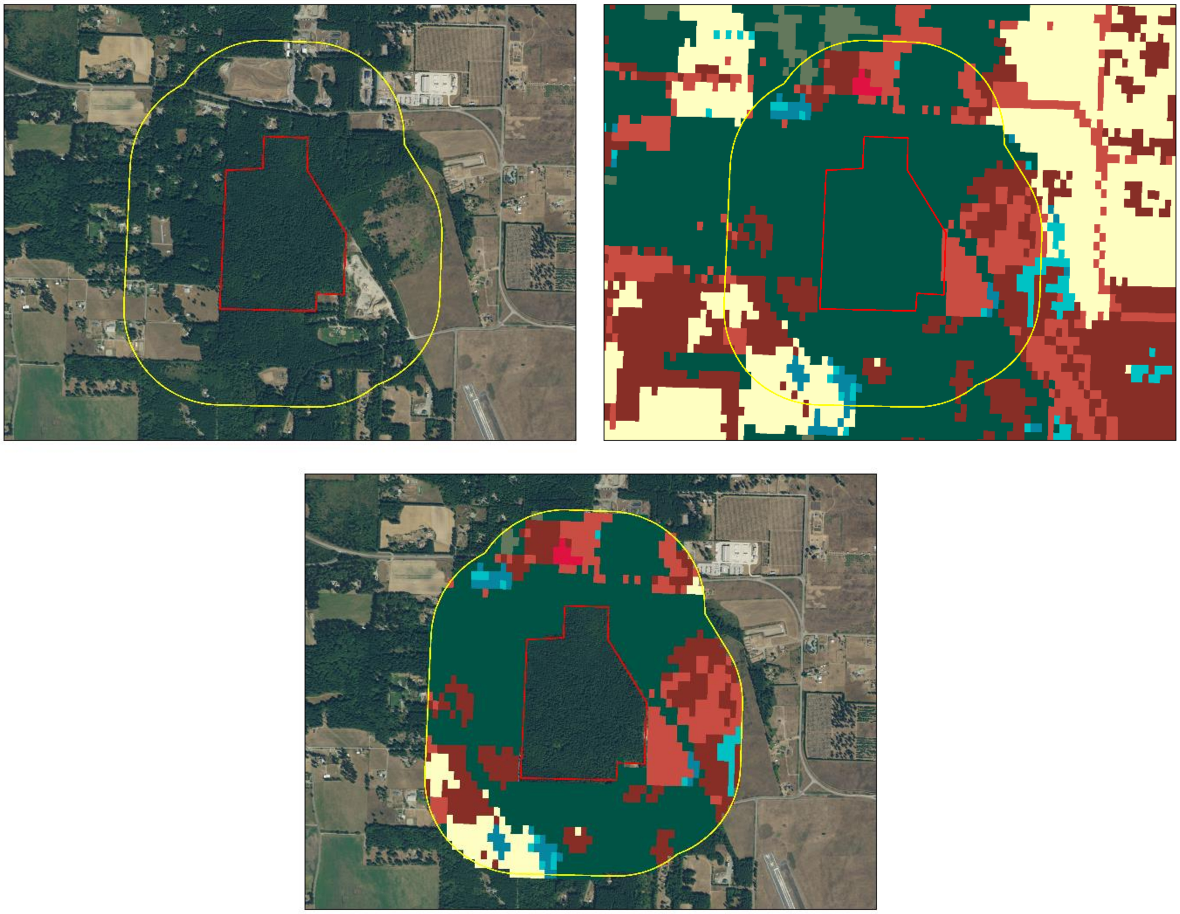

Figure 9. Demonstration of Using Remote Sensing Methods for Scoring the Land Use Index metric. TOP LEFT: Aerial imagery showing the Assessment Area (red line) and 500 m landscape context envelope. TOP RIGHT: NatureServe's Ecological Systems map shows various land uses which have been crosswalked to land use categories (Table 13) in the LAND_USE_CAT field in the GIS download available on the WNHP website. BOTTOM: After clipping, the percent area of each land use is recorded and multiplied by the land use's weight (Table 14). Be sure to look at the imagery closely for any discrepancies (recent disturbance, poor model interpretation of cover, etc.) and incorporate on-the-ground observations. The Land Use Index metric rating in this example was a "C".

Table 13. Demonstration of Using Land Use Coefficients to Assess the Land Use Index Metric.

Count (pixels)	Area (m^2)	Ecological System	Land Use Category
103	3090	North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland	Natural area / land managed for native vegetation
2358	70740	North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	
610	18300	North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	
74	2220	North Pacific Lowland Riparian Forest and Shrubland	

Count (pixels)	Area (m^2)	Ecological System	Land Use Category
2	60	North Pacific Shrub Swamp	
92	2760	Temperate Pacific Freshwater Emergent Marsh	
202	6060	Cultivated Cropland	Agriculture: tilled crop production
507	15210	Pasture/Hay	Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)
715	21450	Harvested Forest - Grass/Forb Regeneration	
63	1890	Harvested Forest-Shrub Regeneration	Heavy logging or tree removal (50-75% of trees > 30 cm DBH removed)
11	330	Quarries, Mines, Gravel Pits and Oil Wells	Gravel pit / quarry / open pit / strip mining
173	5190	Developed, Open Space	Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species
336	10080	Developed, Low Intensity	Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)
74	2220	Developed, High Intensity	

Table 14. Demonstration of final Land Use Index Metric Score.

Land Use Category	Weight	% of Area (by Land Use)	Score
Natural area / land managed for native vegetation	10	60.88%	6.1
Agriculture: tilled crop production	2	3.80%	0.1
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4	22.97%	0.9
Heavy logging or tree removal (50-75% of trees > 30 cm DBH removed)	5	1.18%	0.1
Gravel pit / quarry / open pit / strip mining	0	0.21%	0.0
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5	3.25%	0.2
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0	7.71%	0.0
		TOTAL	7.3
		LAND USE INDEX METRIC RATING	C

Table 15. Metric Rating for Land Use Index.

Metric Rating	*Land Use Index Variant: Small Patch*
EXCELLENT (A)	Average Land Use Score = 9.5-10
GOOD (B)	Average Land Use Score = 8.0-9.4
FAIR (C)	Average Land Use Score = 4.0-7.9
POOR (D)	Average Land Use Score = < 4.0

3.7 EDGE

For rapid assessments, we assess a 100 m zone extending beyond the boundary of the assessment area, using up to three metrics (dependent on patch size): (EDG1) Perimeter with Natural Edge, (EDG2) Width of Natural Edge, and (EDG3) Condition of Natural Edge. These are synonymous with the Buffer metrics in the wetland and riparian EIA (Rocchio et al., 2016). EDG3 requires a field visit in combination with aerial photography. Only the *natural* land cover surrounding the assessment area is assessed for these metrics. Note that Land Use Index (LAN2) includes an evaluation of all land uses within the edge zone (0–100 m), so it addresses the condition of the non-natural parts surrounding the assessment area.

EDG1 Perimeter with Natural Edge

Definition: Percentage of the perimeter of the assessment area that has a natural edge (borders natural land cover).

Background: This metric is similar to the BUF1 “Perimeter with Natural Buffer” metric used in wetland EIAs, with simple nomenclatural changes made to adapt it to upland settings. “Edge effects”—or the influence of one patch on a neighboring patch (Turner et al., 2001)—are major drivers of change in fragmented landscapes. Natural ecosystems experience significant changes in air temperature, light intensity, soil moisture, wind throw, and other key drivers when they border unnatural areas. These impacts are widespread and persistent and may originate from even small disturbances in the surrounding area (Bell et al., In Press). Additionally, unnatural edges are associated with altered fire regimes and increased colonization by exotic plants. We assess key aspects of the edge within a 100 m zone, but add a surrounding landscape assessment that extends to 500 m from the AA boundary (see metrics LAN1 and LAN2 above).

We only include natural habitats as part of the edge, as these habitats are most typical of the historical condition. The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and Ecological System maps to the evaluation. This definition is also consistent with the use of natural habitats for other EIA metrics.

Apply To: All EIA modules and AA sizes. For large AAs, this is scored for the entire assessment area, not individual assessment points.

Measurement Protocol: Estimate the length of the AA perimeter that borders natural land cover. This can be done using remotely sensed data and/or field-based observations. If remotely sensed data are used, field verification is recommended. Use a 10 m minimum edge width. Use Table 9 to help guide your assessment of natural v. unnatural and rate the metric using Table 16.

Table 16. Edge Perimeter Rating.

Metric Rating	Percent of AA with Natural Edge
EXCELLENT (A)	Natural buffer/edge is 100% of AA perimeter
GOOD (B)	Natural buffer/edge is 75-99% of AA perimeter
FAIR (C)	Natural buffer/edge is 25-75% of AA perimeter
POOR (D)	Natural buffer/edge is < 25% of AA perimeter

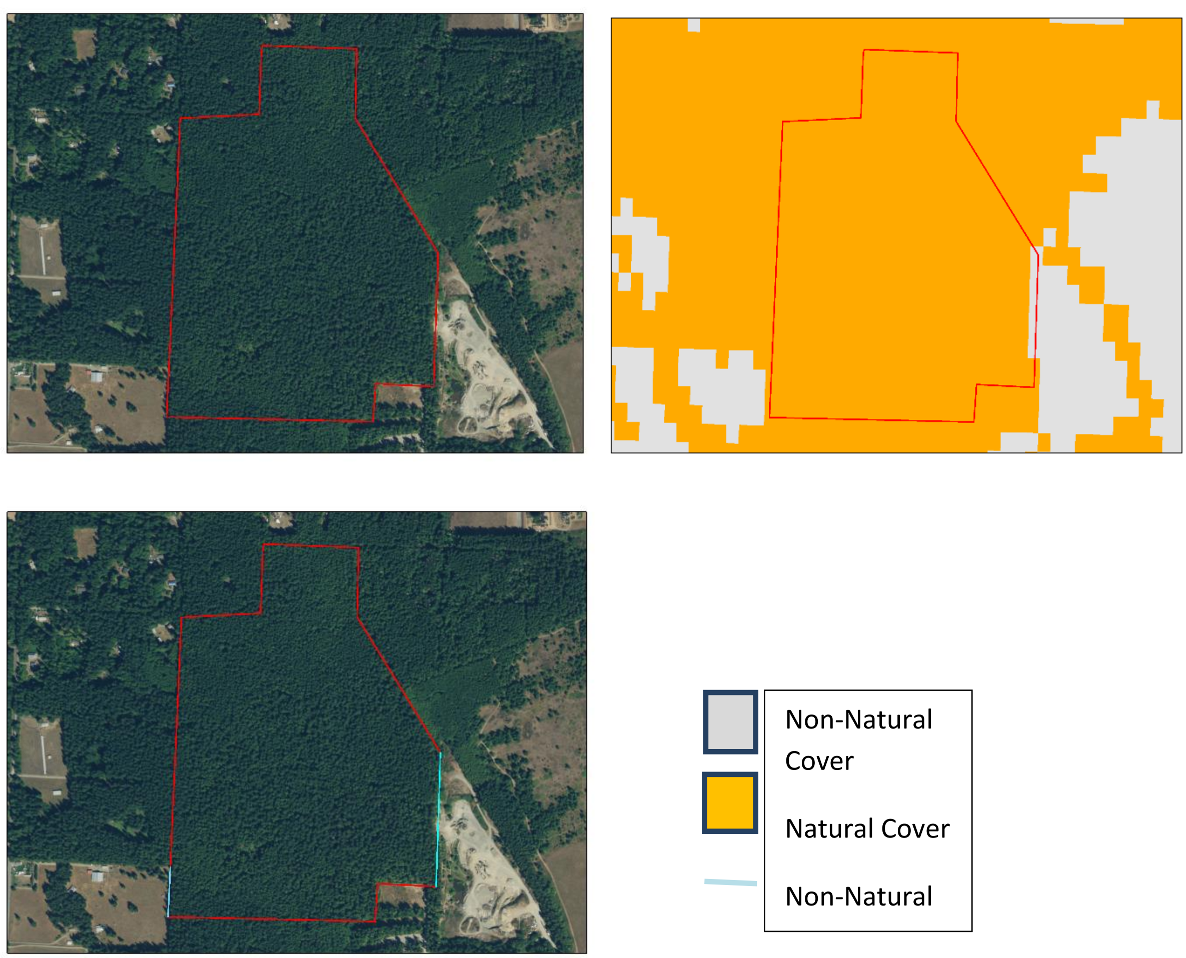

Figure 10. Edge Perimeter Example. TOP LEFT: Aerial imagery showing the assessment area (red line). TOP RIGHT: NatureServe's Ecological Systems map shows location of natural and non-natural land cover types. In this case, it comes close to accurately representing those edges that border non-natural land cover types, but the variations in resolution between the raster and the digitized boundary make it impractical to simply overlay them for this exercise. Aerial photography or ground truthing can compensate for this discrepancy. BOTTOM LEFT: Aerial imagery shows

portions of the edge without a natural cover (blue lines). The total AA perimeter length is 2,910 m and the non-natural portion totals 423 m, meaning the edge is 85% natural (a "B" rating).

EDG2 Width of Natural Edge

Definition: A measure of the average width of the natural edge, extending from the boundary of the Assessment Area to a maximum distance of 100 m.

Background: This metric is similar to the BUF2 "Width of Natural Buffer" metric used in wetland EIAs, with simple nomenclatural changes made to adapt it to upland settings. "Edge effects"—or the influence of one patch type on a neighboring patch (Turner et al., 2001)—are major drivers of change in fragmented landscapes. Natural ecosystems experience significant changes in air temperature, light intensity, soil moisture, wind throw, and other key drivers when they border unnatural areas. These impacts are widespread and persistent and may originate from even small disturbances in the surrounding area (Bell et al., In Press). Additionally, unnatural edges are associated with altered fire regimes and increased colonization by exotic plants. We assess key aspects of the edge within a 100 m zone surrounding the AA.

We only include natural habitats as part of the edge, as these habitats are most typical of the historical condition. The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and system maps to the evaluation. This definition is also consistent with the use of natural habitats for other EIA metrics.

Apply To: All EIA modules and AA sizes. For large AAs, this is scored for the entire assessment area, not individual assessment points.

Measurement Protocol: This metric is applied using one of two approaches: (1) Point-based or Simple Polygon AAs or (2) complex polygon AAs:

<u>Point-based or simple polygon shapes</u>**:** Metric is adapted from Collins et al. (2006) and Collins & Fennessy (2011).

1. Using the most recent aerial imagery, draw eight straight lines radiating out from the approximate center of the AA in eight cardinal directions (N, NE, E, SE, S, SW, W, NW), each extending 100 m beyond the boundary of the AA (Figure 11).
2. Measure the length of each line from the edge of the AA perimeter to the outer extent of the natural edge and record on data form (see example in Table 18).
3. If desired, use the slope multipliers in Table 20 to adjust the rating of upslope edge widths. Multiply by the edge rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.
4. Assign a metric score based on the average edge width (Table 17).

Table 17. Edge Width Rating.

Metric Ratings	Average Natural Edge Width (m)
EXCELLENT (A)	≥ 100 m, adjusted for slope.
GOOD (B)	75-99 m, adjusted for slope.
FAIR (C)	25-75 m, adjusted for slope.
POOR (D)	< 25 m, adjusted for slope.

Table 18. Edge Width Calculation (Simple Polygon Example).

Line	Edge Width (m) (max = 100 m)
1	100
2	100
3	0
4	40
5	100
6	0
7	100
8	68
Average Edge Width (m)	**63.5**

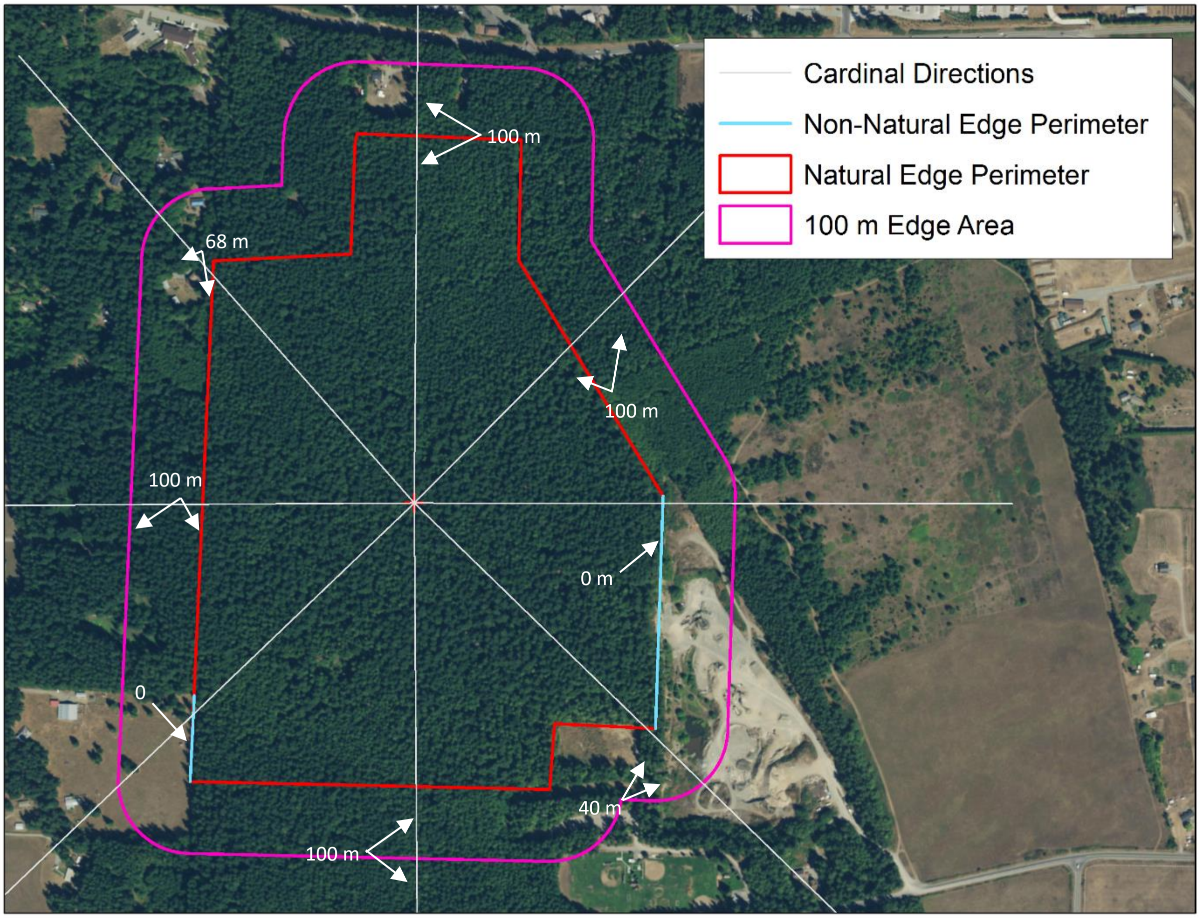

Figure 11. Edge Width Calculation (Point-Based or Simple Polygons). The width of natural edge is measured by calculating the distance between the boundary of the AA and the 100 m buffered line along each of the eight white lines and averaging them. In this example the calculation for average edge width is (moving clockwise): (100+100+0+40+100+0+100+68)/8=63.5 m (Table 18). That translates to a "C" rating (Table 17).

<u>Complex polygon shapes</u>

1. For AA polygons lacking a centroid from which eight spokes could reasonably radiate from, draw a line as near to the center of the AA polygon's long axis as possible where the line follows the broad shape of the polygon, avoiding finer level twists and turns (Figure 12).
2. Once you have determined the length of the line along the AA's long axis, divide the line by five, creating four equally spaced points along the axis. At each of the four points, draw a line perpendicular to the axis such that it extends out 100 m beyond each side of the AA's perimeter. For some arching AA's that close back in on themselves, see guidance below to address situations that may arise from interior spokes (i.e., spokes radiating away from the AA's interior arch).
   a. When two spokes cross one another, eliminate the spoke with the longer natural edge width and locate a new spoke at the more northerly end of the AA's long axis; extend the axis 100 m beyond the AA perimeter to form a new spoke.

   b. When a spoke heads back into the AA in less than 100 m, eliminate the spoke and locate a new spoke at the more northerly end of the AA's long axis.

   c. If two spokes need to be relocated, use both ends of the AA's long axis.

3. For spokes radiating out from the AA's exterior arch, if the spoke begins to cross a smaller lobe of the system in less than 100 m, allow the spoke to continue in the same direction through the lobe and measure edge width where the spoke can be extended beyond the lobe for 100 m (Figure 12).
4. For each of the eight spokes, determine the natural edge width from the AA's boundary until either an unnatural land cover is encountered or 100 m of contiguous natural buffer width is measured, whichever comes first.
5. Determine the average width of the edge (Table 19).
6. If desired, use the slope multipliers in
7. Table 20 to adjust the rating of upslope edge widths. Multiply by the edge rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.
8. Assign a metric score based on the average edge width (Table 17).

Table 19. Edge Width Calculation (Complex Polygon Example).

Spoke or Line	Edge Width (out to a maximum of 100 m)
Single west terminal spoke	10
West exterior spoke	18
West interior spoke	100
West-central exterior spoke	0
West-central interior spoke	0
East-central exterior spoke	0
East-central interior spoke	Not Used
South-east exterior spoke	7
South-east interior spoke	10
Average Edge Width (m)	**18**

Table 20. Slope Modifiers for Edge Width.

Slope Gradient	Additional Edge Width Multiplier
5-14%	1.3
15-40%	1.4
> 40%	1.5

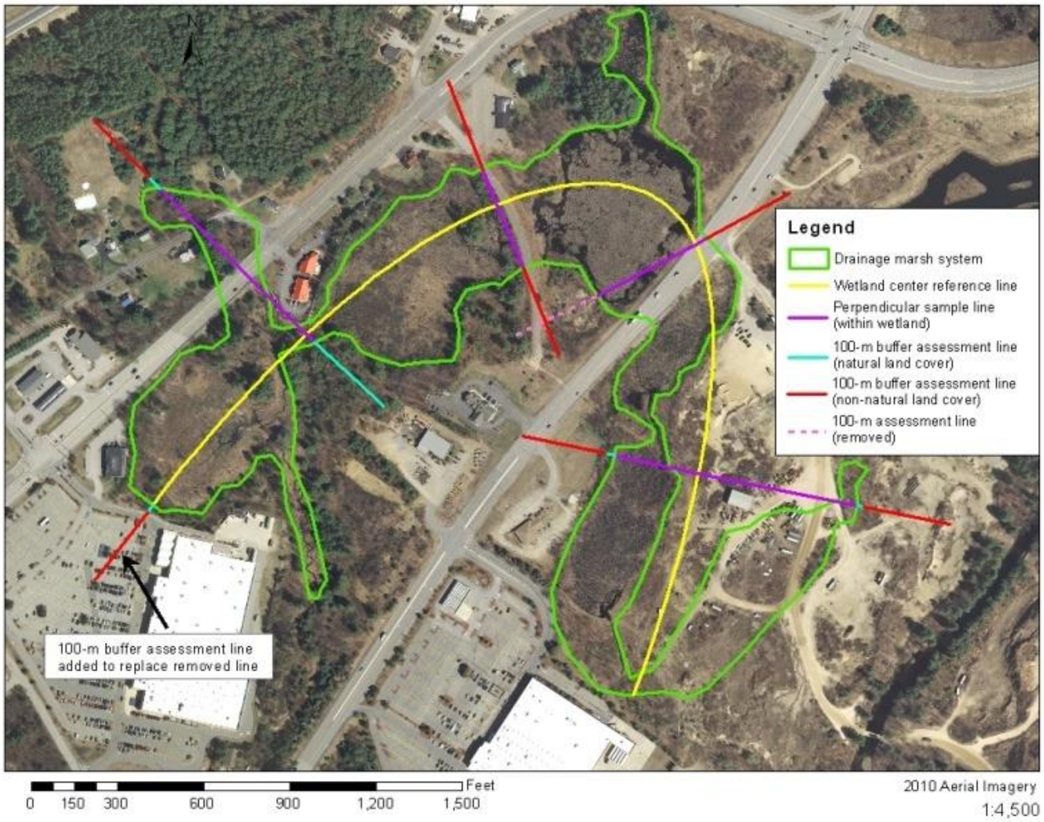

Figure 12. Edge Width Calculation (Complex Polygon Example). The eight spokes or lines are assessed for the edge width. For example, the single west terminal spoke has a 10 m wide edge. Once measured, average the eight edge widths to calculate the average width of the edge. Figure by Bill Nichols, New Hampshire Natural Heritage Program (from a wetland EIA example).

EDG3 Condition of Natural Edge

Definition: A measure of the biotic and abiotic condition of the natural edge, extending from the boundary of the Assessment Area.

Background: This metric is similar to the BUF3 “Condition of Natural Buffer” metric used in wetland EIAs, with simple nomenclatural changes made to adapt it to upland settings. “Edge effects”—or the influence of one patch type on a neighboring patch (Turner et al., 2001)—are major drivers of change in fragmented landscapes. Natural ecosystems experience significant changes in air temperature, light intensity, soil moisture, wind throw, and other key drivers when they border unnatural areas. These impacts are widespread and persistent and may originate from even small disturbances in the surrounding area (Bell et al., In Press). Additionally, unnatural edges are associated with altered fire regimes and increased colonization by exotic plants. We assess key aspects of the edge within a 100 m zone.

Apply To: Small AAs of all EIA modules.

Measurement Protocol: Estimate the overall biotic and abiotic condition within that part of the perimeter that has a natural edge. That is, if perimeter with natural edge is only 30%, assess condition within that 30%. Condition is based on percent cover of native vegetation, disruption to soils, signs of reduced water quality, amount of trash or refuse, various land uses, and intensity of human visitation and recreation. The evaluation can be made by scanning an aerial photograph in the office, followed by ground truthing, as needed. Ground truthing could be made systematic by following the eight lines used to assess edge width (EDG2), scoring each separately and then averaging for the overall metric score.

Table 21. Condition of Natural Edge Rating.

Metric Ratings	Natural Edge Condition
EXCELLENT (A)	Buffer/edge is characterized by abundant (> 95%) cover of native vegetation, with intact soils, no evidence of loss in water quality, and little or no trash or refuse.
GOOD (B)	Buffer/edge is characterized by substantial (75 – 95%) cover of native vegetation, intact or moderately disrupted soils, minor evidence of loss in water quality, moderate or lesser amounts of trash or refuse, and minor intensity of human visitation or recreation.
FAIR (C)	Buffer/edge is characterized by low (25 – 75%) cover of native vegetation, barren ground and moderate to highly compacted or otherwise disrupted soils, strong evidence of loss in water quality, with moderate to strong or greater amounts of trash or refuse, and moderate or greater intensity of human visitation or recreation.
POOR (D)	Buffer/edge is characterized by very low (< 25%) cover of native plants, dominant (> 75%) cover of nonnative plants, extensive barren ground and highly compacted or otherwise disrupted soils, moderate - great amounts of trash, moderate or greater intensity of human visitation or recreation, OR no natural edge at all.

3.8 VEGETATION

Vegetation varies greatly across the diversity of Washington's Ecological Systems. For that reason, some vegetation metrics have different variants based on the EIA module (i.e. grouping of Ecological Systems; Table 22).

Table 22. Metric Variants for Vegetation by EIA Module.

	VEGETATION					
Metric Variant by EIA Module	**VEG1. Native Plant Species Cover**	**VEG2. Invasive Nonnative Plant Species Cover***	**VEG3. Native Plant Species Composition***	**VEG4. Vegetation Structure ****	**VEG5. Woody Regeneration (Optional) ****	**VEG6. Coarse Woody Debris (Optional) ****

Dry Forests & Woodlands	v1	v1	v1	v7	v2	v3
Mesic / Hypermaritime Forests				v8	v3	v4
Shrublands				v9	n/a	n/a
Shrub-Steppe				v10	n/a	n/a
Grasslands / Meadows				v11	n/a	v5
Bedrock / Cliffs				v12	n/a	n/a

* VEG2 and VEG3 metrics are based on specific indicators associated with individual Ecological Systems.

**Metric variants not listed here are wetland variants (see Rocchio et al., 2016).

VEG1 Native Plant Species Cover

Definition: A measure of the relative percent cover of all plant species in the AA that are native to the region. The metric is typically calculated by estimating total absolute cover of all vegetation within each of the two major strata groups (tree and shrub/sapling/herbaceous) and then expressing the total native species cover as a percentage of the total stratum cover. The stratum with the lowest percentage of native cover is used as the basis for the score.

Background: This metric was developed by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al. 2008). Nonvascular species are not included—desirable as that may be in some occurrences—because of difficult species identification and interpretation of what those species indicate about ecological integrity.

Apply To: All EIA modules and AA sizes.

Measurement Protocol: This metric evaluates the relative percent cover of native species compared to all species (native and nonnative) for each of the three major strata (Native cover divided by / (Native + Nonnative cover) * 100). The protocol consists of a visual estimation of native vs. nonnative species cover using midpoints of cover classes (on the field form). The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. First, using cover class values in Table 7, estimate the total cover of vegetation by summing species cover across strata and growth forms (e.g., cover of tree canopy/subcanopy and shrub/ herb strata, combining growth forms within the same strata). The total may easily exceed 100%. Next, estimate the total cover of nonnative species in each and subtract those values from the total vegetation cover values to get the total native cover for each stratum. Divide the total native cover by the total vegetation cover and multiply by 100. This method can be used when all species, or only dominant species, are listed. Assign the score in Table 23 based on the stratum with the *lowest* percent of native plant species cover. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy ecosystems or large AAs, more than one plot may be desirable.

Table 23. Metric Ratings for Native Plant Cover. If scoring strata groups, choose lowest score between groups.

Rank	*Submetric: Tree Strata*	*Submetric: Shrub/Herb Strata*	Metric Score
Excellent (A) > 99% relative cover of native vascular plant species overall, OR whichever is lower in the key layer (either the tree stratum or shrub/herb strata)			
Very Good (A-) 95-99% relative cover of native vascular plant species overall, OR whichever is lower in the key layer (either the tree stratum or shrub/herb strata)			
Good (B) 85-94% relative cover of native vascular plant species overall, OR whichever is lower in the key layer (either the tree stratum or shrub/herb strata)			
Fair (C) 60-84% relative cover of native vascular plant species overall, OR whichever is lower in the key layer (either the tree stratum or shrub/herb strata)			
Poor (D) < 60% relative cover of native vascular plant species overall, OR whichever is lower in the key layer (either the tree stratum or shrub/herb strata)			

VEG2 Invasive Nonnative Plant Species Cover

Definition: The absolute percent cover of nonnative species that are considered invasive to the ecosystem being evaluated. Generally, an invasive species is defined as "*a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause environmental harm*…" (Clinton, 1999; Richardson et al., 2000), thus potentially including species native to a region, but invasive to a particular ecosystem in that region. However, here we treat those "native invasives" as "native increasers" under the Native Species Composition metric. Nonvascular species are not included—desirable as that may be in some occurrences—because of difficult species identification and interpretation of what those species indicate about ecological integrity.

Background: This metric is a counterpart to "Relative Native Plant Species Cover," but only assesses <u>invasive</u> nonnatives, not all nonnatives. Even here, judgment may be required. For example, some species are native to a small part of a region—or have mixed genotypes of both native and nonnative forms—and are widely invasive (e.g., *Phragmites*). Field crews must be provided with a definitive list of what is considered a nonnative invasive in their project area.

The definition of invasive used here is refers to those nonnative plants that have major perceived impacts on ecosystem condition, what Richardson et al. (2000) refer to as "transformers". They distinguish invasives (naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants and thus have the potential to spread over a considerable area) from "transformers" (A subset of invasive plants that change the character, condition, form, or nature of ecosystems over a substantial area relative to the extent of that ecosystem). Although our definition is essentially equal to that of "transformers" in that we are concerned with those naturalized plants that cause ecological impacts, we retain the term "invasive" as the more widely used term. Our use of the term also equates to "harmful non-indigenous plants" of (Snyder & Kaufman, 2004):

> "Invasive species that are capable of invading natural plant communities where they displace indigenous species, contribute to species extinctions, alter the community structure, and may ultimately disrupt the function of ecosystem processes."

Invasives are in turn distinguished from "increasers," which are native species such as *Ericameria nauseosa* that respond favorably to increasing human stressors. Native increasers are treated under the "Native Species Composition" metric.

Apply To: All EIA modules and AA sizes.

Measurement Protocol: Table A-1 provides a draft list of commonly encountered invasive species for each Ecological System. Users may consider additional species as invasive for the purposes of this metric, so long as those species match the definitions given above and are recorded in the VEG2 comments section on the data sheet. Ideally, a comprehensive list of nonnative invasive species would be established for your program's area of interest in order to make the application of this metric as consistent as possible. Remember that not all nonnative plant species are invasive.

The protocol uses a visual estimation of absolute cover of invasive species, with each species summed to produce the total cover. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and take notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy ecosystems or large AAs, more than one plot may be desirable.

Table 24. Invasive Species Metric Rating.

Metric Rating	*Invasive Nonnative Plant Species Cover: ALL TYPES*
EXCELLENT (A)	Invasive nonnative plant species are absent from all strata or cover is very low (< 1% absolute cover).
GOOD (B)	Invasive nonnative plant species are present in at least one stratum, but sporadic (1-4 % cover).
FAIR (C)	Invasive nonnative plant species somewhat abundant in at least one stratum (4-10% cover).
FAIR/POOR (C-)	Invasive nonnative plant species are abundant in at least one stratum (10-30% cover).
POOR (D)	Invasive nonnative plant species are very abundant in at least one stratum (> 30% cover).

VEG3 Native Plant Species Composition

Definition: An assessment of overall species composition and diversity, including native diagnostic species, native decreasers, native increasers (e.g., "native invasives" of Richardson et al. (2000)), and evidence of species-specific diseases or mortality.

Background: This metric evaluates the degree of degradation to the native plant species, including decline in native species diversity and loss of key diagnostic species, as well as shifting dominance caused by positive response to stressors by native increasers (a.k.a., "native invasives", aggressive natives, successful competitors). Increaser species are native species whose dominance is indicative of degraded ecological conditions, such as heavy grazed or browsed occurrences (Daubenmire, 1968). Native increasers often have FQA coefficients of conservatism ≤ 3 (see Rocchio & Crawford, 2013 and http://www.dnr.wa.gov/NHP-FQA). Native decreasers are those species that decline rapidly due to stressors (i.e. species sensitive to human-induced disturbance or those species with FQA coefficients of conservatism ≥ 7). Diagnostic species, are native plant species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (FGDC 2008). Together these species also indicate certain ecological conditions, typically that of minimally disturbed sites. Degraded conditions caused by nonnative invasive species are covered in the "Invasive Plant Species Cover" metric.

Apply To: All EIA modules and AA sizes.

Measurement Protocol: The protocol requires a visual evaluation of variation in overall composition and requires the ability to recognize the major/dominant plant species of each layer or stratum. Lists of diagnostic species and common increasers and decreasers—for each Ecological

System—are available in Table A-1. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and take notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. Using criteria in Table 25, assign ratings to submetrics on the field form.

Note: Native increasers can be difficult for many users to assess, as presence alone is not sufficient to indicate that these species are acting as increasers. Instead, it is their proportion relative to what is expected that triggers such a designation. This concept tends to work well in occurrences exposed to conspicuous stressors such as livestock grazing, where these species tend to dominate or become monocultures. **If you find this submetric difficult to evaluate, make a note in the comment section and skip it.**

Table 25. Native Plant Species Composition Rating Criteria.

Metric Rating	*Vegetation Composition: ALL TYPES*
EXCELLENT (A)	**Native plant species composition (species abundance and diversity) minimally to not disturbed:** Submetrics: i) DIAGNOSTICS: Typical range and diversity of native diagnostic species present. ii) NATIVE DECREASERS: Native species sensitive to anthropogenic degradation (native decreasers) present. iii) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (weedy or ruderal species) absent or, if naturally common in this type, present in expected amounts and not associated with conspicuous stressors.
GOOD (B)	**Native plant species composition with minor disturbed conditions:** Submetrics: i) DIAGNOSTICS: Some native diagnostic species absent (reduced diversity) or substantially reduced in abundance. ii) NATIVE DECREASERS: At least some native species sensitive to anthropogenic degradation present. iii) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present with low cover or, if naturally common in this type, present in slightly greater than expected amounts and associated with conspicuous stressors.
FAIR (C)	**Native plant species composition with moderately disturbed conditions:** Submetrics: i) DIAGNOSTICS: Many native diagnostic species absent (reduced diversity) or substantially reduced in abundance. ii) NATIVE DECREASERS: No native species sensitive to anthropogenic degradation present. iii) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present with moderate cover and associated with conspicuous stressors.

Metric Rating	*Vegetation Composition: ALL TYPES*
POOR (D)	**Native plant species composition with severely disturbed conditions:** Submetrics: i) DIAGNOSTICS: Most or all native diagnostic species absent (reduced diversity), a few may remain in very low abundance. Diagnostic species may be so few as to make the type difficult to key. ii) NATIVE INCREASERS: Native species indicative of anthropogenic disturbance (i.e. weedy or ruderal species) are present in high cover and associated with conspicuous stressors.

VEG4 Vegetation Structure

Definition: An assessment of the overall structural complexity of vegetation layers and growth forms, including presence of multiple strata and the age and structural complexity of the canopy layer. Vegetation structure provides evidence of the integrity of natural disturbance regimes, such as fire, avalanche, windthrow, mass wasting, and disease.

Background: This metric was originally drafted by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al., 2008). Modification to this metric for use in forested ecosystems borrows heavily from the work of Franklin et al. (2002) and Robert Van Pelt (2007, 2008) in outlining the natural stand development stages of Washington forests.

Apply To: All EIA modules and AA sizes (variant dependent on EIA module).

Measurement Protocol: This metric evaluates the horizontal and vertical structure of the vegetation relative to the reference condition of the dominant growth form's structural heterogeneity. Field survey data used to evaluate structure may consist of either 1) qualitative data where the observers walk the entire AA and make notes on vegetation structure, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects. Assign metric/submetric rating based on appropriate variant rating criteria in Table 27. Due to the number of variables considered, a series of submetrics may be used to rate the metric.

<u>Forest Submetrics</u>: For forests, the protocol uses a visual evaluation of variation in overall structure of the tree stratum, with submetrics Canopy Structure and Large Live Trees.

CANOPY STRUCTURE: Assesses tree spacing, canopy layering, and overall structural heterogeneity. Note that snags are assessed within VEG6 Coarse Woody Debris, Snags, and Litter.

LARGE LIVE TREES: Assesses the number of tall, large diameter trees in the occurrence, as well as the frequency of stumps.

<u>Non-Forested Submetrics</u>: In non-forested types, the integrity of dominant growth forms is evaluated (e.g. whether shrubs have been removed, killed, or increased, or herbaceous layer has

been reduced or homogenized by anthropogenic stressors). Submetrics vary by EIA module, but may include:

SHRUB COVER: Assesses the relative cover of shrubs in shrublands.

TREE ENCROACHMENT: Assesses the relative cover of trees in shrublands.

WOODY VEGETATION COVER: Assesses the absolute cover of shrubs and/or trees in shrub-steppe and grasslands/meadows. In shrub-steppe, it also evaluates the prominence of fire-sensitive shrubs specifically (see Table 26).

Table 26. Fire-sensitive Shrubs of Shrub-Steppe Ecosystems.

Sensitive to Fire	NOT Sensitive to Fire
Artemisia tridentata ssp. wyomingensis	*Artemisia tripartita*
Artemisia tridentata ssp. tridentata	*Ericameria/Chrysothamnus sp.*
Artemisia tridentata ssp. vaseyana	*Ribes sp.*
Artemisia arbuscula	*Amelanchier sp.*
Purshia tridentata	*Tetradymia canescens*

BUNCHGRASS COVER: Assesses the relative cover of bunchgrasses in shrub-steppe and grasslands/meadows.

BIOLOGICAL SOIL CRUST: Assesses the continuity, diversity, and structure heterogeneity of lichens and mosses on the soil surface of shrub-steppe and grasslands/meadows.

Table 27. Vegetation Structure Variant Rating Criteria. Variants are provided in six separate tables by EIA module (group of Ecological Systems).

Metric Rating	*v7 Vegetation Structure Variant: DRY FORESTS & WOODLANDS*
EXCELLENT (A)	*Submetrics:* i. CANOPY STRUCTURE: **Oak Woodlands:** Multiple age or size classes of oak may be present but no single class dominates; Canopy architecture represents an appropriate mix of large open-grown trees and younger tree recruitment that will replace older trees when they die. Shrub cover is within the natural range of variability. In the <u>East Cascades</u>, percent live canopy ranges from 25-50%, with > 50% relative cover of oaks. <u>West of the Cascades</u>, total tree cover is 10-60%, shrub cover is also usually 10-60%, and moss + lichen cover is <= 25%. **Other dry forests/woodlands**: Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. ii. LARGE LIVE TREES: Very few, if any, cut stumps present. **Oak Woodlands**: <u>West of the Cascades</u>, large, mature (> 150 yrs old or > 60 cm DBH), widely spaced oaks with single trunks and broad spreading crowns present in a savanna setting. In the <u>East Cascades</u>, a cohort of mature oaks is prominent but not necessarily dominant in the canopy (a woodland). **Other dry forests/woodlands**: Varies by natural stand

Metric Rating	*v7 Vegetation Structure Variant: DRY FORESTS & WOODLANDS*
	development stage (Van Pelt, 2007 p27, 2008 p41): In mid to late seral stands (maturation to old-growth stages), large trees (> 50 cm DBH, > 150-200 yrs old) are present. Numbers of large trees range from > 20-25/ha in dry/dry-mesic mixed-conifer types to > 25-75/ha in Ponderosa and Larch savannas. Large trees may be absent from early seral stands (Biomass accumulation/stem exclusion stage or earlier), but if so, large stumps are also few or absent and there is evidence of a natural disturbance event (e.g., large downed wood from wind storms, or fire scars). Note: Low productivity sites (wooded steppes, savannas) may have old trees < than these diameters; use crown form, bark texture, and color to determine # of old trees in these sites. See Van Pelt (2007, 2008) for old tree indicators.
GOOD (B)	*Submetrics:* i. CANOPY STRUCTURE: **Oak Woodlands:** Fire suppression is allowing dense, even-aged sprouting to occur in some areas or in clumps along with relict open-grown trees. In the East Cascades, percent live canopy ranges from 25-50%, with 40-50% relative cover of oaks. West of the Cascades, tree cover is increasing, but the total is still acceptable (10-60%) over most of the stand. Shrub cover is within the natural range of variability (west of the Cascades: < =60% in oak-shrubland associations or < =10% in oak-herbaceous associations). In westside savannas, moss and lichen cover may be 25-40%. **Other Dry Forests/Woodlands:** Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. ii. LARGE LIVE TREES: Cut stumps may be present, but there are more large trees than large cut stumps. No more than 30% of large, old trees have been harvested. **Oak Woodlands:** Relict large, mature (> 150 yrs old or > 60 cm DBH), widely spaced oaks with single trunks still present, but surrounded by dense small trees in some areas. **Other Dry Forests/Woodlands:** Some old (> 150-200 years) characteristic conifers are present (~10-20 live trees/ha > 50 cm DBH).
FAIR (C)	*Submetrics:* i. CANOPY STRUCTURE: **Oak Woodlands**: Dense, even-aged young cohort present, along with relict open-grown trees, across much of site. In the East Cascades, percent live canopy ranges from 15-25 or 50-60%, with > 20-40% relative cover of oaks. West of the Cascades, tree cover is acceptable (10-60%) in less than half the stand. Shrub cover is moderately outside the natural range of variability (west of the Cascades: 60-75% in oak-shrubland associations or 10-25% in oak-herbaceous associations). In westside savannas, moss and lichen cover may be 25-40%. **Other Dry Forests/Woodlands:** Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. ii. LARGE LIVE TREES: Cut stumps are present and large stumps may slightly outnumber large trees. 30-60% of large, old trees have been harvested. **Oak Woodlands:** Few large, open-grown oaks (> 150 yrs old or > 60 cm DBH) present and remaining examples are surrounded by dense small trees. Most oaks are < 100 yrs old. **Other Dry Forests/Woodlands:** Generally fewer than 10 live trees/ha > 50 cm DBH.

Metric Rating	*v7 Vegetation Structure Variant: DRY FORESTS & WOODLANDS*
POOR (D)	*Submetrics*: i. CANOPY STRUCTURE: **Oak Woodlands**: Single age class of oaks present. In the East Cascades, percent live canopy is typically < 15% or > 60%, with < 20% relative cover of oaks. West of the Cascades, tree cover is > 60% over most of the stand. Shrub cover is well outside the natural range of variability (west of the Cascades: > 75% in oak-shrubland associations or > 25% in oak-herbaceous associations). In westside savannas, moss and lichen cover may be > 40%. **Other Dry Forests/Woodlands:** Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. ii. LARGE LIVE TREES: Cut stumps are present and large stumps greatly outnumber large trees. > 60% of large, old trees have been harvested. **Oak Woodlands**: All oak trees < 100 yrs. old with no large trees. **Other Dry Forests/Woodlands:** < 5 live trees/ha > 50 cm DBH.

Metric Rating	*v8 Vegetation Structure Variant: MESIC / HYPERMARITIME FORESTS*
EXCELLENT (A)	*Submetrics:* i. CANOPY STRUCTURE: Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. **Subalpine Parklands**: Canopy structure consists of clumps of trees (often dense and up to 0.1 ha in area, or more) interspersed with low shrublands and meadows. **Aspen Forests and Woodlands**: Conifers are limited to understory or < 10% of canopy (note: aspen stems may be small if resprouting from recent fire). **Other Mesic / Hypermaritime Forests:** A deep, multilayered canopy is present with a full range of canopy strata, tree heights, and tree diameters (small = 5-24 cm, moderate = 25-49 cm, large = 50-99 cm, and > 100 cm). ii. LARGE LIVE TREES: Few, if any, cut stumps present. **Non-Aspen Forests and Woodlands**: Clusters of old (> 150 years) characteristic conifers prominent (> 20 live trees/ha > 50 cm DBH). Trees > 100 cm present. See Van Pelt (2007) for old tree indicators.
GOOD (B)	*Submetrics:* i. CANOPY STRUCTURE: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. **Aspen Forests and Woodlands**: Conifers make up 10-25% of canopy and some evidence of fire exclusion and/or excessive herbivory. **Other Mesic / Hypermaritime Forests:** Moderate range of canopy strata, tree heights and tree diameters. ii. LARGE LIVE TREES: Cut stumps may be present, but there are more large trees than large cut stumps. No more than 30% of large, old trees have been harvested. **Non-Aspen Forests and Woodlands**: Some old (> 150 years) characteristic conifers are present (~10-20 live trees/ha > 50 cm DBH). Some trees > 100 cm may be present.

Metric Rating	*v8 Vegetation Structure Variant: MESIC / HYPERMARITIME FORESTS*
FAIR (C)	*Submetrics:* i. CANOPY STRUCTURE: Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. **Aspen Forests and Woodlands**: Conifers make up 25-50% of canopy and evidence of fire exclusion and/or excessive herbivory. **Other Types**: Small range of canopy strata, tree heights and tree diameters. ii. LARGE LIVE TREES: Cut stumps are present and large stumps may slightly outnumber large trees. 30-60% of large, old trees have been harvested. **Non-Aspen Forests and Woodlands:** Generally fewer than 10 live trees/ha > 50 cm DBH. Trees > 100 cm present absent.
POOR (D)	*Submetrics:* i. CANOPY STRUCTURE: Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. **Aspen Forests and Woodlands**: Conifers make up > 50% of canopy and evidence of fire exclusion and/or excessive herbivory. **Other Types**: Single cohort present. Homogeneous canopy with narrow range of canopy strata, tree heights and tree diameters. ii. LARGE LIVE TREES: Cut stumps are present and large stumps greatly outnumber large trees. > 60% of large, old trees have been harvested. **Non-Aspen Forests and Woodlands:** < 5 live trees/ha > 50 cm DBH. Trees > 100 cm present absent.

Metric Rating	*v9 Vegetation Structure Variant: SHRUBLANDS*
EXCELLENT (A)	Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. *Submetrics:* i. SHRUB COVER: Relative cover of shrubs is 50-100% with no signs of reduction from anthropogenic stressors. ii. TREE ENCROACHMENT: Trees are absent or minimal.
GOOD (B)	Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. *Submetrics:* i. SHRUB COVER: Due to anthropogenic stressors, relative shrub cover slightly decreased from NRV. ii. TREE ENCROACHMENT: When present, trees are generally shorter than shrubs and 1-10% cover.
FAIR (C)	Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. *Submetrics:* i. SHRUB COVER: Due to anthropogenic stressors, relative shrub cover moderately decreased from NRV. ii. TREE ENCROACHMENT: Trees are generally pole-sized or smaller (susceptible to fire mortality) and have 1-10% cover.

Metric Rating	*v9 Vegetation Structure Variant: SHRUBLANDS*
POOR (D)	Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. *Submetrics:* i. SHRUB COVER: Relative shrub cover greatly reduced by anthropogenic stressors (relative cover may be < 50%) ii. TREE ENCROACHMENT: Trees are generally larger than pole-sized (not susceptible to fire mortality) and have > 10% cover.

Metric Rating	*v10 Vegetation Structure Variant: SHRUB-STEPPE*
EXCELLENT (A)	Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees have minimal cover (< 5%) and are well-spaced when present. Fire-sensitive shrubs (see Table 26) mature and recovered from past fires. ii. BUNCHGRASS COVER: Perennial bunchgrass relative cover > 80% OR cover near site potential. iii. BIOLOGICAL SOIL CRUST: Biological soil crust is largely intact, with a rough surface texture and high diversity of lichens and/or mosses (often 7+)--nearly matching the site capability where natural site characteristics are not limiting (e.g. steep, unstable terrain; draws with significant water runoff; south-facing aspects; areas with dense native grass).
GOOD (B)	Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees are present with moderate cover (5-10%). Fire-sensitive shrubs (see Table 26) common, but not fully recovered from past fires. ii. BUNCHGRASS COVER: Perennial bunchgrasses 50-80% relative cover OR reduced from site potential. iii. BIOLOGICAL SOIL CRUST: Biological soil crust is evident throughout the site and diverse (> 3 species prominent), but its continuity is broken and structure may be simplified (decreased roughness of surface texture).
FAIR (C)	Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees are present with moderate cover (10-25%). Fire-sensitive shrubs (see Table 26) present and recovering from past fires. ii. BUNCHGRASS COVER: Perennial bunchgrasses 30-50% relative cover OR reduced from site potential.

Metric Rating	*v10 Vegetation Structure Variant: SHRUB-STEPPE*
	iii. BIOLOGICAL SOIL CRUST: Biological soil crust is present, but only in protected areas and with a minor component elsewhere. Species diversity is low (< 3 species) and structure is simplified (not rough).
POOR (D)	Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. *Submetrics:* i. WOODY VEGETATION COVER: Fire-sensitive shrubs (see Table 26) rare due to past fires. Shrubs (taller than grass layer) and trees are present with high cover (> 25%). ii. BUNCHGRASS COVER: Perennial bunchgrass < 30% relative cover AND much reduced from site potential. iii. BIOLOGICAL SOIL CRUST: Biological soil crust, if present, is found only in protected areas and with little diversity and/or simplified structure (not rough).

Metric Rating	*v11 Vegetation Structure Variant: GRASSLANDS / MEADOWS*
EXCELLENT (A)	Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees have minimal cover (< 5%) and are well-spaced when present. ii. BUNCHGRASS COVER: Perennial bunchgrass relative cover > 80% OR cover near site potential. iii. BIOLOGICAL SOIL CRUST: **Willamette Valley Upland Prairie and Savanna**: Bryophyte and lichen cover is < 25%, consisting of short, dense turf mosses, short-lived and ephemeral mosses, and leafy liverworts AND with little to no cover of lichens, perennial feather mosses, and tall turf mosses outside of scattered refugia. **All Other Grasslands**: If expected, biological soil crust is largely intact, with a rough surface texture and high diversity of lichens and/or mosses (often 7+)--nearly matching the site capability where natural site characteristics are not limiting (e.g. steep, unstable terrain; draws with significant water runoff; south-facing aspects; areas with dense native grass).
GOOD (B)	Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees are present with moderate cover (5-10%). ii. BUNCHGRASS COVER: Perennial bunchgrasses 50-80% relative cover OR reduced from site potential. iii. BIOLOGICAL SOIL CRUST: **Willamette Valley Upland Prairie and Savanna**: Bryophyte and lichen cover is 25-40%, primarily consisting of short, dense turf mosses, short-

Metric Rating	*v11 Vegetation Structure Variant: GRASSLANDS / MEADOWS*
	lived and ephemeral mosses, and leafy liverworts, but also with perennial feather mosses, tall turf mosses, and some lichens present throughout the stand. **All Other Grasslands**: If expected, biological soil crust is evident throughout the site and diverse (> 3 species prominent), but its continuity is broken and structure may be simplified (decreased roughness of surface texture).
FAIR (C)	Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees are present with moderate cover (10-25%). ii. BUNCHGRASS COVER: Perennial bunchgrasses 30-50% relative cover OR reduced from site potential. iii. BIOLOGICAL SOIL CRUST: **Willamette Valley Upland Prairie and Savanna**: Bryophyte and lichen cover is 25-40%, primarily consisting of perennial feather mosses, tall turf mosses, and lichens, but also with short, dense turf mosses, short-lived and ephemeral mosses, and leafy liverworts present throughout the stand. **All Other Grasslands**: If expected, biological soil crust is present, but only in protected areas and with a minor component elsewhere. Species diversity is low (< 3 species) and structure is simplified (not rough).
POOR (D)	Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. *Submetrics:* i. WOODY VEGETATION COVER: Shrubs (taller than grass layer) and trees are present with high cover (> 25%). ii. BUNCHGRASS COVER: Perennial bunchgrass < 30% relative cover AND much reduced from site potential. iii. BIOLOGICAL SOIL CRUST: **Willamette Valley Upland Prairie and Savanna**: Bryophytes and lichens are abundant, with cover > 40%, primarily consisting of perennial feather mosses, tall turf mosses, and lichens. **All Other Grasslands**: If expected, biological soil crust is absent or found only in protected areas and with little diversity and/or simplified structure (not rough).

Metric Rating	*v12 Vegetation Structure Variant: BEDROCK / CLIFFS*
EXCELLENT (A)	Vegetation structure is at or near minimally disturbed natural conditions. Shrub and herb strata at expected levels of abundance and diversity and/or low cover of shrubs or trees, where appropriate. Overall, no evidence of human-related degradation.
GOOD (B)	Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor.
FAIR (C)	Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate.

Metric Rating	*v12 Vegetation Structure Variant: BEDROCK / CLIFFS*
POOR (D)	Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong.

VEG5 Woody Regeneration

Definition An assessment of tree or tall shrub regeneration.

Background: This metric was developed by NatureServe and WNHP. It combines both structural and compositional information, in that regeneration abundance is assessed with respect to native woody species. Woody Regeneration serves as one of the proxy measures for natural disturbance, particularly fire regime.

Apply To: Dry Forests & Woodlands (v2) and Mesic / Hypermaritime Forests (v3) of all AA sizes.

Measurement Protocol: This metric evaluates the tree and shrub regeneration layer (tree seedlings and shrubs < 1.3 m tall and saplings > 1.3 m tall AND $\leq$ 10 cm DBH). It requires a visual estimation of tree seedling and sapling abundance and/or young shrub growth. The field survey method for estimating woody regeneration may either be (1) a Site Survey (semi-quantitative) method where the observers walk the entire AA and take notes on regeneration of woody species, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. Consult Van Pelt (2007, 2008) for a general idea of the amount of woody regeneration to be expected for a particular stand development stage. Assign metric rating based on appropriate variant rating criteria in Table 28.

Table 28. Woody Regeneration Ratings.

Metric Rating	*v2 Woody Regeneration: DRY FORESTS & WOODLANDS*
EXCELLENT (A)	Native, fire-tolerant tree saplings and/or seedlings or fire-tolerant shrubs common to the type present in expected amounts and diversity for the stand development stage. All trees originated from natural regeneration. Regeneration is limited and occurs in natural gaps or in small clusters within an older stand. Fire-sensitive species, if present, are regenerating only in small refugia.
GOOD (B)	Native, fire-tolerant tree saplings and/or seedlings or fire-tolerant shrubs common to the type present, but in greater than expected density due to anthropogenic stressors (e.g., grazing opening germination opportunities, decreasing competition from herbaceous species, and/or removing fine fuels, etc.). Some of the trees may have been planted but most originate from natural regeneration. Regeneration is occurring outside of natural gaps, moist sites, or protected sites (10-25% of site). Fire-sensitive species (not indicative of the type) may be present and associated with few signs of recent fire (e.g., no charred trees, significant fine litter accumulation, etc.).

Metric Rating	*v2 Woody Regeneration: DRY FORESTS & WOODLANDS*
FAIR (C)	Native fire-tolerant tree saplings and/or seedlings or fire-tolerant shrubs common to the type present but in much greater than expected density due to anthropogenic stressors (e.g., grazing opening germination opportunities, decreasing competition from herbaceous species, and/or removing fine fuels, etc.) OR fire-sensitive species (not indicative of the type) present and becoming abundant and associated with few signs of recent fire (e.g., no charred trees, significant fine litter accumulation, etc.). There may be evidence that many trees were planted, though most originate from natural regeneration. Regeneration occurring outside of natural gaps, moist sites, or protected sites (25-50% of site).
POOR (D)	Dense regeneration dominated by fire-sensitive species not indicative of the type and associated with lack of recent fire (e.g., no charred trees, significant fine litter accumulation, etc.) OR diagnostic species not regenerating OR evidence that over half the trees were planted.

Metric Rating	*V3 Woody Regeneration: MESIC / HYPERMARITIME FORESTS*
EXCELLENT (A)	Native tree saplings and/or seedlings or shrubs common to the type present in expected amounts and diversity for the stand development stage; obvious regeneration where expected for the species (e.g. in gaps caused by windthrow or other natural disturbances, *Tsuga heterophylla* on nurse logs, *Pseudotsuga menziesii* on bare/burned mineral soil). All trees originated from natural regeneration. **Hypermaritime Forests**: Elk browsing is neither excluded nor concentrated (browsing has created a relatively open understory). **Aspen Forests and Woodlands**: Abundant regeneration with little sign of browsing of smaller sprouts and seedlings (> 1.5 m tall, < 3 cm DBH).
GOOD (B)	Native tree saplings and/or seedlings or shrubs common to the type present, but in lower amounts and diversity than expected for the stand development stage. Some of the trees may have been planted but most originate from natural regeneration. **Hypermaritime Forests**: Elk browsing is either excluded or unnaturally concentrated and effect on regeneration has a slight negative impact. **Aspen Forests and Woodlands**: Regeneration is prominent, but with some noticeable damage to sprouts and seedlings (> 1.5 m tall, < 3 cm DBH) from browsing.
FAIR (C)	Native tree saplings and/or seedling or shrubs common to the type present, but in low amounts and diversity OR evidence that many trees were planted, though most originate from natural regeneration. **Hypermaritime Forests**: Elk browsing is either excluded or unnaturally concentrated and effect on regeneration has a moderate negative impact. **Aspen Forests and Woodlands**: Regeneration is merely present OR most sprouts have been damaged by browsing and there is a noticeable lack of seedlings (> 1.5 m tall, < 3 cm DBH).
POOR (D)	Essentially no regeneration of native woody species common to the type OR evidence that over half the trees were planted. **Hypermaritime Forests**: Elk browsing is either excluded or unnaturally concentrated and effect on regeneration has a severe negative impact. **Aspen Forests and Woodlands**: Regeneration is absent or nearly so. Any remaining sprouts have been damaged by browsing.

VEG6 Coarse Woody Debris, Snags, and Litter

Definition An assessment of coarse woody debris (CWD, i.e. logs and branches), as well as standing dead snags and litter.

Background: Particularly in forested systems, woody debris (including snags) plays a critical role in a variety of ecosystem processes. It is a primary driver of carbon and other nutrient cycles (Harmon & Hua, 1991; North et al., 1997; Luyssaert et al., 2008), influences soil moisture (Marra & Edmonds, 1996) and seedling establishment success (Christy & Mack, 1984), and provides microhabitat for invertebrates, fungi, and bryophytes (Marra & Edmonds, 1998), in addition to habitat for birds and small mammals (Bull, 2002). CWD also varies based on the stand development stage and natural disturbance history (Franklin et al., 2002). In general, altered levels of coarse woody debris may indicate a history of logging or other woody vegetation removal, overgrazing, invasive plant colonization, and altered fire regimes.

While creating the metric variant for Dry Forests & Woodlands (v3), the following stressor/condition relationships were considered:

- Fire suppression results in more infrequent, higher intensity fires in these types, leading to greater accumulation of fuels, including snags. Accumulation can be a direct result of reduced consumption by fire, or increased CWD production and tree mortality related to tree density.
- Pathogen outbreaks increase CWD and snags through increased mortality.
- Overgrazing results in reduction of fine fuels.
- Invasive plants—primarily exotic grasses—increase fine fuel loads
- Logging results in reduction of large fuels and snags, but small fuel loads are dependent on the harvesting method, slash burning, etc. Early seral forests with few snags might indicate a history of logging, instead of fire.

Mesic / Hypermaritime Forests (v4) experience fewer CWD stressors, as fire, grazing, and invasive plants are minor components of these systems. The primary stressors considered during development of this variant were logging history and (to a lesser extent) landscape fragmentation.

- As in Dry Forests & Woodlands, logging reduces large CWD and snags, with small fuel impacts dependent on harvesting practices.
- Pathogen outbreaks also increase CWD and snags through increased mortality.
- Landscape fragmentation can cause increased windthrow due to edge effects.

This metric also addresses litter in grassland systems. In grasslands, excess litter can affect germination (Rotundo & Aguiar, 2005), potentially alter biological soil crusts (Belnap et al., 2001), and lead to more intense fires and corresponding exotic plant invasions (D'Antonio & Vitousek, 1992).

Apply To: *Required* for Dry Forests & Woodlands (v3) and Mesic / Hypermaritime Forests (v4). *Optional* for Grasslands / Meadows (v5).

Measurement Protocol: Estimation of coarse woody debris may be based on either 1) qualitative data, where the observers walk the entire AA and make notes on debris size, quantity, and degree of decomposition, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects. Assign metric rating based on appropriate variant rating criteria in Table 29.

<u>v3 Dry Forests & Woodlands and v4 Mesic / Hypermaritime Forests</u>: Pay special attention to the amount of coarse woody debris (including snags) when surveying the AA and remember that levels of debris will vary naturally with stand development stage. Note signs of pathogen outbreaks (bore holes, blisters, conks, etc.), grazing (tracks, scat, vegetation denuded below a certain height), and indications that fine fuels are from nonnative plants (using structural clues like diameter, old inflorescences, accumulation at base of live nonnatives, etc.). These two variants are divided into separate submetrics for CWD and snags.

<u>v5 Grasslands / Meadows</u>: Note the quantity and distribution of litter compared with the baseline expected in the landscape. Litter is often detached from the live plant, but dead plant material at the base of plants (growth from the prior year or before) is also considered litter. Be sure the assessment of litter is not based on seasonality (i.e., when a grassland is surveyed early in the year, the prior years' desiccated vegetation can appear more dense than later in the season because most new growth has yet to occur). This variant is difficult to measure unless the user has considerable field experience with the type in question. As such, it is considered an optional metric.

Table 29. Coarse Woody Debris Ratings. Seral class follows Van Pelt (2007, 2008). Early Seral = cohort establishment to biomass accumulation/stem exclusion phases; Mature = maturation phase; Old-Growth = vertical diversification, horizontal diversification, and pioneer cohort loss phases.

Metric Rating	*Sub metric*	*v3 Coarse Woody Debris, Snags, & Litter: DRY FORESTS & WOODLANDS*		
		Early Seral	Mature	Old-Growth
EXCELLENT (A)	CWD	Accumulation of fine fuels (such as grass litter) appears to have been limited by ground fires and not by overgrazing. No evidence that CWD has been reduced by logging activities; no logging slash and no burned slash piles. Forests in the Columbia River Gorge often have large amounts of CWD due to wind/ice storms, but there is no evidence of increased windthrow attributable to fragmentation of the surrounding landscape.	May be limited to charred stumps in mature stands (indicating periodic, low-intensity fires). Accumulation of fine fuels (such as grass litter) appears to have been limited by ground fires and not by overgrazing. No evidence that CWD has been reduced by logging activities; no logging slash and no burned slash piles.	May be limited to large logs that are not consumable in a single fire (indicating periodic, low-intensity fires). Accumulation of fine fuels (such as grass litter) appears to have been limited by ground fires and not by overgrazing. No evidence that CWD has been reduced by logging activities; no logging slash and no burned slash piles.
	SNAGS	Stands regenerating after natural disturbance may have numerous snags (legacies of the previous stand) in early stages of decay.	May have few snags, as most legacies of the previous stand have decayed.	Characteristically have large snags of wide decay-class diversity present throughout.
GOOD (B)	CWD	Considering the natural stand development stage (Van Pelt, 2007 p27, 2008 p41), these forests have moderately altered CWD proportions due to fire suppression, overgrazing, invasive plants, exotic pathogens, and/or past logging. Large CWD has been moderately reduced and may be sporadic due to logging OR landscape fragmentation (windthrow) or decreased fire frequency has resulted in moderately increased amounts of CWD, either through reduced consumption by fire or increased CWD production related to tree density. This includes fallen mortality from pine beetles (*Dendroctonus* sp., etc.) and other forest outbreaks related to density. Fine fuels (such as grass litter) are beginning to accumulate OR appear to have been reduced by grazing. Evidence of minor logging slash OR isolated slash pile burn sites may be present.		

Metric Rating	*Sub metric*	*v3 Coarse Woody Debris, Snags, & Litter: DRY FORESTS & WOODLANDS*		
		Early Seral	Mature	Old-Growth
	SNAGS	Considering the natural stand development stage (Van Pelt, 2007 p27, 2008 p41), these forests have moderately altered snag proportions. May have fewer legacy snags than expected, indicating establishment after logging, rather than fire.	Considering the natural stand development stage, these forests have moderately altered snag proportions. Snags in early stages of decay are moderately more common than expected due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks.	
FAIR (C)	CWD	Considering the natural stand development stage, these forests have significantly altered CWD proportions due to fire suppression, overgrazing, invasive plants, exotic pathogens, and/or past logging. Large CWD has been significantly reduced and may be nearly absent due to logging OR landscape fragmentation (windthrow) or decreased fire frequency has resulted in significantly increased amounts of CWD, either through reduced consumption by fire or increased CWD production related to tree density. This includes fallen mortality from pine beetles (*Dendroctonus* sp., etc.) and other forest outbreaks related to density. Fine fuels (such as grass litter) have significant accumulation OR appear to have been significantly reduced by overgrazing. Evidence of significant logging slash OR slash pile burn sites are common.		
	SNAGS	Considering the natural stand development stage, these forests have significantly altered snag proportions. May have very few legacy snags, indicating establishment after logging, rather than fire.	Considering the natural stand development stage, these forests have significantly altered snag proportions. Snags in early stages of decay are significantly more common than expected due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks.	
POOR (D)	CWD	Considering the natural stand development stage, these forests have extremely altered CWD proportions due to pervasive fire suppression, overgrazing, invasive plants, exotic pathogens, or past logging. Large CWD is essentially absent due to logging OR landscape fragmentation (windthrow) or fire suppression has resulted in jackpots of CWD, either through elimination of consumption by fire or increased CWD production related to tree density. This includes fallen mortality from pine beetles (*Dendroctonus* sp., etc.) and other forest outbreaks related to density. Fine fuels (such as grass litter) have accumulated to great depth OR appear to have been nearly eliminated by overgrazing. Pervasive logging slash OR slash pile burn sites are abundant.		

Metric Rating	*Sub metric*	*v3 Coarse Woody Debris, Snags, & Litter: DRY FORESTS & WOODLANDS*		
		Early Seral	Mature	Old-Growth
	SNAGS	Considering the natural stand development stage, these forests have extremely altered snag proportions. Snags in early stages of decay are pervasive throughout due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks. Early seral forests (cohort establishment to biomass accumulation/stem exclusion stages) have no legacy snags, indicating establishment after logging, rather than fire.	Considering the natural stand development stage, these forests have extremely altered snag proportions. Snags in early stages of decay are pervasive throughout due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks.	

Metric Rating	*Sub metric*	*v4 Coarse Woody Debris, Snags, & Litter: MESIC / HYPERMARITIME FORESTS*		
		Early Seral	Mature	Old-Growth
EXCELLENT (A)	CWD	Stands that regenerate after natural disturbance may have abundant CWD of wide size-class diversity, but limited decay-class. Stands in the biomass accumulation/competitive exclusion stage often have abundant small-diameter, highly decayed CWD. No evidence that CWD has been reduced by logging activities; no logging slash and no burned slash piles. Coastal, hypermaritime forests often have large amounts of CWD, but there is no evidence of increased windthrow attributable to fragmentation of the surrounding landscape.	Moderate to high numbers of logs of diverse decay classes. No evidence that CWD has been reduced by logging activities; no logging slash and no burned slash piles. Coastal, hypermaritime forests often have large amounts of CWD, but there is no evidence of increased windthrow attributable to fragmentation of the surrounding landscape.	

<table>
<tr><th rowspan="2">Metric Rating</th><th rowspan="2">Sub metric</th><th colspan="3">v4 Coarse Woody Debris, Snags, & Litter: MESIC / HYPERMARITIME FORESTS</th></tr>
<tr><th>Early Seral</th><th>Mature</th><th>Old-Growth</th></tr>
<tr><td></td><td>SNAGS</td><td>Stands regenerating after natural disturbance may have numerous snags (legacies of the previous stand) of wide size-class diversity, but limited decay-class diversity. Note that coastal, hypermaritime forests subject to severe wind storms may have significantly fewer snags.</td><td>May have few snags, as most legacies of the previous stand have decayed.</td><td>Characteristically have large snags of wide decay-class diversity present throughout. Note that coastal, hypermaritime forests subject to severe wind storms may have significantly fewer snags.</td></tr>
<tr><td rowspan="2">GOOD (B)</td><td>CWD</td><td colspan="3">Considering the natural stand development stage (Van Pelt, 2007 p27, 2008 p41), these forests have moderately reduced CWD proportions and decay-class diversity due to past logging OR moderately increased CWD due to mortality from pine beetles (Dendroctonus sp., etc.) or other density-related forest outbreaks. CWD remains within NRV, but large CWD has been moderately reduced and may be sporadic. Evidence of minor logging slash OR isolated slash pile burn sites is present. Coastal, hypermaritime forests have some evidence of moderately increased windthrow due to fragmentation of the surrounding landscape.</td></tr>
<tr><td>SNAGS</td><td>Considering the natural stand development stage, these forests have moderately reduced snag numbers due to past logging OR snags in early stages of decay are moderately more common than expected in mature and old-growth stands due to pine beetles (Dendroctonus sp., etc.) or other forest outbreaks. May have fewer legacy snags than expected, indicating establishment after logging, rather than fire. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.</td><td colspan="2">Considering the natural stand development stage, these forests have moderately reduced snag numbers due to past logging OR snags in early stages of decay are moderately more common than expected in mature and old-growth stands due to pine beetles (Dendroctonus sp., etc.) or other forest outbreaks. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.</td></tr>
</table>

Metric Rating	*Sub metric*	*v4 Coarse Woody Debris, Snags, & Litter: MESIC / HYPERMARITIME FORESTS* Early Seral	Mature	Old-Growth
FAIR (C)	CWD	Considering the natural stand development stage, these forests have significantly reduced CWD proportions and decay-class diversity due to past logging OR significantly *increased* CWD due to mortality from pine beetles (Dendroctonus sp., etc.) or other density-related forest outbreaks. CWD is outside NRV, large CWD has been significantly reduced and may be hard to find. Evidence of significant logging slash OR slash pile burn sites are common. Coastal, hypermaritime forests have some evidence of significantly increased windthrow due to increased fragmentation of the surrounding landscape.		
	SNAGS	Considering the natural stand development stage, these forests have significantly reduced snag numbers due to past logging OR snags in early stages of decay are significantly more common than expected in mature and old-growth stands due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks. These stands may have very few legacy snags, indicating establishment after logging, rather than fire. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.	Considering the natural stand development stage, these forests have significantly reduced snag numbers due to past logging OR snags in early stages of decay are significantly more common than expected in mature and old-growth stands due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.	
POOR (D)	CWD	Considering the natural stand development stage, these forests have extremely reduced CWD proportions and decay-class diversity due to pervasive past logging OR extremely *increased* CWD due to mortality from pine beetles (Dendroctonus sp., etc.) or other density-related forest outbreaks. CWD is well outside NRV, large CWD has been eliminated. Pervasive logging slash OR slash pile burn sites are abundant. Coastal, hypermaritime forests are clearly experiencing significantly increased windthrow due to major fragmentation of the surrounding landscape.		

Metric Rating	*Sub metric*	*v4 Coarse Woody Debris, Snags, & Litter: MESIC / HYPERMARITIME FORESTS*		
		Early Seral	Mature	Old-Growth
	SNAGS	Considering the natural stand development stage, these forests have extremely reduced snag numbers due to past logging OR snags in early stages of decay are significantly more common than expected in mature and old-growth stands due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks. These stands may have no legacy snags, indicating establishment after logging, rather than fire. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.	Considering the natural stand development stage, these forests have extremely reduced snag numbers due to past logging OR snags in early stages of decay are significantly more common than expected in mature and old-growth stands due to pine beetles (*Dendroctonus* sp., etc.) or other forest outbreaks. Note that coastal, hypermaritime forests may naturally have few or no legacy snags due to major windthrow events.	

Metric Rating	*v5 Coarse Woody Debris, Snags, & Litter: GRASSLANDS / MEADOWS*
EXCELLENT (A)	Considering climate and weather, litter is present but with minimal accumulation (accumulation is greater in cold and moist grasslands than hot and dry grasslands). Site productivity or regular burning limits it to a thin layer of recently deposited material (generally < 20 % cover, < 0.5 cm deep other than beneath mature shrubs). Accumulation does not appear to reduce seedling germination or species diversity. Nutrient and water availability, disease, and herbivory incidence appear to be within NRV.
GOOD (B)	Considering climate and weather, litter accumulation is beginning to exceed expected amounts (roughly 20-30% cover, 0.5-2 cm deep outside shrub canopies). Localized impacts on seedling germination or survival may be occurring due to patchy accumulation of litter beyond the NRV. Nutrient and water availability, disease, and herbivory incidence may be slightly outside NRV.
FAIR (C)	Considering climate and weather, there is significant accumulation of litter (roughly 30-50% cover, 2-5 cm deep outside shrub canopies). Seedling germination and diversity is reduced and may be limited to favorable microsites. Nutrient and water availability, disease, and herbivory incidence are outside NRV.
POOR (D)	Fire exclusion or shifts in species composition have allowed widespread, very deep accumulation of litter (roughly > 50% cover, > 5 cm deep outside shrub canopies). Litter has nearly eliminated establishment of seedlings. Nutrient and water availability, disease, and herbivory incidence are significantly outside NRV.

3. 9 SOIL / SUBSTRATE

Conducting rapid assessments of soil condition is challenging, and here we limit the assessment to visible evidence of soil surface or soil profile alterations that degrade the soil structure, as well as obvious signs of soil moisture degradation due to anthropogenic stressors.

SOI1 Soil Condition

Definition: An indirect measure of soil condition based on stressors that increase the potential for erosion or sedimentation. Soil condition is evaluated based on intensity of human impacts to soils on the site. Anthropogenic alterations to soil moisture are also considered here.

Background: This metric is partly based on one developed by Mack (2001) and the NatureServe Ecological Integrity Working Group (Faber-Langendoen et al., 2008). This metric has also been called "Substrate / Soil Disturbance."

Apply To: All EIA modules and AA sizes.

Measurement Protocol: Prior to fieldwork, aerial photography of the site can be reviewed to determine if any soil alterations have occurred, but the primary assessment is based on field observations of the AA. Assign metric rating based on appropriate variant rating criteria in Table 30.

Table 30. Soil Condition Rating Criteria.

Metric Rating	*Soil Surface Condition: ALL TYPES*
EXCELLENT (A)	Undisturbed, with little bare soil OR bare soil is limited to naturally caused disturbances such as frost heaving, blowouts, burrowing, or game trails OR substrate is naturally bare (balds, sand dunes, etc.). On naturally unstable substrates, slope movements have not been altered directly by human activities. Natural water erosion may occur on slopes. No disturbances are evident from human- or livestock-induced trampling, erosion, soil compaction, ruts, or sedimentation. Soil layers are intact and there are no management-created platy soils. No changes in soil moisture availability due to anthropogenic impacts (e.g. raised water table due to tree removal in mesic/subhydric sites, lowered water table due to downcutting of streams by grazing animals, decreased soil moisture due to overgrazing, excess water from irrigation seepage, logging roads diverting water, soil compaction reducing infiltration).
GOOD (B)	Small amounts of bare or disturbed soil from anthropogenic activities are present, with minimal extent and impact. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction by machinery or particularly heavy foot traffic, or ruts or other disturbances from ATV or other vehicular activity. The depth of disturbance is limited to only a few inches (several centimeters) and does not show evidence of active displaced litter, pedestals, and/or terracettes. Soil layers are generally intact, though soil structure may be discontinuously changed to platy (soil pedestals wider than tall) or massive (essentially structureless) in places. On naturally unstable substrates, slope movements have been minimally altered by human activities (< 10% of area). Nearly natural pattern of water movement and infiltration, minor erosion on slopes. Minor impacts to evaporative processes and/or water table levels have occurred due to anthropogenic causes.
FAIR (C)	Moderate amounts of bare or disturbed soil from anthropogenic activities are present and the extent and impact is moderate. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction by machinery or particularly heavy foot traffic, or ruts or other disturbances from ATV or other vehicular activity. The depth of disturbance may extend 5-10 cm (2-4 in), with localized deeper ruts. Moderate evidence of exposed roots, displaced litter, pedestals and/or terracettes. On naturally unstable substrates, slope movements have been moderately altered directly by human activities (10-25% of area). Apparent changes in natural pattern of water movement and infiltration, with occasional erosion on slopes. Forest-floor duff and litter layers are partially missing. Surface soil is partially intact and maybe mixed with subsoil; structure may be changed from undisturbed conditions and may be platy or massive. Moderate impacts to evaporative processes and/or water table levels have occurred due to anthropogenic causes.
POOR (D)	Substantial amounts of bare or disturbed soil from anthropogenic activities are present, with extensive and long lasting impacts to natural processes. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, or deep ruts or other disturbances from ATV or other vehicular activity. The depth of disturbance or compaction is persistent and extends > 10 cm (4 in). Common evidence of exposed roots, displaced litter, pedestals and/or terracettes. On naturally unstable substrates, slope movements have been severely altered by human activities (> 25% of area). Obvious changes in natural pattern of water movement and infiltration, active erosion on slopes, water is

Metric Rating	*Soil Surface Condition: ALL TYPES*
	channeled or ponded. Forest-floor duff and litter layers are missing. Surface soil is removed through gouging or piling by machinery and overall structure may be platy or massive throughout. Significant impacts to evaporative processes and/or water table levels have occurred due to anthropogenic causes have pushed soil moisture well outside of NRV. Altered soil moisture is resulting in mortality of numerous species and plant community composition change.

3.10 SIZE

The role of size in EIAs varies depending on the application. Inventory or monitoring programs that focus on condition across large areas, with an emphasis on statistical design, often rely on a point based sampling approach (e.g. 0.5 ha AA). In this case, the overall occurrence size is not used to evaluate the assessment area, since it is predetermined by the sampling protocol. Conversely, programs that focus on assessing individual polygons, more typically consider the size of the occurrence as important to its overall integrity. Size does interact with landscape context, such that small occurrences embedded in entirely natural landscapes do not, necessarily, have less ecological integrity than a larger example in the same landscape. Conversely, a large occurrence in a fragmented landscape is likely to be more buffered from landscape stressors than a small one in a similarly fragmented landscape. Thus, a scorecard should give careful consideration to the appropriate manner in which to score size, taking into account this suite of contextual factors.

SIZ1 Comparative Size (Patch Type)

Definition: A measure of the current absolute size (ha) of the entire ecosystem occurrence polygon. The metric is assessed either with respect to its comparative size based on size distribution (Table 31) OR expected patch-type sizes for the type across its range (Table 32).

Background: This metric accounts for one aspect of the size of specific occurrences of an ecosystem. Assessors are sometimes hesitant to use patch size as part of an EIA out of concern that a small, high quality example will be down-ranked unnecessarily. We address these concerns, to a degree, by providing an absolute patch-type scale, so that types that typically occur as small patches (e.g. mesic meadows) are scored differently than types that may occur over large, extensive areas (e.g., many forests).

Apply To: All EIA modules and AA sizes. For large AAs, this is scored for the entire assessment area, not individual assessment points.

Measurement Protocol:

(1) Determine Spatial Size. It is important to know the spatial pattern typical of the ecosystem being assessed. This information is found in the Ecological System descriptions in Rocchio & Crawford (2015) and generalized in Table 1.

(2) Rate Size As Informed by Patch Type. Use Table 32 to assign a Spatial Pattern Size Metric Rating based on the ecosystem's patch type. Compare this to the Comparative Size Metric Rating from Table 31. Essentially, the rating from Table 32 is the same as Table 31.

NOTE: For large-patch and matrix patch types, this measure is made over the entire extent of the AA, not individual assessment points within the AA.

For fragmented occurrences made up of several disjunct AAs, the Comparative Size Metric is scored based on the aggregate of all AAs AND the single largest one. If these are different, assign a range rating (e.g. if the aggregate results in a 'B' rating but the largest patch would only receive a 'C' rating on its own, the resulting rating is 'BC'; if they both come out as 'B', then the overall score is also 'B'.

Table 31. Comparative Size Metric Rating

Metric Rating	*Comparative Size: ALL Types*
EXCELLENT (A)	Very large size compared to other examples of the same type, based on current and historical spatial patterns (and meeting the requirements for all, or almost all, of the area-sensitive indicator species dependent on the system, if within range)
GOOD (B)	Large size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for some of the area-sensitive indicator species; i.e., they are likely to be absent, if within range[1]).
FAIR (C)	Medium to small size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for several to many of the area-sensitive indicator species, if within range[1]).
POOR (D)	Small to very small size, based on current and historical spatial patterns (and not meeting the requirements for most to all area-sensitive indicator species, if within range[1]).

[1] If known, record the area-dependent species that are missing.

Table 32. Spatial Pattern Size Metric Rating: Area by Spatial Pattern of Type. Consult Rocchio & Crawford (2015) to determine the patch type of the AA's Ecological System.

Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (hectares)*		
Spatial Pattern Type	Matrix (ha)	Large Patch (ha)	Small Patch (ha)
EXCELLENT (A)	> 5,000	> 125	> 10
GOOD (B)	500-5,000	25-125	2-10
FAIR (C)	100-500	5-25	0.5-2
POOR (D)	< 100	< 5	0.5
Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (acres)*		

Spatial Pattern Type	Matrix (ac)	Large Patch (ac)	Small Patch (ac)
EXCELLENT (A)	> 12,500	> 300	> 25
GOOD (B)	1,250-12,500	60-300	5-25
FAIR (C)	250-1,250	12-60	1-5
POOR (D)	< 250	< 12	1

SIZ2 Change in Size (optional)

Definition: A measure of the current size of the occurrence relative to its historical extent.

Background: This metric is one aspect of the size of specific occurrences of an ecosystem type. The metric assesses the proportion of the AA that has been converted or destroyed compared to its original extent.

Apply To: *Required* for small AAs of large-patch/matrix ecosystem targets. Optional for all other small AAs.

Measurement Protocol: This metric only applies to small AA sizes. Relative size can be measured in GIS using aerial photographs, orthophoto quads, or other data layers and is calculated as follows:

Change in Size = Current Size / Historical Size * 100

Field assessments of current size may be required since it can be difficult to discern the historical area of the occurrence from remotely sensed data. However, use of old aerial photographs may also be helpful, as they may show the historical extent of an occurrence. Relative size can also be estimated in the field using 7.5 minute topographic quads, NPS Vegetation maps, or a global positioning system. The definition of the “historical” timeframe will vary by region, but generally refers to the intensive Euro-American settlement that began in the 1600s in the eastern United States and extended westward into the 1800s. If the historical time frame is unclear, use a minimum of a 50-year time period--long enough to ensure that the effects of area loss are well-established and the occurrence has essentially adjusted to the change in size. Assign the rating based on Table 33.

Table 33. Change in Size Metric Rating.

Metric Rating	*Change in Size: Small AA Sizes*
EXCELLENT (A)	Occurrence is at, or only minimally reduced[1] (< 5%) from its original, natural extent. See note below for interpretation of “reduction.”
GOOD (B)	Occurrence is only somewhat reduced (5-10%) from its original natural extent.
FAIR (C)	Occurrence is modestly reduced (10-30%) from its original natural extent.

POOR (D)	Occurrence is substantially reduced (> 30%) from its original natural extent.

[1]Note: Reduction in size for metric ratings A-D can include conversion or disturbance (e.g., development, changes caused by recent cutting, etc.). Assigning a metric rating depends on the degree of reduction.

4.0 Calculate EIA Score and Determine Element Occurrence Status.

4.1 Ecological Integrity Assessment Scorecard

The major components of the EIA include three primary rank factors (landscape context, on-site condition, and size) which are subdivided into five major ecological factors of landscape, edge, vegetation, soils, and size. Together these are the components that capture the structure, composition, processes, and connectivity of an occurrence. Whether one needs to roll up scores is dependent on the project objective. Land managers may only be interested in the metric scores, as they provide insight into management needs, goals, and measures of success. On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, then an overall EIA score/rank may be needed. Primary and major ecological factor scores/ranks can be helpful for understanding current status of primary ecological drivers. Details on the scorecard are provided in (Faber-Langendoen et al., 2016b).

Landscape context metrics address the “outer workings” while on-site condition metrics measure the “inner workings” of an ecosystem. A third primary rank factor, the size of an ecosystem patch or occurrence, helps to characterize patterns of diversity, area-dependent species, and resistance to stressors. Addressing all of these characteristics and processes will contribute not only to understanding the current levels of ecological integrity, but to the resilience of the ecosystem in the face of climate change and other global stressors.

A point-based approach is used to facilitate integration of metrics into an overall rating. Undue emphasis should not be placed on numerical scoring--it is the overall rating that matters. Although metric ratings and scores are primarily based on a four-part scale (Table 8), when two or more metrics are used to score a major ecological factor, a seven-part scale (A+, A-, B+, B-, C+, C-, D) can be informative. A “rounded” four-part scale (A, B, C, D) can still be applied (Table 34).

Table 34. Ratings and Points for Ecological Integrity, Primary Rank Factors, and Major Ecological Factors.

EIA and Factor Rating*	*7 Part Scale*	*Metric Rating*	*4 Part Scale*
A+	3.8 - 4.00	A (Excellent)	3.5 - 4.0
A-	3.5 - 3.79		
B+	3.0 - 3.49	B (Good)	2.5 - 3.49
B-	2.5 - 2.99		
C+	2.0 - 2.49	C (Fair)	1.5 - 2.49
C-	1.5 - 1.99		
D	1 - 1.49	D (Poor)	1.0 - 1.49

*This scale is applied to the overall EIA, as well as Primary Rank Factors and Major Ecological Factors.

4.2 Calculate Major Ecological Factor (MEF) Scores and Ratings

Below are instructions on how to calculate each Major Ecological Factor score. Once scores are calculated, their associated ratings can be found Table 35.

Table 35. Conversion of Major Ecological Factor Scores/Ratings.

Score/Rating Conversions for Major Ecological Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.2.1 Landscape Context MEF Score/Rating

To calculate the Landscape Context MEF score, take the average of LAN1 and LAN2 metrics. Enter the score and associated rating on the field form.

4.2.2 Edge MEF Score/Rating

Small AA sizes: The Edge MEF score is calculated by first taking the geometric mean of EDG1 and EDG2 scores. Then the geometric mean of that result and EDG3 is used as the Edge MEF score. A geometric mean gives greater weight to the lower of the two values. Enter the score and associated rating on the field form.

Large AA sizes: The Edge MEF score is calculated by taking the geometric mean of EDG1 and EDG2 scores. A geometric mean gives greater weight to the lower of the two values. Enter the score and associated rating on the field form.

4.2.3 Vegetation MEF Score/Rating

Vegetation MEF score is calculated by taking the average of VEG1+VEG2+VEG3+VEG4+VEG5 (if scored)+VEG6 (if scored). Enter the score and associated rating on the field form.

4.2.4 Soils MEF Score/Rating

The Soil MEF score is simply the score for SOI1. Enter the score and associated rating on the field form.

4.2.5 Size MEF Score/Rating

The Size MEF score is either simply the score for SIZ1 or, if also using SIZ2, then the average of SIZ1 and SIZ2. Enter the score and associated rating on the field form.

4.3 Calculate Primary Factor Scores

Below are instructions on how to calculate each Primary Factor score. Once scores are calculated, their associated ratings can be found in Table 36.

Table 36. Conversion of Primary Factor Scores/Ratings.

Score/Rating Conversions for Primary Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.3.1 Landscape Context Primary Factor Score/Rating

The Landscape Context Primary Factor score is calculated by the following formulas, depending on spatial pattern type of the Ecological System:

Matrix: (Edge MEF score*0.33) + (Landscape Context MEF score*0.67)

Large-Patch: (Edge MEF score*0.50) + (Landscape Context MEF score*0.50)

Small-Patch: (Edge MEF score*0.67) + (Landscape Context MEF score*0.33)

Enter the score and associated rating on the field form.

4.3.2 Condition Primary Factor Score/Rating

The Condition Primary Factor score is calculated by the following formula: (Vegetation MEF score*0.85) + (Soil MEF score*0.15). Enter the score and associated rating on the field form.

4.3.3 Size Primary Factor Score/Rating

The Size Primary Factor score is equivalent to the Size MEF score. Enter the score and associated rating on the field form.

4.4 Calculate Overall Ecological Integrity Assessment Score/Rating

The overall Ecological Integrity Assessment (EIA) score is calculated using only Landscape Context and Condition Primary Factor scores with the following formulas (NatureServe, 2002), depending on spatial pattern type of the Ecological System:

Matrix/Large-Patch: (Condition Primary Factor score*0.55) + (Landscape Context Primary Factor score*0.45).

Small-Patch: (Condition Primary Factor score*0.70) + (Landscape Context Primary Factor score*0.30).

The associated rating for the score is found in Table 37. Enter the score and associated rating on the field form.

Table 37. Conversion of Overall Ecological Integrity Assessment Scores/Ratings.

Score/Rating Conversions for Overall Ecological Integrity							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Size is not used for the EIA score, as the role of patch size in assessing ecological integrity is not as straightforward as landscape context and condition. For some ecosystem types, patch size can vary widely for entirely natural reasons (e.g., a forest type may have very large occurrences on rolling landscapes, and be restricted in other landscapes to small occurrences on north slopes or ravines). Thus, smaller sites are not necessarily a result of degradation in ecological integrity. On the other hand, size overlaps with landscape context as a factor, where the more fragmented the landscape surrounding an occurrence is, the more size becomes important in reducing edge effects or buffering the overall occurrence.

Thus, while from an EIA rating perspective, we can develop vegetation, soil, and landscape metric ratings based on ecological considerations (e.g., we can establish the ecological criteria for which natural edges are effective), it is harder to do so for size. Instead, Size is used as an additional factor to help prioritize sites for conservation actions (see below).

4.5 Calculate The Element Occurrence Rank

Ecological Integrity Assessment (EIA) scores and Element Occurrence Ranks (EORANKS) are closely related. The EIA score provides a succinct assessment of the current ecological condition and landscape context of an occurrence. For conservation purposes, we often want to do more than that; namely, we want to establish its conservation value. The Element Occurrence (EO) is a core part of Natural Heritage Methodology and is defined as follows:

> *An **Element Occurrence** (EO) is an area of land and/or water in which a species or ecosystem (natural community, vegetation type or Ecological System) element is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For ecosystem types ("elements"), the EO may represent a single stand or patch or a cluster of stands or patches of an ecosystem.* (NatureServe, 2002).

For the EORANK approach, EIAs are foundational, but more is needed to determine the practical conservation value for an ecosystem. In particular, size plays a more substantial role in the EORANK process than in other applications of EIAs. This is because, for many conservation purposes, larger observations are considered more important and more likely to retain their integrity than smaller observations. For some types, diversity of animals or plants may be higher in larger occurrences than in smaller occurrences that are otherwise similar. Larger occurrences often have more microhabitat features and are more resistant to stressors such as invasion by exotics, because they buffer their own interior portions. Thus, size can serve as a readily measured proxy for some ecological processes and for the diversity of interdependent assemblages of plants and animals. Even here, caution is needed, for although size helps identify higher diversity sites, higher diversity *per se* is not always tied to ecological integrity (i.e., sites vary naturally with respect to levels of diversity and size).

To calculate EORANK, points are added to the EIA score based on the plant community's patch size (Table 32) and Size Primary Factor rating (Table 38). The associated rating for the score is found in Table 39. Enter the score and associated rating on the field form.

Table 38. Point Contribution of Size Primary Factor Score.

Size Primary Factor Rating	Small Patch	Large Patch	Matrix
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Table 39. Conversion of EORANK Scores/Ratings.

Score/Rating Conversions for EORANK							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.6 Determine Element Occurrence Status

Using the conservation status rank and the EORANK of the AA, refer to Table 40 to determine whether the AA meets Element Occurrence criteria. If it does, please submit documentation of the occurrence to the Washington Natural Heritage Program for inclusion in our database.

Table 40. Decision Matrix to Determine Ecosystem Element Occurrences.

Global / State Conservation Status Rank Combination	Ecological Integrity Assessment Rank			
	A (+ or -) Excellent Integrity	B (+ or -) Good Integrity	C (+ or -) Fair Integrity	D (+ or -) Poor Integrity
G1S1, G2S1, GNRS1, GUS1				
G2S2, GNRS2, G3S1, G3S2, GUS2				
GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR				
G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5				
Red Shading = Element Occurrence				

5.0 Stressor Checklist

A stressor is an anthropogenic perturbation within the AA or surrounding landscape that can negatively affect the condition and function of the occurrence. Stressors are *direct threats* and are further defined as "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes" (NatureServe, 2017). Identifying stressors within the AA or its buffer can help determine causes of the AA's degradation. Stressors may be characterized in terms of ***scope*** and ***severity****.* Scope is defined as the proportion of the AA that can reasonably be expected to be affected by the stressor with continuation of current circumstances and trends. Severity is the degree of degradation within the scope from the stressor, which can reasonably be expected with continuation of current circumstances and trends.

Step 1 Rate Scope and Severity of Stressors: Stressors are rated if they are observed or inferred to occur. They are not assessed if they are projected to occur in the near term, but have not yet been observed. Record and estimate the scope and severity of applicable stressors in the AA or its edge (Table 41). Things to consider when filling out the form:

- Stressor checklists must be completed for all categories (Buffer, Vegetation, and Soils/Substrate). The hydrology category has been omitted from initial drafts of upland assessments.
- Buffer perimeter is the entire perimeter **around the AA,** out to a distance of 100 m. Rely on imagery in combination with field observations.
- Assess edge perimeter stressors and their effects within the buffer perimeter itself (**NOT how buffer stressors may impact the AA**).
- Stressors for Vegetation and Soils are assessed across the AA.
- Some stressors may overlap (e.g., 10 [low impact recreation] may overlap with 26 [indirect soil disturbance]); choose the one with the highest impact and note overlap.
- Stressors are rated if they are observed or inferred to occur in the present (i.e., within a 10 year timeframe), **or** occurred anytime in the past with effects that persist into the present.

Table 41. Stressor Scoring Categories.

Assess for up to next 20 yrs.	Threat Scope (% of AA affected)	Assess for up to next 20 yrs.	Threat Severity within the Scope (degree of degradation of AA)
1 = Small	Affects a small (1-10%) proportion	1 = Slight	Likely to only slightly degrade/reduce
2 = Restricted	Affects some (11-30%)	2 = Moderate	Likely to moderately degrade/reduce

3 = Large	Affects much (31-70%)	3 = Serious	Likely to seriously degrade/reduce
4 = Pervasive	Affects most or (71-100%)	4 = Extreme	Likely to extremely degrade/destroy or eliminate

Step 2 Determine Impact Rating of Each Stressor: The impact rating of each stressor is based on the combination of its scope and severity score (Table 42). Enter the corresponding impact rating score in the "Impact" cell for each stressor. If no stressors are present or their impact is presumed to be minimal, check the appropriate box on the stressor form.

Table 42. Stressor Impact Ratings.

Stressor Impact Calculator		Scope			
		Pervasive	Large	Restricted	Small
Severity	Extreme	Very High = 10	High = 7	Medium = 4	Low = 1
	Serious	High = 7	High = 7	Medium = 4	Low = 1
	Moderate	Medium = 4	Medium = 4	Low = 1	Low = 1
	Slight	Low = 1	Low = 1	Low = 1	Low = 1

Step 3 Determine Overall Stressor Impact Rating for Stressor Categories: For each category (Buffer, Vegetation, and Soils), sum the total impact scores and enter the corresponding impact rating and point value (Table 43) in the appropriate cell at the bottom of the field form. For example, if the summed impact scores across all stressors in the Buffer category is 8, then the impact rating is "High" and has a corresponding point value of 3.

Table 43. Conversion of Total Impact Scores to Stressor Category Ratings/Points.

STRESSOR RATING Summary for Categories	Sum of Stressor Impact Scores	Stressor Rating	Pts
1 or more Very High, **OR** 2 or more High, **OR** 1 High + 1 or more Medium **OR** 3 or more Medium	10+	Very High	4
1 High, **OR** 2 Medium **OR** 1 Medium + 3 or more Low	7 – 9.9	High	3
1 Medium + 1-2 Low **OR** 4 -6 Low	4 – 6.9	Medium	2
1 to 3 Low	1 – 3.9	Low	1
0 stressors	0 – 0.9	Absent	0

Step 4 Determine Human Stressor Impact (HSI) Rating for AA: Next, using the algorithms on the field form, calculate overall impact scores based on each stressor category's impact points. HSI scores are calculated for three different metrics: (1) Total HSI (all stressor categories are used); (2) Onsite HSI (Buffer stressors are excluded); and (3) Abiotic HSI (Vegetation stressors are excluded). HSI scores can be converted to a rating using Table 44.

Table 44. Conversion of Human Stressor Index (HSI) Scores to Ratings.

HSI Score	HSI Site Rating
3.5-4.0	Very High
2.5-3.4	High
1.5-2.4	Medium
0.5-1.4	Low
0.0-0.4	Absent

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Appendix A. Diagnostic Species and Common Increasers, Decreasers, and Invasive Plants of Washington's Ecological Systems (DRAFT- In Progress)

Table A-1 presents diagnostic species for each Ecological System known to occur in Washington. These species help define the system and should be found in most occurrences with high integrity. They are generally *not* exclusive to any one system, however. Additionally, Table A-1 provides example increaser, decreaser, and invasive species for each Ecological System. Increaser and decreaser species may also be accompanied by the stressor generally responsible for their increase or decrease. These lists are not comprehensive and should be readily modified using professional judgment and local knowledge. In addition, you can use the Floristic Quality Assessment (FQA) calculators on the WNHP website (http://www.dnr.wa.gov/NHP-FQA) to help identify increasers (c-values ≤ 3) and decreasers (c-values ≥ 7).

Table A-1. Diagnostic Species and Common Increasers, Decreasers, and Invasive Plant of Washington's Ecological Systems.

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Columbia Basin Foothill and Canyon Dry Grassland (Campbell, 1962; Daubenmire, 1970; Tisdale, 1986; Johnson, 1998; Rocchio & Crawford, 2013, 2015)	Pseudoroegneria spicata Festuca idahoensis Koeleria macrantha Poa secunda Aristida purpurea var. longiseta Balsamorhiza sagittata Sporobulus cryptandrus Opuntia polyacantha	Achillea millefolium Antennaria luzuloides (grazing) Aristida purpurea var. longiseta Arnica sororia Astragalus inflexus Balsamorhiza sagittata (grazing) Collinsia parviflora Danthonia unispicata (grazing) Epilobium brachycarpum (=E. paniculatum) Ericameria nauseosa Erigeron pumilis Gutierrezia sarothrae (grazing) Lithophragma glabrum (=L. bulbifera) Lagophylla ramosissima Madia glomerata (grazing) Microsteris gracilis Penstemon deustus Stellaria nitens Tonella floribunda (grazing)	Poa secunda (grazing) Festuca idahoensis (grazing)	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Poa bulbosa Centaurea spp. Hypericum perforatum Ventenata dubia
Columbia Basin Palouse Prairie	Pseudoroegneria spicata Festuca idahoensis	Achillea millefolium	Astragalus spaldingii Calochortus elegans	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum)

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
(Daubenmire, 1970; Johnson, 1998; Parish et al., 1999; Rocchio & Crawford, 2015)	Koeleria macrantha Poa secunda Rosa nutkana Eriogonum spp. Symphoricarpos albus	Claytonia rubra ssp. depressa (Montia perfoliata) Clematis ligusticifolia Collinsia parviflora Danthonia unispicata (grazing) Epilobium brachycarpum (=E. paniculatum) Erigeron corymbosus Eriogonum heracleoides (grazing) Geum triflorum Iris missouriensis Koeleria macrantha Lagophylla ramosissima Lithophragma glabrum (=L. bulbifera) Microsteris gracilis Montia linearis Myosurus apetalus (=M. aristatus) Olsynium douglasii var. inflatum (=Sisyrinchium inflatum) Stellaria nitens Tonella floribunda (grazing)	Festuca idahoensis Geranium viscosissimum Geum triflorum Helianthella uniflora Hieracium albertinum Potentilla gracilis Triteleia grandiflora var. grandiflora (=Brodiaea douglasii) Rosa nutkana (grazing) Symphoricarpos albus (grazing)	Ventenata dubia Poa bulbosa Poa pratensis Hypericum perforatum Potentilla recta Euphorbia virgata Centaurea spp.
Columbia Plateau Low Sagebrush Steppe (Daubenmire, 1970; Crowe & Clausnitzer, 1997; Johnson, 1998; Rocchio & Crawford, 2015)	Artemisia arbuscula ssp. arbuscula Artemisia rigida Eriogonum spp. Festuca idahoensis Poa secunda Pseudoroegneria spicata Koeleria macrantha	Achillea millefolium Antennaria luzuloides (grazing) Artemisia arbuscula ssp. arbuscula (grazing) Balsamorhiza sagittata (grazing) Ericameria nauseosa (grazing) Eriogonum heracleoides (grazing) Lomatium nudicaule Madia glomerata (grazing) Phlox sp. Trifolium macrocephalum Elymus elymoides (= Sitanion hystrix)	Agoseris retrorsa Frasera albicaulis Trifolium macrocephalum	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Poa bulbosa Centaurea spp. Linaria dalmatica ssp. dalmatica
Columbia Plateau Scabland Shrubland	Artemisia rigida Eriogonum (compositum, douglasii, sphaerocephalum, strictum, thymoides)	Achillea millefolium Balsamorhiza (serrata, incana) Danthonia unispicata (grazing)	Trifolium macrocephalum	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Poa bulbosa

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
(Daubenmire, 1970; Johnson, 1998; Rocchio & Crawford, 2015)	Stenotus stenophyllus Poa secunda	Elymus elymoides (= Sitanion hystrix) Lomatium nudicaule Phlox sp. Trifolium macrocephalum (surface disturbance)		Centaurea spp. Linaria dalmatica ssp. dalmatica
Columbia Plateau Steppe and Grassland (Daubenmire, 1970; Crowe & Clausnitzer, 1997; Johnson, 1998; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Achnatherum hymenoides Achnatherum thurberianum Elymus elymoides (= Sitanion hystrix) Elymus lanceolatus ssp. lanceolatus Hesperostipa comata Festuca idahoensis Koeleria macrantha Poa secunda Pseudoroegneria spicata	Achnatherum hymenoides Antennaria luzuloides (grazing) Artemisia tridenta ssp. wyomingensis (grazing, lack of fire) Balsamorhiza (sagittata, serrata, incana) Carex douglasii (grazing, soil compaction) Chrysothamnus viscidiflorus Elymus elymoides (= Sitanion hystrix) Ericameria nauseosa (grazing) Eriogonum heracleoides (grazing) Madia glomerata (grazing) Tetradymia spp.	Agoseris retrorsa Poa cusickii ssp. cusickii Trifolium macrocephalum	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Poa bulbosa Centaurea spp. Linaria dalmatica ssp. dalmatica
Columbia Plateau Western Juniper Woodland and Savanna (Daubenmire, 1970; Crowe & Clausnitzer, 1997; Johnson, 1998; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Juniperus occidentalis Artemisia tridentata susbsp. Tridentata? Or wyomingensis?	Artemisia tridenta ssp. wyomingensis (grazing, lack of fire) Balsamorhiza sagittata (grazing) Ericameria nauseosa (grazing) Penstemon deustus (grazing) Penstemon venustus (grazing) Senecio integerrimus var. exaltatus (grazing)	Carex (cordillerana, backii) (grazing)	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Poa bulbosa Centaurea spp.
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland (John & Tart, 1986; Johnson, 1988, 2004; Lillybridge et al., 1995;	Pseudotsuga menziesii Abies grandis Tsuga heterophylla Thuja plicata Pinus contorta Pinus monticola Larix occidentalis	Elymus glaucus Lathyrus pauciflorus (grazing) Linnaea borealis (logging) Luina hypoleuca (grazing) Pteridium aquilinum Spiraea betulifolia (grazing, logging, soil disturbance)	Achlys triphylla Arnica lanceolata Carex bolanderi Corallorhiza maculata Listera cordata Listera caurina	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Tannas, 2001; Rocchio & Crawford, 2013, 2015)	Acer circinatum Achlys triphylla Symphoricarpos hesperius Mahonia nervosa	Symphoricarpos hesperius Thalictrum occidentale (soil disturbance) Urtica dioica	Melica subulata var. subulata Nothochelone nemorosa	
East Cascades Oak-Ponderosa Pine Forest and Woodland (John & Tart, 1986; Johnson, 1988; Lillybridge et al., 1995; Crowe & Clausnitzer, 1997; Tannas, 2001; Rocchio & Crawford, 2013, 2015)	Quercus garryana Pinus ponderosa Pseudotsuga menziesii Calamagrostis rubescens Festuca idahoensis Carex geyeri Carex rossii Carex inops Corylus cornuta Elymus glaucus Pseudoroegneria spicata Symphoricarpos albus	Achillea millifolium Carex rossii (grazing, soil disturbance) Collomia grandiflora Elymus glaucus Lathyrus lanszwertii var. lanszwertii Lupinus arbustus Potentilla gracilis (grazing) Rosa woodsii var. ultramontana	Festuca idahoensis (grazing) Frasera albicaulis Poa cusickii ssp. cusickii	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Cynosurus echinata Poa bulbosa
Inter-Mountain Basins Active and Stabilized Dune (Daubenmire, 1970; Hallock et al., 2007; Rocchio & Crawford, 2015)	Psoralidium lanceolatum Achnatherum hymenoides Corispermum sp. Rumex venosus Phacelia hastata Elymus lanceolatus Ericameria nauseosa Chrysothamnus viscidiflorus Purshia tridentata Artemisia tridentata ssp. wyomingensis	Achnatherum hymenoides Chrysothamnus viscidiflorus	Rumex venosus	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Salsola kali Sisymbrium altissimum
Inter-Mountain Basins Big Sagebrush Steppe (Daubenmire, 1970; Johnson, 1998; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Artemisia tridentata ssp. tridentata Artemisia tridentata ssp. xericensis Artemisia tridentata ssp. wyomingensis Artemisia tripartita ssp. tripartita Purshia tridentata Pseudoroegneria spicata Poa secunda Poa cusickii Koeleria macrantha	Antennaria luzuloides (grazing) Balsamorhiza sagittata (grazing) Carex douglasii (grazing, soil compaction) Ericameria nauseosa (grazing) Eriogonum heracleoides (grazing) Hesperostipa comata Lomatium nudicaule Madia glomerata (grazing) Potentilla gracilis	Carex vallicola (grazing) Poa cusickii ssp. cusickii	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Linaria dalmatica ssp. dalmatica Sisymbrium altissimum

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Hesperostipa comata Achnatherum thurberiana			
Inter-Mountain Basins Cliff and Canyon (Daubenmire, 1970; Rocchio & Crawford, 2013, 2015)	Amelanchier spp. Celtis reticulata Rhus glabra Juniperus spp. Artemisia tridentata Purshia tridentata Cercocarpus ledifolius	-	Delphinium nuttallii	-
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland (Daubenmire, 1970; Johnson, 1998; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Cercocarpus ledifolius Pseudoroegneria spicata Festuca idahoensis	Balsamorhiza sagittata (grazing) Penstemon deustus (grazing) Penstemon venustus (grazing) Senecio integerrimus var. exaltatus (grazing)	Carex (cordillerana, backii) (grazing)	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Linaria dalmatica ssp. dalmatica Sisymbrium altissimum Centaurea spp.
Inter-Mountain Basins Montane Sagebrush Steppe (Daubenmire, 1970; Johnson, 1988, 1998, 2004; Crowe & Clausnitzer, 1997; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Artemisia tridentata ssp. vaseyana Artemisia tridentata ssp. spiciformis (= A. spiciformis). Purshia tridentata Symphoricarpos spp. Amelanchier spp. Ericameria nauseosa Ribes cereum Chrysothamnus viscidiflorus Festuca idahoensis Festuca campestris	Antennaria luzuloides (grazing) Artemisia tridentata ssp. vaseyana (grazing) Bromus carinatus (grazing, soil disturbance) Chrysothamnus viscidiflorus Elymus elymoides (= Sitanion hystrix) Ericameria nauseosa (grazing) Eriogonum heracleoides (grazing) Lomatium nudicaule Madia glomerata (grazing) Potentilla gracilis Senecio integerrimus var. exaltatus (grazing)	Carex petasata (grazing) Carex vallicola (grazing) Festuca campestris	Poa pratensis Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum)
Inter-Mountain Basins Semi-Desert Shrub-Steppe (Daubenmire, 1970; Crowe & Clausnitzer,	Grayia spinosa Krascheninnikovia lanata Ericameria nauseosa Artemisia tridentata Achnatherum hymenoides Achnatherum thurberiana	Artemisia tridentata ssp. wyomingensis (grazing) Carex douglasii (grazing, soil compaction) Elymus elymoides (= Sitanion hystrix)	Atriplex canescens Krascheninnikovia lanata	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Linaria dalmatica ssp. dalmatica Salsola kali Sisymbrium altissimum

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
1997; Wilson et al., 2014; Rocchio & Crawford, 2015)	Elymus elymoides (= Sitanion hystrix) Poa secunda Sporobolus airoides Hesperostipa comata			
North Pacific Active Volcanic Rock and Cinder Land	n/a	n/a	n/a	n/a
North Pacific Alpine and Subalpine Bedrock and Scree (Pojar & MacKinnon, 1994; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Agrostis variabilis Artemisia ludoviciana Athyrium distentifolium (= A. americanum) Cryptogramma acrostichoides Lomatium martindalei Luetkea pectinata Luina hypoleuca Luzula piperi Micranthes tolmiei Oxyria digyna Penstemon davidsonii var. davidsonii Penstemon rupicola Phacelia hastata	Polygonum minimum	Agrostis variabilis Aspidotis densa Asplenium viride Athyrium distentifolium (= A. americanum) Campanula piperi Carex breweri Cryptogramma acrostichoides Elmera racemosa Luina hypoleuca Oxyria digyna Penstemon davidsonii var. davidsonii Penstemon rupicola Senecio neowebsteri Silene acaulis	n/a
North Pacific Alpine and Subalpine Dry Grassland (Douglas & Bliss, 1977; Johnson, 1988, 2004; Crowe & Clausnitzer, 1997; Tannas, 2001; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Arenaria capillaris Carex spectabilis Carex hoodii Eucephalus (engelmannii, ledophyllus) Festuca idahoensis Festuca viridula Festuca roemeri Ligusticum grayi Lupinus latifolius ssp. subalpinus Luetkea pectinata Phlox diffusa Polygonum bistortoides Potentilla flabellifolia	Antennaria lanata Lupinus spp. Achnatherum occidentale Carex rossii (grazing, soil disturbance) Elymus glaucus Leptosiphon nuttallii ssp. nuttallii (grazing) Rudbeckia occidentalis Juncus parryi Penstemon sp. Potentilla gracilis (grazing) Cirsium edule Phacelia hastata Polygonum minimum	Anemone occidentalis Carex hoodii (grazing) Delphinium glareosum Festuca viridula Ligusticum grayi Podagrostis humilis (= Agrostis humilis) Trisetum spicatum (grazing)	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
North Pacific Avalanche Chute Shrubland	Acer circinatum Alnus viridis ssp. sinuata Rubus parviflorus Chamaecyparis nootkatensis Prunus virginiana Amelanchier alnifolia Vaccinium membranaceum	n/a	Polystichum andersonii	-
North Pacific Broadleaf Landslide Forest and Shrubland (Tannas, 2001; Chappell, 2006a; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Alnus rubra Acer macrophyllum Rubus spectabilis Rubus parviflorus Ribes bracteosum Oplopanax horridus Polystichum munitum	Elymus glaucus Geum macrophyllum Pteridium aquilinum Rubus ursinus Urtica dioica	Polystichum andersonii Woodwardia fimbriata	Hedera helix Rubus bifrons (= R. discolor, R. armeniacus) Geranium robertianum Cytisus scoparium Ranunculus repens
North Pacific Coastal Cliff and Bluff (Chappell, 2006b; Rocchio & Crawford, 2013, 2015)	Calamagrostis nutkaensis Equisetum telmateia Festuca rubra Gaultheria shallon Grindelia hirsutula (= G. stricta, nana) Vicia nigra ssp. gigantea	Achillea millefolium Epilobium ciliatum ssp. ciliatum Solidago canadensis	-	Bromus (diandrus, hordeaceus) Cirsium spp. Cytisus scoparius Conium maculatum Holcus lanatus Ulex europaeus
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field, or Meadow (Johnson, 1998; Tannas, 2001; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Cassiope mertensiana Phyllodoce empetriformis Phyllodoce glanduliflora Luetkea pectinata Saxifraga tolmiei Carex (breweri, capitata, nardina, proposita, scirpoidea var. pseudoscirpoidea, spectabilis) Dasiphora fruticosa Empetrum nigrum Erigeron aureus Eriogonum pyrolifolium Festuca roemeri Lupinus latifolius ssp. subalpinus Lupinus lepidus var. lobbii (=L. sellulus)	Antennaria lanata Danthonia intermedia (grazing) Eriogonum pyrolifolium Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling) Phleum alpinum (grazing)	Agoseris aurantiaca var. aurantiaca Agrostis variabilis Anemone occidentalis Antennaria alpina Carex breweri Carex heteroneura Carex nardina Carex preslii Carex proposita (recreation, trampling) Carex scirpoidea var. pseudoscirpoidea Empetrum nigrum (trampling) Festuca viridula Luzula piperi Packera streptanthifolia	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Luzula piperi Oreostemma alpigenum Packera cana Phlox diffusa Salix cascadensis Vaccinium deliciosum		Phyllodoce empetriformis (trampling) Phyllodoce glanduliflora (trampling) Podagrostis humilis (= Agrostis humilis) Salix cascadensis Saxifraga tolmiei Campanula piperi Salix nivalis Trisetum spicatum (grazing) Vahlodea atropurpurea Veronica cusickii	
North Pacific Dry Douglas-fir Forest and Woodland (John & Tart, 1986; Tannas, 2001; Chappell, 2006a; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Pseudotsuga menziesii Arbutus menziesii Pinus contorta var. contorta Acer macrophyllum Abies grandis Corylus cornuta var. californica Holodiscus discolor Lonicera hispidula Mahonia nervosa Rosa gymnocarpa Rubus ursinus Symphoricarpos albus Vaccinium ovatum Festuca occidentalis Pteridium aquilinum var. pubescens	Alnus rubra (logging) Elymus glaucus Symphoricarpos albus Polystichum munitum Pteridium aquilinum var. pubescens Rubus ursinus	Kopsiopsis hookeri (= Boschniakia hookeri) Corallorhiza maculata Festuca subuliflora Melica subulata var. subulata	Agrostis capillaris Hedera helix Holcus lanatus Poa pratensis Bromus diandrus (= B. rigidus) Daphne laureola Cynosurus echinatus Festuca arundinacea Hypericum perforatum Ilex aquifolium Cytisus scoparium
North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest (Henderson et al., 1989, 1992; Tannas, 2001; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Tsuga heterophylla Abies amabilis Pseudotsuga menziesii Chamaecyparis nootkatensis Abies procera Abies amabilis Achlys triphylla Mahonia nervosa Xerophyllum tenax Vaccinium membranaceum	Alnus rubra Elymus glaucus Geum macrophyllum Pteridium aquilinum Urtica dioica	Achlys triphylla Listera caurina Rhododendron albiflorum	Geranium robertianum

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Vaccinium ovalifolium Rhododendron macrophyllum Rhododendron albiflorum			
North Pacific Herbaceous Bald and Bluff (Tannas, 2001; Chappell, 2006b; Rocchio & Crawford, 2013, 2015)	Festuca roemeri Danthonia californica Achnatherum lemmonii Festuca rubra Koeleria macrantha Camassia quamash Camassia leichtlinii Triteleia hyacinthina Mimulus guttatus Plectritis congesta Lomatium martindalei Allium cernuum Phlox diffusa Arctostaphylos uva-ursi Arctostaphylos nevadensis Juniperus communis	Camassia quamash Cerastium arvense (grazing) Fragaria virginiana (grazing, soil disturbance) Mimulus guttatus	Lomatium martindalei Selaginella wallacei	Cytisus scoparium Hypericum perforatum Hypochaeris radicata Holcus lanatus Chrysanthemum leucanthemum Hieracium pilosella Potentilla recta Centaurea spp. Bromus hordeaceus Agrostis capillaris Anthoxanthum odoratum Poa pratensis Arrhenatherum elatius Taeniatherum caput-medusae Festuca arundinacea Ulex europaeus
North Pacific Hypermaritime Shrub and Herbaceous Headland (Tannas, 2001; Chappell, 2006b; Rocchio & Crawford, 2013, 2015)	Gaultheria shallon Vaccinium ovatum Lonicera involucrata Rubus spectabilis Rubus parviflorus Vaccinium alaskaense Vaccinium ovalifolium Festuca rubra Calamagrostis nutkaensis Elymus glaucus Danthonia californica Bromus sitchensis Solidago canadensis Lomatium martindalei Vicia gigantea Equisetum telmateia Artemisia suksdorfii Pteridium aquilinum Blechnum spicant	Artemisia suksdorfii Calamagrostis nutkaensis Elymus glaucus Solidago canadensis	Lomatium martindalei	Anthoxanthum odoratum Holcus lanatus Dactylis glomerata Ulex europaeus

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
North Pacific Hypermaritime Sitka Spruce Forest (Henderson et al., 1989; Crawford et al., 2009; Rocchio & Crawford, 2015)	Picea sitchensis Tsuga heterophylla Thuja plicata Gaultheria shallon Vaccinium ovatum Maianthemum dilatatum Oxalis oregana Polystichum munitum Dryopteris spp. Blechnum spicant	Acer circinatum Alnus rubra Polystichum munitum Pteridium aquilinum Rubus spectabilis Urtica dioica	Monotropa uniflora	Hedera helix Geranium robertianum Ranunculus repens
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest (Henderson et al., 1989; Crawford et al., 2009; Rocchio & Crawford, 2015)	Tsuga heterophylla Thuja plicata Gaultheria shallon Vaccinium ovatum Maianthemum dilatatum Oxalis oregana Polystichum munitum Dryopteris spp. Blechnum spicant	Acer circinatum Alnus rubra Polystichum munitum Pteridium aquilinum Rubus spectabilis Urtica dioica	Maianthemum dilatatum Monotropa uniflora	Hedera helix Geranium robertianum Ranunculus repens
North Pacific Maritime Coastal Sand Dune (Wiedemann, 1984; Christy et al., 1998; Rocchio & Crawford, 2015)	Ambrosia chamissonis Abronia latifolia Cakile maritime Cakile edentula Leymus arenarius (= Elymus arenarius) Festuca rubra Leymus mollis Gaultheria shallon Vaccinium ovatum Pinus contorta var. contorta	-	Poa macrantha	Agrostis spp. Ammophila (arenaria, breviligulata) Anthoxanthum odoratum Holcus lanatus Cytisus scoparius Ulex europaeus
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest (Chappell, 2006a; Crawford et al., 2009; Rocchio & Crawford, 2015)	Pseudotsuga menziesii Tsuga heterophylla Abies grandis Thuja plicata Acer macrophyllum Gaultheria shallon Mahonia nervosa Rhododendron macrophyllum Linnaea borealis	Alnus rubra Geum macrophyllum Polystichum munitum Pteridium aquilinum Rubus spectabilis Urtica dioica	Achlys triphylla Boschniakia hookeri Corallorhiza maculata Listera cordata Listera caurina Nothochelone nemorosa Polystichum andersonii Pyrola picta	Digitalis purpurea Hedera helix Geranium robertianum Ranunculus repens

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Achlys triphylla Vaccinium ovatum Acer circinatum			
North Pacific Maritime Mesic Subalpine Parkland (Henderson et al., 1989, 1992; Johnson, 1998; Tannas, 2001; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Tsuga mertensiana Abies amabilis Chamaecyparis nootkatensis Abies lasiocarpa Phyllodoce empetriformis Cassiope mertensiana Vaccinium deliciosum Lupinus latifolius ssp. subalpinus Valeriana sitchensis Carex spectabilis Polygonum bistortoides	Elymus glaucus Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling) Lupinus latifolius ssp. subalpinus	Phyllodoce empetriformis (trampling) Elliottia pyroliflora Lycopodium sitchense Sorbus sitchensis var. sitchensis	-
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest (Henderson et al., 1989, 1992; Chappell, 2006a; Crawford et al., 2009; Rocchio & Crawford, 2015)	Polystichum munitum Acer circinatum Tsuga heterophylla Thuja plicata Pseudotsuga menziesii Acer macrophyllum Alnus rubra Oxalis oregana Rubus spectabilis Oplopanax horridus	Alnus rubra Geum macrophyllum Polystichum munitum Pteridium aquilinum Urtica dioica	Arnica lanceolata Carex hendersonii Corallorhiza maculata Listera cordata Listera caurina Viola sempervirens	Digitalis purpurea Hedera helix Geranium robertianum Ranunculus repens
North Pacific Mesic Western Hemlock-Silver Fir Forest (Henderson et al., 1989, 1992; Crawford et al., 2009; Rocchio & Crawford, 2015)	Tsuga heterophylla Abies amabilis Chamaecyparis nootkatensis Vaccinium ovalifolium Oxalis oregana Blechnum spicant Rubus pedatus	Alnus rubra Geum macrophyllum Polystichum munitum Pteridium aquilinum	Arnica lanceolata Corallorhiza maculata Corallorhiza mertensiana Elliottia pyroliflora Monotropa uniflora Orthilia secunda Polystichum andersonii Rubus pedatus Streptopus lanceolatus Streptopus streptopoides Viola sempervirens	Geranium robertianum
North Pacific Montane Massive Bedrock, Cliff and Talus	Chamaecyparis nootkatensis Tsuga spp. Thuja plicata Pseudotsuga menziesii	-	Aspidotis densa Asplenium viride Cryptogramma acrostichoides Luina hypoleuca	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
(Rocchio & Crawford, 2015)	Abies spp. Acer circinatum Alnus spp. Ribes spp.		Penstemon davidsonii var. davidsonii Penstemon rupicola Polypodium hesperium Polystichum andersonii Sedum oreganum Selaginella wallacei	
North Pacific Montane Shrubland (Henderson et al., 1989, 1992; Crowe & Clausnitzer, 1997; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Acer circinatum Vaccinium membranaceum Ceanothus velutinus Holodiscus discolor Philadelphus lewisii Xerophyllum tenax Rubus parviflorus	Rubus parviflorus (ground disturbance)	-	-
North Pacific Mountain Hemlock Forest (Henderson et al., 1989, 1992; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Tsuga mertensiana Abies amabilis Elliottia pyroliflorus, Rubus lasiococcus Clintonia uniflora Orthilia secunda Streptopus lanceolatus var. curvipes (= S. roseus) Valeriana sitchensis Tiarella trifoliata var. unifoliata Luzula glabrata Rubus pedatus Rhododendron albiflorum Menziesia ferruginea Vaccinium membranaceum Vaccinium ovalifolium	-	Clintonia uniflora Menziesia ferruginea Pectiantia breweri (= Mitella breweri) Pectiantia pentandra (= Mitella pentandra) Rhododendron albiflorum Rubus pedatus Streptopus lanceolatus	-
North Pacific Oak Woodland (Erickson, 1978; Johnson, 1988; Tannas, 2001; Chappell, 2006a; Wilson et al., 2008; Rocchio &	Quercus garryana Pseudotsuga menziesii Arbutus menziesii Symphoricarpos albus Holodiscus discolor Rosa spp. Mahonia aquifolium (=Berberis	Amsinckia menziesii Bromus carinatus Camassia quamash Carex tumulicola (grazing) Elymus glaucus Fragaria vesca (grazing, soil disturbance)	Dichelostemma congestum Festuca roemeri Fritillaria affinis Piperia elegans Trillium parviflorum Trillium ovatum	Cytisus scoparius Arrhenatherum elatius Avena fatua Dactylis glomerata Holcus lanatus Poa pratensis Prunus avium

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Crawford, 2013, 2015; D. Wilderman, pers. comm., April 10, 2017)	aquifolium) Amelanchier alnifolia Oemleria cerasiformis Festuca roemeri Carex inops ssp. inops Bromus carinatus Danthonia californica Elymus glaucus Camassia quamash Vicia americana Galium aparine Fragaria vesca Lomatium utriculatum Lithophragma parviflora Synthris reneformis Balsamorhiza deltoidea Sanicula crassicaulis Erythronium oregonum Potentilla glandulosa Delphinium trollifolium Cardamine nuttallii	Galium aparine Mahonia aquifolium (=Berberis aquifolium) Oemleria cerasiformis Symphoricarpos albus Carex inops ssp. inops Camassia quamash		Crataegus monogyna Agrostis capillaris Anthoxanthum odoratum Phleum pratense Bromus diandrus (= B. rigidus) Bromus hordeaceus Cirsium arvense Plantago lanceolata Rumex acetosella Cynosurus echinatus Festuca arundinacea Geranium robertianum Hypericum perforatum
North Pacific Serpentine Barren (Kruckeberg, 1992; Freeman & Reveal, 2005; Rocchio & Crawford, 2013, 2015)	Pseudotsuga menziesii Pinus ponderosa Pinus monticola Aspidotis densa Arctostaphylos nevadensis Pseudoroegneria spicata Pinus contorta var. latifolia Pinus albicaulis Abies lasiocarpa Tsuga mertensiana Juniperus communis Ledum glandulosum Vaccinium scoparium Festuca viridula Poa curtifolia Aconogonon davisiae	-	Aspidotis densa Festuca viridula Polystichum imbricans ssp. imbricans Polystichum kruckebergii Polystichum lemmonii Polystichum scopulinum	-
North Pacific Wooded Volcanic Flowage	Pseudotsuga menziesii Pinus contorta	-	-	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
(Crawford et al., 2009; Rocchio & Crawford, 2015)	Pinus monticola Abies lasiocarpa Acer circinatum Vaccinium membranaceum Arctostaphylos uva-ursi Mahonia nervosa Amelanchier alnifolia Xerophyllum tenax			
Northern Rocky Mountain Avalanche Chute Shrubland (Daubenmire & Daubenmire, 1968; Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	Abies lasiocarpa Acer glabrum Alnus viridis ssp. sinuata Alnus incana Populus balsamifera ssp. trichocarpa Populus tremuloides Cornus sericea Paxistima myrsinites Prunus emarginata Salix scouleriana Sorbus scopulina Sorbus sitchensis	n/a	Clintonia uniflora	-
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998; Lillybridge et al., 1995; Crowe & Clausnitzer, 1997; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Pseudotsuga menziesii Pinus ponderosa Pinus contorta var. latifolia Pinus monticola Larix occidentalis Calamagrostis rubescens Carex geyeri Pseudoroegneria spicata Carex rossii Arctostaphylos uva-ursi Acer glabrum Juniperus communis Physocarpus malvaceus Purshia tridentata Symphoricarpos albus Spiraea betulifolia Vaccinium membranaceum	Arnica cordifolia (grazing) Balsamorhiza sagittata (grazing) Carex concinnoides (logging, soil disturbance) Carex rossii (grazing, soil disturbance) Danthonia unispicata (grazing) Eriogonum heracleoides (grazing) Luina hypoleuca (grazing) Lupinus (caudatus, laxiflorus) (grazing) Symphoricarpos albus Poa secunda Potentilla gracilis (grazing) Pteridium aquilinum Thalictrum occidentale (soil disturbance) Trifolium longipes (trampling)	Agrostis variabilis Calochortus elegans var. elegans Carex (cordillerana, backii) (grazing) Erigeron speciosus	Linaria dalmatica Poa compressa Poa pratensis

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Northern Rocky Mountain Foothill Conifer Wooded Steppe (Daubenmire & Daubenmire, 1968; Lillybridge et al., 1995; Johnson, 1998; Rocchio & Crawford, 2013, 2015)	Pinus ponderosa Pseudotsuga menziesii Pseudoroegneria spicata Poa secunda Hesperostipa spp. Achnatherum spp. Elymus elymoides (= Sitanion hystrix) Festuca idahoensis Festuca campestris	Achillea millefolium Antennaria luzuloides (grazing) Artemisia tridenta ssp. wyomingensis (grazing, lack of fire) Balsamorhiza sagittata (grazing) Elymus elymoides (= Sitanion hystrix) Eriogonum heracleoides (grazing) Koeleria macrantha Lomatium nudicaule	Agoseris retrorsa Festuca campestris Frasera albicaulis Orobanche fasciculata Poa cusickii ssp. cusickii Trifolium macrocephalum	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Centaurea spp.
Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland (Daubenmire, 1970; Tisdale, 1986; Crowe & Clausnitzer, 1997; Johnson, 1998, 2004; Tannas, 2001; Johnson & Swanson, 2005; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Pseudoroegneria spicata Festuca campestris Festuca idahoensis Hesperostipa comata Achnatherum hymenoides Achnatherum (nelsonii, occidentale) Achnatherum richardsonii Hesperostipa curtiseta Koeleria macrantha Leymus cinereus Elymus trachycaulus Bromus inermis ssp. pumpellianus (= B. pumpellianus) Pascopyrum smithii Carex filifolia Danthonia intermedia	Agoseris glauca (grazing, erosion) Amsinckia menziesii Aristida purpurea var. longiseta Artemisia frigida (grazing) Balsamorhiza (sagittata, serrata, incana) Elymus elymoides (= Sitanion hystrix) Eriogonum heracleoides (grazing) Gaillardia aristata (grazing) Gallium boreale (grazing) Geranium viscosissimum (grazing) Hieracium scouleri Leymus cinereus Lomatium nudicaule Madia glomerata (grazing) Penstemon deustus (grazing) Penstemon venustus (grazing) Perideridia gairdneri (grazing) Potentilla gracilis (grazing)	Carex petasata (grazing) Carex vallicola (grazing) Festuca campestris Frasera albicaulis Orobanche fasciculata	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Ventenata dubia Bromus inermis Phleum pratense Poa pratensis Hypericum perfoliatum Potentilla recta Euphorbia virgata Centaurea spp.
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998;	Abies grandis Tsuga heterophylla Thuja plicata Picea engelmannii Pseudotsuga menziesii Asarum caudatum Clintonia uniflora Coptis occidentalis	Arnica cordifolia (grazing) Astragalus canadensis var. mortonii Carex concinnoides (logging, soil disturbance) Carex rossii (grazing, soil disturbance) Lathyrus pauciflorus (grazing)	Actaea rubra Aralia nudicaulis Arnica parryi ssp. parryi Asarum caudatum Calypso bulbosa Carex bolanderi Clintonia uniflora Corallorhiza maculata	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Lillybridge et al., 1995; Crowe & Clausnitzer, 1997; Rocchio & Crawford, 2013, 2015)	Prosartes hookeri Gymnocarpium dryopteris Tiarella trifoliata Trientalis borealis ssp. latifolia Trillium ovatum Viola glabella	Lupinus (caudatus, laxiflorus) (grazing) Potentilla gracilis (grazing) Spiraea betulifolia (grazing, logging, soil disturbance) Thermopsis montana var. ovata (grazing) Trifolium longipes (trampling) Linnaea borealis (logging) Pteridium aquilinum Urtica dioica	Pectiantia breweri (= Mitella breweri) Pectiantia pentandra (= Mitella pentandra)	
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland (Daubenmire & Daubenmire, 1968; Johnson, 1998; Rocchio & Crawford, 2013, 2015)	Physocarpus malvaceus Spiraea douglasii Amelanchier alnifolia Prunus emarginata Prunus virginiana Holodiscus discolor Symphoricarpos albus Menziesia ferruginea Crataegus douglasii Rosa spp.	Agastache urticifolia (grazing) Crataegus douglasii (grazing, lack of fire) Eriogonum heracleoides (grazing) Potentilla gracilis (grazing)	Menziesia ferruginea	Poa pratensis Phleum pratense Centaurea solstitialis Hypericum perfoliatum Poa pratensis Prunus cerasifera
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998, 2004; Lillybridge et al., 1995; Crowe & Clausnitzer, 1997; Tannas, 2001; LANDFIRE, 2007; Rocchio & Crawford, 2013, 2015)	Pinus ponderosa Pseudoroegneria spicata Hesperostipa spp. Achnatherum spp. Festuca idahoensis Festuca campestris Calamagrostis rubescens Carex geyeri Artemisia tridentata Arctostaphylos uva-ursi Arctostaphylos patula Ceanothus velutinus Physocarpus malvaceus Purshia tridentata Symphoricarpos albus Prunus virginiana Amelanchier alnifolia Rosa spp.	Achnatherum (nelsonii, occidentale) (grazing) Arnica cordifolia (grazing) Artemisia tridentata? Balsamorhiza sagittata (grazing) Ericameria nauseosa (grazing) Eriogonum heracleoides (grazing) Gaillardia aristata (grazing) Lupinus (caudatus, laxiflorus) (grazing) Hieracium scouleri Madia glomerata (grazing) Potentilla gracilis (grazing) Prunus virginiana Senecio integerrimus var. exaltatus (grazing) Symphoricarpos albus	Agoseris retrorsa Calochortus elegans var. elegans Festuca campestris Gaultheria ovatifolia Poa cusickii ssp. cusickii Pyrola picta Trifolium macrocephalum	Bromus (briziformis, commutatus, japonicus, hordeaceus, tectorum) Centaurea spp.

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Northern Rocky Mountain Subalpine Deciduous Shrubland (Crowe & Clausnitzer, 1997; Johnson, 1998, 2004, Rocchio & Crawford, 2013, 2015)	Menziesia ferruginea Rhamnus alnifolia Ribes lacustre Rubus parviflorus Alnus viridis Rhododendron albiflorum Sorbus scopulina Sorbus sitchensis Vaccinium myrtillus Vaccinium scoparium Vaccinium membranaceum Shepherdia canadensis Ceanothus velutinus	Rubus parviflorus (ground disturbance)	Menziesia ferruginea Rhododendron albiflorum	-
Northern Rocky Mountain Subalpine Woodland and Parkland (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998, 2004, Rocchio & Crawford, 2013, 2015)	Pinus albicaulis Larix lyallii Abies lasiocarpa Phyllodoce glanduliflora Phyllodoce empetriformis Empetrum nigrum Cassiope mertensiana Festuca viridula Vahlodea atropurpurea Luzula glabrata Juncus parryi	Achnatherum (nelsonii, occidentale) (grazing) Anaphalis margaritacea Arnica cordifolia (grazing) Carex rossii (grazing, soil disturbance) Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling) Hieracium albiflorum Leptosiphon nuttallii ssp. nuttallii (grazing) Lupinus spp. Penstemon venustus (grazing) Juncus parryi Achillea millifolium Thalictrum occidentale (soil disturbance)	Arnica parryi ssp. parryi Empetrum nigrum (trampling) Eucephalus ledophyllus var. ledophyllus Festuca viridula Phyllodoce empetriformis (trampling) Phyllodoce glanduliflora (trampling) Packera streptanthifolia Sorbus sitchensis var. sitchensis Vahlodea atropurpurea	-
Northern Rocky Mountain Subalpine-Upper Montane Grassland (Johnson, 1988, 1998, 2004; Crowe & Clausnitzer, 1997; Tannas, 2001; Johnson &	Koeleria macrantha Festuca campestris Festuca idahoensis Festuca viridula Achnatherum (nelsonii, occidentale) Achnatherum richardsonii Bromus inermis ssp. pumpellianus Elymus trachycaulus	Agoseris glauca (grazing, erosion) Danthonia intermedia (grazing) Juncus parryi Achillea millifolium Achnatherum (nelsonii, occidentale) (grazing) Antennaria lanata Bromus carinatus	Agoseris aurantiaca var. aurantiaca Anemone occidentalis Arnica mollis Eriogonum pyrolifolium Festuca campestris Carex hoodii (grazing) Carex scirpoidea var. pseudoscirpoidea	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Swanson, 2005; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Phleum alpinum Trisetum spicatum Carex hoodii Carex obtusata Carex scirpoidea Lupinus argenteus var. laxiflorus Potentilla diversifolia Potentilla flabellifolia Fragaria virginiana Chamerion angustifolium	Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling) Leptosiphon nuttallii ssp. nuttallii (grazing) Lupinus sericeus (grazing) Penstemon spp. Potentilla gracilis (grazing) Carex pachystachya Chamerion angustifolium Collinsia parviflora Fragaria virginiana (grazing, soil disturbance) Hieracium scouleri Potentilla gracilis	Podagrostis humilis (= Agrostis humilis) Rainiera stricta Trisetum spicatum (grazing)	
Northern Rocky Mountain Western Larch Savanna (Johnson, 1988, 1998; Crowe & Clausnitzer, 1997; Rocchio & Crawford, 2013, 2015)	Larix occidentalis Pseudotsuga menziesii Pinus contorta var. latifolia Arctostaphylos uva-ursi Calamagrostis rubescens, Linnaea borealis Spiraea betulifolia Vaccinium caespitosum Xerophyllum tenax Ligusticum grayi Carex geyeri	Achnatherum (nelsonii, occidentale) (grazing) Carex concinnoides (logging, soil disturbance) Madia glomerata (grazing) Potentilla gracilis (grazing) Senecio integerrimus var. exaltatus (grazing)	Ligusticum grayi	-
Rocky Mountain Alpine Bedrock and Scree (Crawford et al., 2009; Rocchio & Crawford, 2013, 2015)	n/a	n/a	Agrostis variabilis Aspidotis densa Asplenium viride Athyrium distentifolium (= A. americanum) Boechera lemmonii Elmera racemosa Oxyria digyna Penstemon davidsonii var. davidsonii Penstemon rupicola Silene acaulis	n/a

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Rocky Mountain Alpine Dwarf-Shrubland, Fell-Field, and Turf (Johnson, 1998, 2004, Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Cassiope mertensiana Salix arctica Salix reticulata Salix vestita Phyllodoce empetriformis Erigeron spp. Luetkea pectinata Antennaria lanata Oreostemma alpigenum (= Aster alpigenus) Pedicularis spp. Castilleja spp. Deschampsia caespitosa Caltha leptosepala ssp. howellii Erythronium spp. Juncus parryi Luzula piperi Carex spectabilis Carex nigricans Polygonum bistortoides Arenaria capillaris Geum rossii Kobresia myosuroides Minuartia obtusiloba Myosotis asiatica Paronychia pulvinata Phlox pulvinata Sibbaldia procumbens Silene acaulis Trifolium dasyphyllum Trifolium parryi Artemisia arctica Carex elynoides Carex siccata Carex scirpoidea Carex nardina Carex rupestris Festuca brachyphylla Festuca idahoensis	Erigeron compositus Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling)	Antennaria alpina Boechera lemmonii Caltha leptosepala ssp. howellii Carex proposita (recreation, trampling) Carex raynoldsii (grazing) Carex scirpoidea var. pseudoscirpoidea Luzula piperi Minuartia obtusiloba Phyllodoce empetriformis (trampling) Salix arctica Salix nivalis Sibbaldia procumbens Silene acaulis Cassiope tetragona var. saximontana Trisetum spicatum (grazing) Veronica cusickii	-

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Rocky Mountain Aspen Forest and Woodland (Johnson, 1988, 1998, 2004; Crowe & Clausnitzer, 1997; Tannas, 2001; Hadfield & Magelssen, 2004; Rocchio & Crawford, 2013, 2015; Wilson et al., 2014)	Populus tremuloides Symphoricarpos oreophilus Symphoricarpos albus	Agastache urticifolia (grazing) Bromus carinatus (grazing, soil disturbance) Elymus glaucus Potentilla gracilis (grazing) Symphoricarpos albus Veratrum californicum	Carex vallicola (grazing)	Poa pratensis Cirsium spp.
Rocky Mountain Cliff, Canyon and Massive Bedrock (Rocchio & Crawford, 2013, 2015)	Pseudotsuga menziesii Pinus ponderosa Populus tremuloides Abies lasiocarpa Juniperus occidentalis Amelanchier alnifolia Juniperus communis Holodiscus sp. Ribes sp. Penstemon sp. Physocarpus sp. Rosa sp. Mahonia sp.	-	Cryptogramma acrostichoides Lewisia columbiana Penstemon davidsonii var. davidsonii Penstemon rupicola Polypodium hesperium	-
Rocky Mountain Lodgepole Pine Forest (Rocchio & Crawford, 2013, 2015)	Pinus contorta var. latifolia Acer glabrum Amelanchier alnifolia Holodiscus discolor Salix scouleriana Rosa gymnocarpa Shepherdia canadensis Spiraea betulifolia Symphoricarpos albus Vaccinium membranaceum Mahonia repens Ceanothus velutinus Paxistima myrsinites Arctostaphylos uva-ursi A. nevadensis Vaccinium scoparium	Elymus elymoides (= Sitanion hystrix) Salix scouleriana Symphoricarpos albus	Agrostis variabilis Anemone drummondii	Poa pratensis

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Xerophyllum tenax Calamagrostis rubescens Carex geyeri			
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998, 2004; Lillybridge et al., 1995; Rocchio & Crawford, 2013, 2015)	Picea engelmannii Abies lasiocarpa Pseudotsuga menziesii Pinus contorta var. latifolia Larix occidentalis Paxistima myrsinites Vaccinium scoparium Juniperus communis Calamagrostis rubescens Carex geyeri	Arnica cordifolia (grazing) Carex hoodii (logging) Carex rossii (grazing, soil disturbance) Linnaea borealis (logging) Pteridium aquilinum Sibbaldia procumbens (trampling) Thalictrum occidentale (soil disturbance) Thermopsis montana var. ovata (grazing)	Podagrostis humilis (= Agrostis humilis) Trisetum spicatum (grazing)	-
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland (Daubenmire & Daubenmire, 1968; Johnson, 1988, 1998, 2004, Rocchio & Crawford, 2013, 2015)	Picea engelmannii Abies lasiocarpa Pinus contorta var. latifolia Menziesia ferruginea Rhododendron albiflorum Actaea rubra Maianthemum stellatum Clintonia uniflora Cornus canadensis Erigeron eximius Gymnocarpium dryopteris Rubus pedatus Saxifraga bronchialis Tiarella spp. Lupinus latifolius ssp. subalpinus Valeriana sitchensis Luzula glabrata var. hitchcockii Calamagrostis Canadensis Xerophyllum tenax	Arnica cordifolia (grazing) Geum macrophyllum Lupinus latifolius ssp. subalpinus Pteridium aquilinum Senecio triangularis (grazing) Sibbaldia procumbens (trampling) Thalictrum occidentale (soil disturbance) Urtica dioica Veratrum californicum	Menziesia ferruginea Saxifraga bronchialis Packera streptanthifolia Rubus pedatus	-
Rocky Mountain Subalpine-Montane Mesic Meadow (Johnson, 1988, 1998, 2004, Rocchio &	Senecio triangularis Erigeron peregrinus Erythronium grandiflorum Ligusticum spp. Veratrum viride Valeriana spp.	Bromus carinatus (grazing, soil disturbance) Camassia quamash Chamerion angustifolium Danthonia intermedia (grazing)	Allium crenulatum Agoseris aurantiaca var. aurantiaca Annemone occidentalis Arnica mollis	Poa pratensis Bromus inermis Phleum pratense Hieracium caespitosum Hieracium aurantiacum

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
Crawford, 2013, 2015; Wilson et al., 2014)	Arnica chamissonis Camassia quamash Erigeron speciosus Eucephalus spp. Symphyotrichum spp. Mertensia spp. Chamerion angustifolium Penstemon procerus Geum macrophyllum Campanula rotundifolia Solidago canadensis Zigadenus elegans Thalictrum occidentale Senecio hydrophiloides Senecio serra Deschampsia caespitosa Koeleria macrantha Carex spp.	Erigeron glacialis var. glacialis (= E. peregrinus) (grazing, trampling) Fragaria virginiana (grazing, soil disturbance) Lupinus sericeus (grazing) Geum macrophyllum Potentilla gracilis Senecio serra Sibbaldia procumbens (trampling) Solidago canadensis Thermopsis montana var. ovata (grazing) Veratrum californicum	Arnica parryi ssp. parryi Boechera lemmonii Carex raynoldsii (grazing) Erigeron speciosus Eucephalus ledophyllus var. ledophyllus Packera streptanthifolia Penstemon procerus Rainiera strictaTrisetum spicatum (grazing) Vahlodea atropurpurea Zigadenus elegans	Ranunculus acris Leucanthemum vulgare
Willamette Valley Upland Prairie and Savanna (Johnson, 1988; Crowe & Clausnitzer, 1997; Tannas, 2001; Wilson et al., 2008; Alverson, 2009; Rocchio & Crawford, 2013, 2015; D. Wilderman, pers. comm., April 10, 2017)	Festuca roemeri Danthonia californica Carex inops ssp. inops Brodiaea coronaria ssp. coronaria Camassia quamash ssp. (azurea, maxima) Campanula rotundifolia Balsamorhiza deltoidea Cerastium arvense Dodecatheon hendersonii, Erigeron speciosus Hieracium scouleri Solidago simplex Solidago missouriensis Eriophyllum lanatum var. leucophyllus Fritillaria affinis var. affinis Lomatium utriculatum Lomatium triternatum (= L. pugetensis) Lotus micranthus	Achillea millefolium Amsinckia menziesii Carex tumulicola (grazing) Cerastium arvense (grazing) Fragaria virginiana (grazing, soil disturbance) Prunella vulgaris ssp. lanceolata (grazing) Viola adunca (grazing) Carex inops ssp. Inops (grazing, fire) Camassia quamash Lupinus albicaulis Lupinus lepidus	Festuca roemeri Delphinium nuttallii Sericocarpus rigidus Zigadenus venenosus var. venenosus Micranthes integrifolia Dodecatheon hendersonii Fritillaria affinis Hieracium scouleri	Cytisus scoparium Crataegus monogyna Avena fatua Hypericum perforatum Hypochaeris radicata Holcus lanatus Chrysanthemum leucanthemum Agrostis capillaris Anthoxanthum odoratum Poa pratensis Arrhenatherum elatius Hieracium pilosella Potentilla recta Centaurea spp. Schedonorus phoenix Trifolium subterraneum Vulpia myuros Rumex acetosella Plantago lanceolata

Ecological System	Diagnostics	Example Increasers	Example Decreasers	Example Invasive Plants
	Microseris laciniata Prunella vulgaris ssp. lanceolata Ranunculus occidentalis var. occidentalis Sericocarpus rigidus Viola adunca Zigadenus venenosus var. venenosus Symphoricarpos albus Rosa nutkana Toxicodendron diversilobum Amelanchier alnifolia Arctostaphylos uva-ursi			

Appendix F

Field manual for applying rapid Ecological Integrity Assessments
in Wetlands and Riparian Areas in Washington State

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March 2017

Field Manual for Applying Rapid Ecological Integrity Assessments in Wetlands and Riparian Areas in Washington State

March, 2017

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Contents

Figures

Tables

1.0 INTRODUCTION

This document describes the protocols for applying rapid, field-based Ecological Integrity Assessments (Level 2 EIA) to wetland and riparian ecological targets in Washington State. For upland ecosystems, reference Rocchio et al. (2017). A more detailed overview of ecological integrity assessments is found in Rocchio and Crawford (2011) and Faber-Langendoen et al. (2016a,b,c).

The EIA assessment target is defined based on classification criteria. If the objective of the assessment is to determine whether the site meets the criteria of a Wetland of High Conservation Value (or element occurrence), then Rocchio et al. (2016a,b) is used to classify the native wetland or riparian vegetation type. Otherwise, a specific HGM Class and U.S. National Vegetation Classification Formation type are used to define the assessment target. Specific project objectives may result in further adjustments to the assessment target. The process for establishing assessment target boundaries (i.e., assessment area) and protocols for collecting data necessary to apply the EIA metrics are provided in this document. Section 2 focuses on the steps needed to employ the Level 2 EIA, including which metrics to apply based on wetland type. Section 3 provides protocols for measuring each metric.

Once metrics are scored, they are rolled-up into six major ecological factors: landscape, buffer, vegetation, hydrology, soils, and size. These major ecological factor scores are in turn rolled-up into three primary rank factors: landscape context, condition, and size. These three factors can then combined to calculate an overall EIA score/rank. Whether one needs to roll-up scores is dependent on the project objective. Land managers may only be interested in the metric scores, as they provide insight into management needs, goals, and measures of success. On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, an overall EIA score/rank may be needed. Primary and major ecological factor scores/ranks can be helpful for understanding the current status of primary ecological drivers.

2.0 APPLYING LEVEL 2 ECOLOGICAL INTEGRITY ASSESSMENTS

In addition to standard footwear and attire for working in wetlands, the following materials and supplies are needed for applying the EIA:

- EIA field forms (http://www.dnr.wa.gov/NHPdata)
- *Field Guide to Wetland and Riparian Plant Associations of Washington State* (Rocchio et al. 2016a) (http://www.dnr.wa.gov/NHPecoreports)
- *Guide to Wetland and Riparian Types of Washington State* (Rocchio et al. 2016b) (http://www.dnr.wa.gov/NHPecoreports)
- Local plant identification keys and field guides. Users are strongly encouraged to use technical dichotomous keys such as *Flora of the Pacific Northwest* (Hitchcock and Cronquist), especially for graminoids and willows which are notoriously difficult to identify.

Color photo field guides typically only list common species. While they are an indispensable tool for identification, they do not cover the entire flora.

- Hand lens, compass, camera, small trowel or shovel, pin flags and/or flagging/tape (for plot layout)
- GIS is recommended for assessing Landscape Context and Buffer metrics. However, using online map viewers could suffice. NatureServe's Ecological System's map is useful for determining land use patterns (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states).

Below are general guidelines for applying a Level 2 EIA.

Step 1: Assemble background information about the management and history of the site.

Step 2: Identify the assessment area(s). See Section 2.1 and 2.2 for details.

Step 2a: Classify the wetland to be assessed.

- If your objective is to identify a potential Washington Natural Heritage Program element occurrence (i.e., an occurrence of a rare wetland type or high-quality example of a common wetland type), then use Rocchio et al. (2016a,b) to classify the wetland to U.S. National Vegetation Classification Plant Association and Subgroup types. Each potential element occurrence should be considered to be a separate assessment area (AA).
- Otherwise, classify the target wetland using HGM and U.S. National Vegetation Classification Formation keys provided in this document (see 3.0 Classification section). Each HGM and/or Formation type should be delineated as separate assessment areas to ensure that the correct EIA metrics are used.
- If assessing an upland ecosystem occurrence, STOP and switch to the EIA manual for upland plant communities (Rocchio et al., 2017)

Step 2b: Using the guidance in Section 2.2 below, delineate final AA boundaries.

Step 3: Using GIS, establish the landscape context boundary for the AA by delimiting the buffer (0-100 m), Core Area (100-250 m) and Supporting Area (250-500 m) boundary around the outer AA boundary.

Step 4: Before implementing the assessment, consult metric protocols to ensure they are measured systematically. Verify the appropriate season and other timing aspects of field assessment. (Section 3.0)

Step 5: Conduct the office assessment of landscape context, on-site conditions, and stressors of the AA.

Step 6: Conduct the field assessment of on-site conditions and stressors of the AA. The entire AA should be assessed, including--as much as feasibly possible--the 100 m buffer around the AA. This is typically aided by aerial photography or other imagery. The assessment often follows a site walkthrough approach where metrics are scored based on visual observations. For larger AAs, or for long-term monitoring, relevé plots are recommended for collecting data necessary to score metrics.

Step 7: Complete assessment scores and QA/QC Procedures. Automated EIA calculators are available on WNHP's website (http://www.dnr.wa.gov/NHP-EIA)

Step 8: Using the conservation status rank and overall EIA rank of the AA, refer to Table 3 to determine whether the wetland meets Wetland of High Conservation criteria.

2.1 Assessment Area

The Assessment Area (AA) is the spatial area within which the EIA will be applied. The AA is "the entire area, subarea, or point of an occurrence of a wetland type with a relatively homogeneous ecology and condition" (Faber-Langendoen et al. 2016a,b,c). There are many different approaches for determining the AA boundary. The approach used is contingent on project objectives, wetland target, etc. The approaches for AA delineation can generally be grouped into two categories: (1) point-based and (2) polygon-based.

2.1.1 Point-Based Assessment Area

Point-based approaches are best suited for assessing the ecological condition of a population of wetlands, such as an entire watershed or National Wildlife Refuge. These approaches typically define a relatively small area (e.g., 0.5 ha) around pre-determined points that are randomly distributed across the geographic area of interest. Assessments are then conducted within around these points. A point based approach offers some advantages (Fennessy et al. 2007, Stevens and Jensen 2007):

- simple sampling design.
- does not require a mapped boundary of the ecosystem type
- limited practical difficulties in the field for assessing the entire area, as the area is typically relatively small (0.5–2 ha).
- long-term ambient monitoring programs often use a point-based approach because of these advantages.

For point-based AAs, some EIA metrics may not be applicable (e.g., Size metrics) or require modifications to rating criteria and/or roll-up procedures to make them logically consistent with their development. Those modifications are not within the scope of this document. Please contact WNHP for more information about using point-based sampling for EIAs.

2.1.1 Polygon-Based Assessment Area

The polygon approach is best suited for assessment of individual wetlands, as opposed to wetland populations. It is *possible* to use polygon-based AAs to estimate ecological condition of wetland populations, but point-based AAs are typically more conducive to those applications. Advantages of polygon-based AAs are:

- mapping boundaries facilitate whole ecosystem and landscape interpretations.

- decision-makers and managers are often more interested in “stands” or “occurrences,” rather than points.
- programs that maintain mapped occurrences of ecosystem types are most interested in the status and trends of those occurrences.

This field manual is tailored for a polygon-based EIA approach.

2.2 Determine the Assessment Area Boundaries

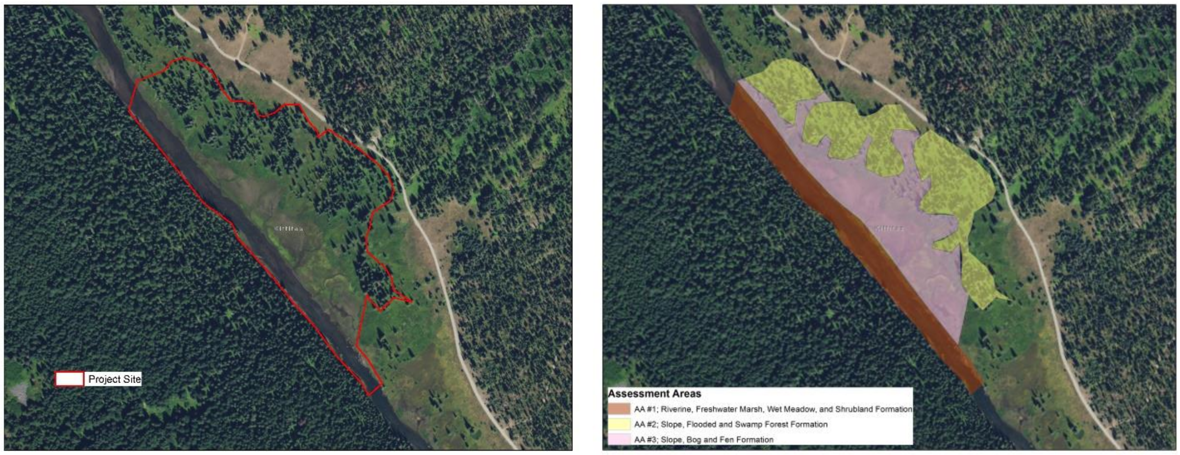
Outlined below are the series of steps necessary to delineate an element occurrence and AA boundary.

Step 1. Estimation of Wetland Boundary*:* Map the wetland area to be assessed. This can be completed via a rigorous wetland delineation, as is often require for wetland regulatory applications, or using readily observable ecological attributes such as vegetation, soil, and hydrological characteristics.

Step 2. Classification and Mapping Variation within Wetland: AAs need to reflect a single HGM class and single U.S. National Vegetation Classification (USNVC) formation. These classification types form the basis for numerous metric ratings (Table 4). If your assessment objective is to determine whether a site meets the criteria for a Wetland of High Conservation Value, classify the various native wetland or riparian ecosystem types defined by Rocchio et al. (2016a,b). Each patch of a given type should be mapped within the wetland delineated in Step 1. [Note: Because vegetation types often occur in a mosaic, the final map of a given type may include multiple, discontinuous patches or polygons within the wetland mapped in Step 1.]). Each of the Rocchio et al. (2016a,b) types correspond to an individual HGM Class and USNVC Formation.

If your project objectives are not concerned with Wetlands of High Conservation Value, you must determine if the mapped wetland boundary from Step 1 has multiple HGM classes and/or USNVC Formations (Faber-Langendoen et al. 2016c; keys are provided below). If so, an AA will need to be established for each of these classes. For example, if the target wetland mapped in Step 1 has two HGM classes (Riverine and Slope) and each HGM Class is considered to be part of the USNVC Freshwater Marsh, Wet Meadow, and Shrubland Formation, then two AAs should be established (one for the Riverine and another for the Slope type). However, if each HGM Class includes more than one USNVC Formation (e.g., Freshwater Marsh, Wet Meadow, and Shrubland Formation, Bog and Fen Formation, and Flooded and Swamp Forest Formation) then multiple AAs are required (e.g. one for each HGM and USNVC Formation combination; Figure 1). As noted above, a single AA may contain multiple patches or polygons within the wetland mapped in Step 1 (see AA #2 in Figure 1). Whether or not you are concerned with Wetlands of High Conservation Value, it is still necessary to identify the Subgroup type of the AA--Subgroup descriptions provide necessary guidance on scoring many of the metrics (Rocchio et al. 2016b).

A key consideration in classifying and mapping is the concept of minimum size defined by the



wetland patch type (Table 1). A patch or collection of patches must meet the minimum size criteria to justify classification and/or mapping as a separate AA. If the patch or collection of patches is smaller than the minimum size then those areas should be considered variation of the type, or AA, in which it is embedded. Refer to Table 1 to determine the minimum size of the wetland type of interest.

Figure 1. Assessment Area Delineation Based on HGM and USNVC Formation Types. LEFT: Project site boundary is shown by red line. RIGHT: Two HGM classes (Riverine and Slope) are present. Within the Riverine HGM Class, only one USNVC Formation is present. Within the Slope HGM Class, two USNVC Formations are present. Thus, three distinct assessment areas are delineated.

Table 1. Patch Type and Minimum Size

Patch Size	Recommended Minimum Size for EO
Matrix (no wetlands in WA are of this type)	2 ha (~5 acres)
Large Patch (no wetlands in WA are of this type)	0.4 ha (~1 acre)
Medium Small Patch (salt marsh, intertidal)	0.2 ha (0.5 acre)
Small Patch (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	0.05 ha (500 m^2)
Very Small Patch (seep/spring, horizontal wet rock, vernal pool)	50 m^2
Very Small Patch (vertical wet rock)	2 m in length
Linear (riparian)	30 meter in length

<u>HGM Classification Key</u>: (adapted from Hruby 2014a,b). Consider the entire wetland when using this key. If the criteria do not apply across the entire wetland, multiple HGM classes may be present.

1. Are tides one of the primary drivers of hydrology in the AA?

   NO – go to 2 **YES = Estuarine Fringe (Tidal) Class**

2. Is the entire AA flat or elevated so that precipitation is the only source of water to it? Groundwater and surface water runoff are NOT sources of water to the unit.

NO – go to 3 | **YES** = **Flats Class – go to 2.1**

2.1 Does the AA have organic soils (≥ 40 cm of peat)?

NO – Mineral Soils Flat Subclass | **YES – Organic Soils Flat Subclass**

3. Does the entire AA **meet all** of the following criteria?

___The vegetated part of the wetland is on the shores of a body of permanent open water at least 8 ha (20 acres) in size;

___At least 30% of the open water area is deeper than 6.6 ft. (2 m).

NO – go to 4 | **YES = Lacustrine Fringe Class**

4. Does the entire AA **meet all** of the following criteria?

____The AA is on a slope (*slope can be very subtle*);

____The water flows through the AA in one direction (unidirectional) and usually comes from seeps or springs. It may flow subsurface, as sheetflow, or in a swale without distinct banks;

____The water leaves the AA **without being impounded**.

NO - go to 5 | **YES = Slope Class**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually < 3 ft. in diameter and less than 1 ft. deep).

5. Does the entire AA **meet all** of the following criteria?

____The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river;

____ Overbank flooding is common, occurring at least once every two years (indicators include: scour marks, recent sediment deposition, vegetation damaged/bent in one direction, soils with alternating deposits, channel banks with flood marks).

NO - go to 6 | **YES** = **Riverine Class**

6. Is the entire AA in a topographic depression in which water ponds, or soil is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.* ***OR*** Is the entire AA located in a very flat area with no obvious depression and no overbank flooding and does not have unidirectional flow? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet

NO – go to 7 | **YES** = **Depressional Class**

7. The wetland is difficult to classify because of a confusing mix of hydrological regimes, some of which appear to be minor components of the wetland. Use Table 2 to identify the appropriate class. If you are still unable to determine which of the above criteria apply to your wetland, default to a classification of Depressional and note the confounding issues.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the AA. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

Table 2. How to Classify an AA with Multiple HGM Classes.

HGM Classes Within the Wetland Unit Being Rated	HGM Class to Use for EIA
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake-fringe	Lake-fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake-fringe	Depressional
Riverine + Lake-fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Estuarine Fringe

USNVC Formation Key: use the key below to assign the U.S. National Vegetation Classification Formation (based on key in Faber-Langendoen et al. 2016c).

1a. One or more layers of the vegetation's structure and/or composition determined by regular human activity such as planting, tilling, cropping, mowing, and/or irrigating---AGRICULTURAL & DEVELOPED VEGETATION (EIA IS NOT DESIGNED FOR USE IN THESE TYPES)
1b. Vegetation's structure and/or composition determined by a spontaneously growing set of plants species shaped by ecological processes---GO TO 2.

2a. Wetland dominated by trees---GO TO 3
2b. Wetland dominated by shrubs and/or herbaceous species---GO TO 4.

3a. Trees form closed canopy on mineral soils, or if on organic soils then very well decomposed (i.e. = sapric or muck); trees are relatively vigorous (generally straight, over 10 m) with pointed crowns; *Sphagnum* is absent or confined to sporadic patches near tree bases or small depressions; sites with a flowing, flooded, or fluctuating semi-permanent, near-surface water table ---FLOODED & SWAMP FOREST FORMATION
3b. Trees form relatively open canopy on organic soils; trees are generally stunted and may have a bonsai form, with rounded tops; trees > 5m are typically < 10% cover although denser stands can occur; organic soils are typically of hemic to fibric decomposition stage in top 16 in.; understory typically has nearly continuous cover of mosses (often Sphagnum); in western WA, *Ledum groenlandicum*, *Kalmia microphylla*, and/or *Gaultheria shallon* are typically dominant in the understory; in eastern WA, sedges, *Betula glandulosa*, and/or small-statured willows are common understory dominants---BOG AND FEN FORMATION

4a. Permanent still or slow-moving shallow waters dominated by floating or rooted, submerged aquatic plants---AQUATIC VEGETATION FORMATION
4b. Wetland dominated by emergent herbaceous species and/or shrubs---GO TO 5

5a. Wetland is dominated by salt-tolerant species; associated with tidal hydrology in western WA; interior salt marshes in eastern WA often have salt crusts on the soil surface; ---SALT MARSH FORMATION
5b. Wetland is freshwater, or if saline, then not affected by tides---GO TO 6

6a. Wetland occurs on organic soils with persistent soil saturation (but rarely significant depth above soil surface) and dominated by sedges; Sphagnum or other mosses often cover ground surface OR if drier, then ground cover is predominantly dominated by Sphagnum species with shrubs such as *Ledum groenlandicum*, *Kalmia microphylla*, *Vaccinium oxycoccos*, and/or *Gaultheria shallon*---BOG AND FEN FORMATION

6b. Wetland occurs on mineral soils OR if on organic soils then soils are highly decomposed and associated with fluctuating water regimes; sites may be semi-permanently to permanently flooded or seasonally flooded and drying during summer---FRESHWATER MARSH, WET MEADOW, AND SHRUBLAND FORMATION

If your project objectives are not concerned with Wetlands of High Conservation Value, then skip to Step 4. Otherwise, proceed to Step 3.

Step 3. Preliminary Determination of the Ecological Observation's Conservation Significance

In order to be considered a Wetland of High Conservation Value, the wetland must be a rare type or a common type of excellent ecological integrity (Table 3). Specifically, the conservation status rank (Global/State rank) of a native wetland or riparian vegetation type and the EIA rank of a specific occurrence of that type are used to determine whether that particular occurrence qualifies as a Wetland of High Conservation Value (Table 3). In other words, all occurrences of rare wetland types qualify, regardless of their condition, while only good to excellent condition examples of common types are considered Wetlands of High Conservation Value (Table 3).

Before proceeding further with the EIA, one should make a preliminary determination of whether the specific occurrence in question may qualify as a Wetland of High Conservation Value. To do this, consult Rocchio et al. (2016a,b) to determine the conservation status rank of the vegetation type being assessed. If it is a common type (e.g., G4 or G5), use your professional judgment regarding the ecological condition of the occurrence to determine whether it is valuable to proceed further. For example, if the occurrence is a *Typha latifolia* Pacific Coast Marsh (conservation status rank = G5) and it appears very degraded, further assessment is probably unnecessary because only occurrences of G5 plant association elements with A-rank or "excellent integrity" are considered Wetlands of High Conservation Value (Table 3). If there is reason to believe the occurrence could have excellent ecological integrity (e.g., A rank) then continue to Step 4. Conversely, if the observation is of a plant association with a conservation status rank of G1, then further assessment is warranted since any EIA rank of that occurrence would make it a Wetland of High Conservation Value (Table 3).

Table 3. Decision Matrix to Determine Ecosystem Element Occurrences

Global / State Conservation Status Rank Combination	Ecological Integrity Assessment Rank			
	A Excellent integrity	B Good Integrity	C Fair integrity	D Poor integrity
G1S1, G2S1, GNRS1, GUS1				
G2S2, GNRS2, G3S1, G3S2, GUS2				
GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR				
G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5				
Red Shading = Element Occurrence				

Step 4. Aggregate Polygons into AA Boundaries: If each type identified in Step 2 or 3 has only one polygon or patch, then proceed to Step 5. Otherwise, use the key below to determine whether to aggregate multiple patches or polygons of the same wetland type as a single AA or to consider them as separate AAs.

1. Is the distance between two separate observation ≥ 5km?
   Yes = they are separate AAs
   No – GO TO 2
2. Do the observations share connected linear riparian / floodplain / coastal habitat?
   Yes = GO TO 3
   No – GO TO 4
3. Is there an area of cultural vegetation/development ≥ 2 km long (following linear habitat) between observations?
   Yes = they are separate AAs
   No – they are the same AA
4. Is there an area of development ≥ 100 m wide?
   Yes = they are separate AAs
   No – GO TO 5
5. Is there cultural vegetation / water ≥ 300 m wide?
   Yes = they are separate AAs
   No – GO TO 6
6. Is there contrasting wetlands / uplands ≥ 500 m wide? (i.e., if element is upland, contrast = wetland, and vice-versa)
   Yes = they are separate AAs
   No – GO TO 7
7. If the observations occur in depressional settings, are they hydrologically connected (e.g., they occur in the same basin or if in separate basins they have a hydrological connection via inlet/outlet or occasional overflow between them)?
   Yes = they are the same AA
   No – GO TO 5

8. If the observations are slope wetlands (e.g., groundwater discharge wetland) do they discharge into the same wetland complex and/or surface water drainage?
   Yes = they are same AA
   No – they are separate AAs

Step 5. Modifications to AA Boundaries Based on Variation in Land Use: If significant change in management or land use results in distinct ecological differences across the AA boundary then those areas should be considered separate AAs. Some examples follow:

- A heavily grazed wetland on one side of a fence line and ungrazed wetland on the other could result in separate AAs, even if they are both of the same HGM Class and USNVC Formation.
- Anthropogenic changes in hydrology. For example, ditches, water diversions, irrigation inputs, and roadbeds that substantially alter a site's hydrology relative to adjacent areas justify separate AAs if ecological integrity varies substantially between the different areas.

Step 6. Apply Level 2 EIA to AA boundaries: In most cases, the extent of the AA boundary at this stage will result in a reasonably sized area that allows practical application of the EIA. If the AA exceeds a reasonable size to survey as part of a rapid assessment, then consider: (1) creating sub-AAs so that each is a practical assessment unit for a site walkthrough approach to data collection OR (2) establish a series of random relevé plots within the AAs. If using sub-AAs, the EIA would be applied to each and then weighted based on area and merged to get the final EIA rank of the AA. Similarly, if using random relevé plots, data can be averaged across plots and then used to score EIA metrics. Section 2.3 discusses how to determine which metrics to apply, based on classification of the AA.

2.3 Determine Which Metrics to Apply

As noted above, the type of wetland dictates which metrics should be used in the Level 2 EIA. Consult Table 4 to determine which metrics or ratings to apply to your AA.

Table 4. EIA Metrics and Applicable Wetland Types

Primary Rank Factor	Major Ecological Factor	Metric/Variant NAME	Where Measured	Apply to:
LANDSCAPE CONTEXT	LANDSCAPE	LAN1 Contiguous Natural Cover (0-500 m)	Office then field check	All Types (not for use with sub-AAs or points)
		Submetrics: *Inner Landscape (0-100 m)*		
		Outer Landscape (100-500 m)		
		LAN2 Land Use Index (0-500 m)	Office then field check	All Types (not for use with sub-AAs or points)
		Submetrics: *Inner Landscape (0-100 m)*		
		Outer Landscape (100-500 m)		
	BUFFER	BUF1 Perimeter with Natural Buffer	Office then field check	All Types (not for use with sub-AAs or points)
		BUF2 Width of Natural Buffer Width	Office then field check	All Types (not for use with sub-AAs or points)
		BUF3 Condition of Natural Buffer	Office then field check	All Types (not for use with sub-AAs or points)
CONDITION	VEGETATION	VEG1 Native Plant Species Cover	Field	All Types; Use lowest submetric score
		Submetrics: *Tree Stratum*		Flooded & Swamp Forest Formation
		Shrub/Herb Stratum		All Types
		VEG2 Invasive Nonnative Plant Species Cover	Field	All Types
		VEG3 Native Plant Species Composition	Field	All Types
		Submetrics: *Native Diagnostic Species*		See USNNVC Subgroup descriptions for guidance
		Native Species Sensitive to Anthropogenic Disturbance		See USNNVC Subgroup descriptions for guidance
		Native Species Indicative of Anthropogenic Disturbance		See USNNVC Subgroup descriptions for guidance
		VEG4 Vegetation Structure	Field	All Types (variant differs by USNVC Formation)
		VEG4, variant 1		Flooded & Swamp Forest Formation
		VEG4, variant 3		Freshwater Marsh, Wet Meadow and Shrubland Formation
		VEG4, variant 4		Salt Marsh Formation
		VEG4, variant 5		Bog and Fen Formation
		VEG4, variant 6		Aquatic Vegetation Formation

Primary Rank Factor	Major Ecological Factor	Metric/Variant NAME	Where Measured	Apply to:
		VEG5. Woody Regeneration	Field	Flooded & Swamp Forest Formation and optional for shrub-dominated types
		VEG6 Coarse Woody Debris	Field	Flooded & Swamp Forest Formation and optional for shrub-dominated types
		VEG6, variant 1		Flooded & Swamp Forest Formation
		VEG6, variant 2		All other wetlands
	HYDROLOGY	HYD1 Water Source	Field & Office	All Types (varies by HGM Class)
		HYD1, variant 1		Riverine (non-tidal)
		HYD1, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD1, variant 3		Depression, Lacustrine, Slope
		HYD1, variant 4		Estuarine Fringe (tidal)
		HYD2 Hydroperiod	Field	All Types (varies by HGM)
		HYD2, variant 1		Riverine (non-tidal)
		HYD2, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD2, variant 3		Depression, Lacustrine, Slope
		HYD2, variant 4		Estuarine Fringe (tidal)
		HYD3 Hydrologic Connectivity	Field	All Types (varies by HGM)
		HYD3, variant 1		Riverine (non-tidal)
		HYD3, variant 2		Organic Soil Flats, Mineral Soil Flats
		HYD3, variant 3		Depression, Lacustrine, Slope
		HYD3, variant 4		Estuarine Fringe (tidal)
	SOIL	SOI1 Soil Condition	Field	All Types (variant differs by USNVC Formation)
		SOI1, variant 1		Flooded and Swamp Forest, Freshwater Marsh, Wet Meadow and Shrubland (nontidal), Bog and Fen, and Aquatic Vegetation formations.
		SOI1, variant 2		Salt Marsh Formation and Freshwater Marsh, Wet Meadow, and Shrubland (tidal) Formation
SIZE	SIZE	SIZ1 Comparative Size (Patch Type)	Office then field check	All Types (ratings vary by patch type); not for use with sub-AAs or points
		SIZ2 Change in Size (optional)	Office then field check	All Types (not for use with sub-AAs or points)

3.0 Level 2 EIA Protocol

This section provides guidance on how to populate the field form. The first four sections address basic site-level data. Thereafter, protocols for each metric are described. They are organized by Rank Factor categories. The majority of protocols used for the WA wetland/riparian Level 2 EIAs are the same as outlined by Faber-Langendoen et al. (2016a,b). Occasionally, regional language is used for some of the metric ratings. Additionally, many of the metric ratings have been updated/combined/modified from EIA scorecard matrices previously developed by WNHP for specific Ecological Systems (Crawford 2011a-aj; Crawford & Rocchio, 2011; Rocchio, 2011a-e).

3.1 Site & Classification Information

Site Name: Provide a unique name for the survey site.

AA Name (if > 1 AAs): If multiple assessment areas are established at the site, provide a unique name/identifier for the assessment area. For example, if there are multiple AAs at a site called "Elk Lake" the individual AAs should be labeled something like "Elk Lake-01" and "Elk Lake-02".

HGM: Note the HGM Class determined in Section 2.2

Cowardin: Use table below to assign applicable Cowardin categories to each level.

	Palustrine Systems	Lacustrine System	Estuarine System
Subsystem	n/a	Littoral	Intertidal Subtidal
Class/Subclass	AB – aquatic bed 1 Algal 2 Aquatic moss 3 Rooted Vascular 4 Floating vascular EM – Emergent 1 Persistent 2 Non-persistent 5 *Phragmites australis* ML – Moss-lichen 1 Moss 2 Lichen SS – Scrub-shrub 1 Broad-leaved deciduous 2 Needle-leaved deciduous 3 Broad-leaved evergreen 4 Needle-leaved evergreen 5 Dead 6 Deciduous 7 Evergreen FO – Forested 1 Broad-leaved deciduous 2 Needle-leaved deciduous 3 Broad-leaved evergreen 4 Needle-leaved evergreen 5 Dead	AB – aquatic bed 1 Algal 2 Aquatic moss 3 Rooted Vascular 4 Floating vascular EM – Emergent 2 Non-persistent	AB – aquatic bed 1 Algal 3 Rooted vascular 4 Floating Vascular EM – Emergent 1 Persistent 2 Non-persistent 5 *Phragmites australis*

	6 Deciduous 7 Evergreen		
Water Regime	See definitions in Table 5.		
Water chemistry	**Coastal Halinity** 1 Hyperhaline – salinity > 40% ppt due to ocean-derived salts 2 Euhaline –salinity 30 to 40 ppt due to ocean-derived salts 3 Mixohaline (brackish) – salinity 0.5 to 30 ppt due to ocean-derived salts 4 Polyhaline – salinity 18 to 30 ppt due to ocean-derived salts 5 Mesohaline – salinity of 5 to 18 ppt due to ocean-derived salts 6 Oligohaline – salnity 0.5 to 5 ppt due to ocean-derived salts 0 Fresh – salinity < 0.5 ppt **Inland Salinity** 7 Hypersaline – salinity > 40% ppt due to land-derived salts 8 Eusaline –salinity 30 to 40 ppt due to land-derived salts 9 Mixosaline (brackish) – salinity 0.5 to 30 ppt due to land-derived salts 0 Fresh – salinity < 0.5 ppt **Freshwater (pH)** a Acid – pH < 5.5 t Circumneutral – pH of 5.5 to 7.4 I Alkaline – pH > 7.4		
Soil	g Organic – soil composed of predominantly organic rather than mineral material (=histosol) n Mineral – soil composed of predominantly mineral rather than organic materials.		
Special	b Beaver – wetland formed due to beaver dam impoundment d Partly drained/ditched – water level has been artificially lowered, but the area is still a wetland. f Farmed – soil surface has been mechanically or physically altered for crop production h Diked/impounded – created or modified by a barrier or dam (human) which purposely or unintentionally obstructs outflow of water. r Artificial - wetland created by humans. s Spoil – wetland formed on spoils excavated from elsewhere and deposited onsite. X Excavated – lies within a basin or channel excavated by humans.		

NVC Formation: Note the Formation type determined in Section 2.2.

NVC Subgroup: Use the key provided in Rocchio et al. (*2016b*) to assign the Subgroup name.

NVC Plant Association: Use the key provided in Rocchio et al. (2016a) to assign the National Vegetation Classification Plant Association name.

Global/State Rank: Use the key provided in Rocchio et al. (2016a,b) to note Global and State Conservation Status ranks.

Observer: first and last name of the surveyor(s).

Date: date of the survey.

County: county in which the site (or AA) occurs.

VegPlot(s): If vegetation plots are established within the site/AA, list their unique plot codes.

TRS: Township, Range, and Section in which the AA occurs.

Table 5. Hydrological Regime Definitions (based on Cowardin et al. 1979)

Hydrological Regime	Definition
Nontidal	
B Saturated	Substrate is saturated to the surface for nearly the entire year, but surface water is seldom present, or if present, just a few inches above the soil surface in low spots.
E Seasonally saturated	Substrate is saturated to the surface through late spring/early summer, but thereafter tends to dry out.
H Permanently flooded	Water covers the surface throughout the year in all years.
G Intermittently exposed	Surface water is present throughout the year except in years of extreme drought.
F Semipermanently flooded	Water covers the surface throughout the growing season in most years. When surface water is absent the water table is usually at or very near the surface.
C Seasonally flooded	Surface water is present for extended periods, especially early in the growing season, but absent by the end of the season in most years. When surface water is absent, the water table often remains near the surface.
A Temporarily flooded	Surface water is present for brief periods during the growing season, but the water table usually lies well below the surface for most of the season. Plants that grow in both uplands and wetlands are characteristic.
J Intermittently flooded	The substrate is usually exposed, but surface water is present for variable periods without detectable seasonal periodicity. Weeks, months, or even years may intervene between periods of inundation. Dominant plant communities may changes as soil moisture conditions changes. Some areas aren't considered wetlands under USFWS definitions.
K Artificially flooded	The amount and duration of flooding is controlled by means of pumps or siphons in combination with dikes or dams. In contrast to the Cowardin et al. 1979 definition, wetlands resulting from leakages from subsurface irrigation discharge/wastewater, artificial impoundments, irrigation from diversions or ditches ARE included here IF they wouldn't exist without these sources (i.e. they do not have a natural source of water).
Saltwater Tidal	
L Subtidal	Substrate is permanently flooded with tidal water
M Irregularly exposed	Substrate is exposed by low tides less often than daily
N Regularly flooded	Tidal water alternately floods and exposes the land surface at least once daily.
P Irregularly flooded	Tidal water floods the land surface less often than daily
Freshwater Tidal	
S Temporarily flooded-tidal	Same definition as above but for tidal sites
R Seasonally flooded-tidal	Same definition as above but for tidal sites
T Semipermanently flooded-tidal	Same definition as above but for tidal sites
V Permanently flooded-tidal	Same definition as above but for tidal sites

Photos: If photos are taken, please provide the photographer's name and associated file names. Files names ideally should have the photographer's initials and a numeric code (e.g., fjr_001). A brief description of each photo's content should be documented in (1) a field notebook or (2) file name; or (3) in the photo's metadata.

EOID: This is the "element occurrence ID" code from BIOTICS. This only applies to existing records in Washington Natural Heritage Program's BIOTICS database.

FeatureID: This is the "Feature ID" code from BIOTICs. Element occurrences can have more than 1 polygon. The FeatureID is used to uniquely code each polygon. This only applies to existing records in Washington Natural Heritage Program's BIOTICS database.
Owner(s): List the owners of the site/AA.
Site Description: Please provide a written description of the site's characteristics. Focus on the setting in which the site occurs, ecological and vegetation patterns within and adjacent to the site, notable stressors or human activity, signs of wildlife, etc. A drawing may also be helpful.

3.2 Environmental

Slope (deg/%): Enter the slope of the AA in degrees or as percent slope.
Aspect (downslope): Facing downslope, note the aspect of the AA (in degrees).
Topographic Position: Select the landform that best fits the location of the AA; if needed, use the empty box to enter a landform not represented in the table.
Water Source: Select the primary water source for the AA; if more than one water source is present, check each and indicate in the comments field which is primary, secondary, etc.
Hydrodynamics: Refer to Table 6 and record the hydrodynamics that best describes the AA.

Table 6. Hydrodynamic Categories

Hydrodynamic Category	Definition
Stagnant	Stagnant to very gradually moving soil water; Vertical fluctuations minimal. Permanent surface saturation, but minimal or no surface flooding. Basins or hollows with stable water regimes. Abundant organic matter accumulation with high bryophyte cover.
Sluggish	Gradual groundwater movement through peat or fine-textured mineral soils along a hydrological gradient; Minor vertical water table fluctuations. Semi-permanent soil saturation with some elevated microsites or brief periods of surface aeration. Hollows, slopes, and water tracks in basins or lake flats not directly influenced by the waterbody. Abundant peat accumulation and bryophyte cover.
Mobile	Distinct flooding and drawdown or pronounced lateral water movements. Peripheral areas of peatlands, sites adjacent to open water tracks, small rivulets or ponds, small potholes with relatively stable water regimes, protected lake embayments, or backmarshes in estuaries. Can have deep, but well-decomposed, accumulations of peat. Patchy bryophyte cover.
Dynamic	Significant lateral flow and/or strong vertical water table fluctuations through mineral soils. Potholes in arid climates that experience significant drawdown, wave-exposed shores, floodplain back channels, and protected estuary sites. Little organic matter accumulation, few bryophytes.
Very dynamic	Highly dynamic surface water regime. Exposed tidal sites, shallow potholes in arid climates that experience significant drawdown, wave-exposed shores, and sites directly adjacent to and influenced by river flow. No organic matter accumulation; no bryophytes.

Soil Type: Select the primary type of soil found in the AA; if more than one type exists, select each and then describe the distribution of each type in the comments.

Mineral soil: soil is predominantly of abiotic origin; sand, silt, and clay dominate most layers. A histic epipedon or organic soil horizon may be present, but is less than 40 cm deep and is typically present as an O horizon on the surface.

Organic soil (sapric): highly decomposed organic material in which the original plant parts are not recognizable; contains more mineral matter and is usually darker in color than peat; often called muck (von Post H7 to H10; see below)

Organic soil (hemic): unconsolidated soil material consisting of accumulated, slightly decomposed organic matter (von Post H4 to H6).

Organic soil (fibric): unconsolidated soil material consisting of accumulated, relatively undecomposed organic matter (von Post H1 to H3).

<u>Mineral Soil Texture</u>: Using the key below, determine soil texture at approximately 15 cm depth.

<u>pH</u>: Record pH using a handheld pH meter or other methods. Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

<u>Conductivity</u>: Record electrical conductivity using a handheld meter. Be sure to record units of measurement (e.g., µS/cm). Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

<u>Temp</u>: Record water temperature using a handheld meter. Be sure to record measurement units (C or F). Ideal measurements are from soil water (water drained into a soil pit), but other locations are possible (see Sample Source below).

<u>Instrument</u>: Indicate make/model of instrument used to determine pH/conductivity/temp (e.g., Hanna Instruments, HI98129 probe, pH paper strips, etc.)

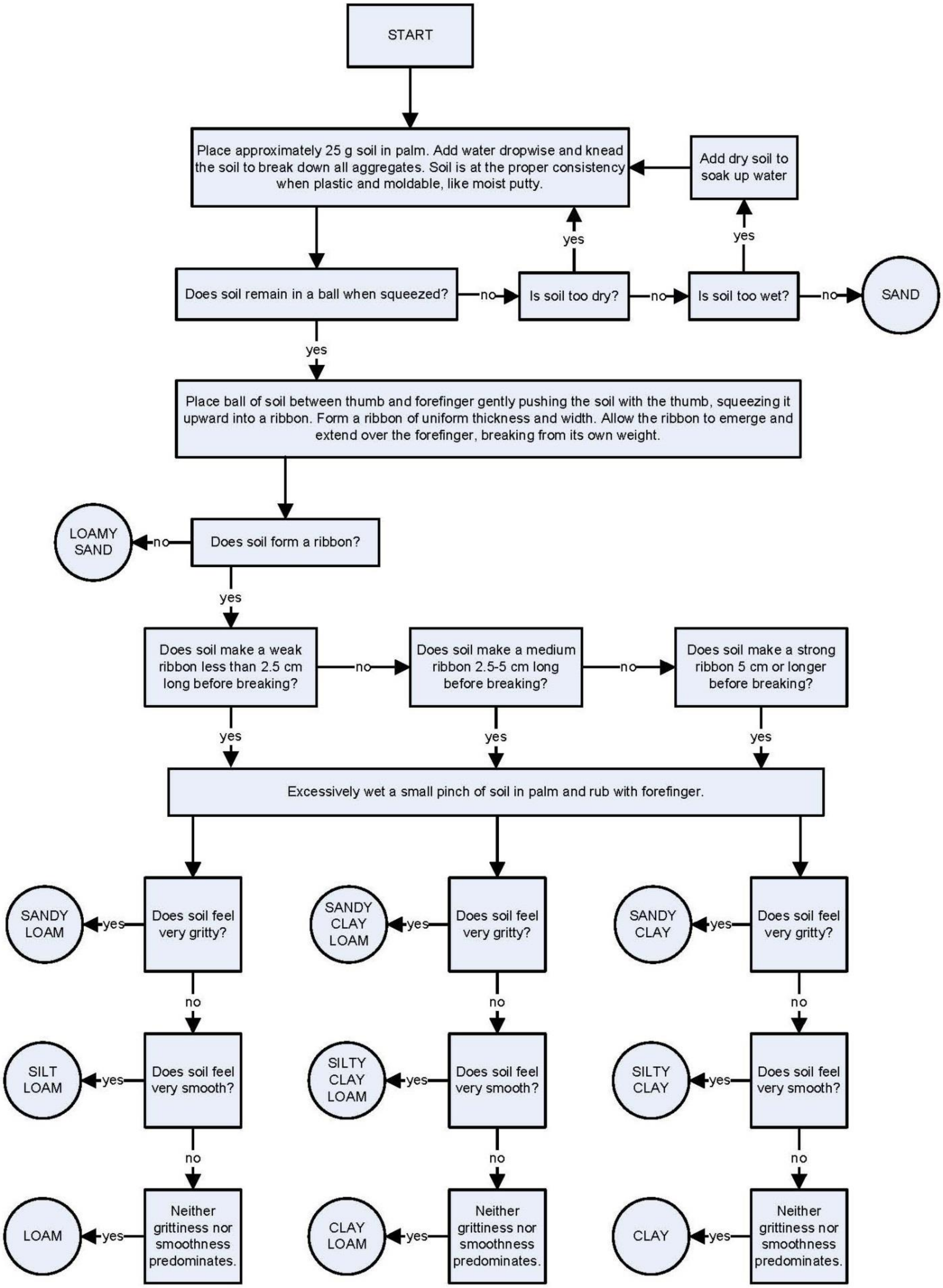
<u>Sample Source</u>: Note the location from which water quality readings were taken. Location examples: (1) small pool; (2) water from soil pit; (3) water extracted from squeezing mosses; (4); moving surface water such as a creek or rill; or (5) pond or lakeshore.

<u>Von Post Index</u> (only applicable to organic soils): Grab a handful of peat and gently squeeze. Based on what is extracted from your hand, determine and record the von Post index using Table 7.

Table 7. von Post Index

Von Post Index	Definition
H1:	Completely undecomposed peat (but not "live"); only clear water can be squeezed out.
H2:	Almost undecomposed and mud-free peat; water that is squeezed out is almost clear and colorless.
H3:	Very little decomposed and very slightly muddy peat; when squeezed water is obviously muddy but no peat passes through fingers. Residue retains structure of peat.
H4:	Poorly decomposed and somewhat muddy peat; when squeezed, water is muddy. Residue muddy but it clearly shows growth structure of peat.
H5:	Somewhat decomposed, rather muddy peat; growth structure visible but somewhat indistinct; when squeezed some peat passes through fingers but mostly very muddy water. Press residue muddy.

H6:	Somewhat decomposed, rather muddy peat; growth structure indistinct; less than 1/2 of peat passes through fingers when squeezed. Residue very muddy, but growth structure more obvious than in unpressed peat.
H7:	Rather well-decomposed, very muddy peat; growth structure visible, about 1/2 of peat squeezed through fingers. If water is squeezed out, it is porridge-like.
H8:	Well-decomposed peat; growth structure very indistinct; about 2/3 of peat passes through fingers when pressed, and sometimes a somewhat porridge-like liquid. Residue consists mainly of roots and resistant fibers.
H9:	Almost completely decomposed and mud-like peat; almost no growth structure visible. Almost all peat passes through fingers as a homogeneous porridge if pressed.
H10:	Completely decomposed and muddy peat; no growth structure visible; entire peat mass can be squeezed through fingers.


START
Place approximately 25 g soil in palm. Add water dropwise and knead the soil to break down all aggregates. Soil is at the proper consistency when plastic and moldable, like moist putty.
Add dry soil to soak up water
yes
yes
Does soil remain in a ball when squeezed?
no
Is soil too dry?
no
Is soil too wet?
no
SAND
yes
Place ball of soil between thumb and forefinger gently pushing the soil with the thumb, squeezing it upward into a ribbon. Form a ribbon of uniform thickness and width. Allow the ribbon to emerge and extend over the forefinger, breaking from its own weight.
LOAMY SAND
no
Does soil form a ribbon?
yes
Does soil make a weak ribbon less than 2.5 cm long before breaking?
no
Does soil make a medium ribbon 2.5-5 cm long before breaking?
no
Does soil make a strong ribbon 5 cm or longer before breaking?
yes
yes
yes
Excessively wet a small pinch of soil in palm and rub with forefinger.
SANDY LOAM
yes
Does soil feel very gritty?
SANDY CLAY LOAM
yes
Does soil feel very gritty?
SANDY CLAY
yes
Does soil feel very gritty?
no
no
no
SILT LOAM
yes
Does soil feel very smooth?
SILTY CLAY LOAM
yes
Does soil feel very smooth?
SILTY CLAY
yes
Does soil feel very smooth?
no
no
no
LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY LOAM
yes
Neither grittiness nor smoothness predominates.
CLAY
yes
Neither grittiness nor smoothness predominates.

Natural Disturbance Comments: Comments may include information on vegetation or ground cover disturbance, evidence of animal use, disturbance history, erosion, fire, storms, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided. Only comments on the natural disturbance evidence within the AA itself should be included in this field; although including information on the surrounding context cannot entirely be avoided, the focus should be on the AA. Information on disturbances to the surrounding landscape should be entered in the Landscape Context Comments field instead.

Anthropogenic Disturbance Comments: Comments may include information on vegetation or ground cover disturbance, logging, plowing, scraping, mowing, fire suppression, etc. If available, information on the type of disturbance, intensity, frequency, years of past disturbances, and seasonality may also be provided.

Geology Comments: Description of the geologic substrate that influences the community Element Occurrence (EO).

Environmental Comments: Comments on other important aspects of the environment that affect this particular community Element Occurrence (EO), including information on climate, seasonality, or any other relevant environmental factors.

3.4 VEGETATION

Plot Type: Circle the type of plot used for data collection (write it in if not listed). The plot form is tailored for relevé or site walkthrough data collection. Columns for up to 10 relevé plots are provided on the form. If transect quadrats or nested subplots were used, attach the associated plot form to the EIA field form.

Plot Size: Note the plot size used. Standard plot sizes for specific strata include: 100 m^2 for herbaceous and shrubland types and 400 m^2 for forest types. Note size by dimension (e.g. 10x10 m; 20x20 m; 10x40 m, etc.). If site walkthrough method was used, estimate area walked and approximate time spent searching.

Vegetative Cover by Stratum: Estimate canopy cover of each stratum using the cover class midpoints in Table 8. Canopy cover is "percentage of ground covered by a vertical projection downward of the outermost perimeter of the natural spread of foliage of plants" (Society of Range Management 1989). Enter the cover class midpoint on the field form. Note the cover of nonnative or exotic species in each strata in separate columns from native species.

Species Cover: List the species observed in the AA in the left hand column. For each species, enter the appropriate strata code. Columns for up to 10 relevé plots are provided. Estimate canopy cover (see definition above) of the species within the plot and enter the midpoint of the cover class (Table 8). For example, if *Carex obnupta* has 10-25% cover, the midpoint value of 17.5% would be entered. If multiple plots are sampled, enter the average cover across plots for each species (this will help with metric calculations). For each species, be sure to enter the appropriate values for the Exotic/Invasive, Diagnostic, and Increaser/Decreaser columns. Examples of these species are listed in Subgroup descriptions (Rocchio et al., 2016b). Definitions of these categories are:

Exotic species: species not considered native to Washington.

Invasive species: aggressive nonnative species that change or transform the character, condition, form, or nature of ecosystems.

Diagnostic species: the characteristic combination of native species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (FGDC 2008). Together these species indicate specific ecological conditions--typically that of minimally disturbed sites.

Native Decreaser Species: native species that decline rapidly from stressors (sometimes referred to as "conservative species."). Species with a coefficient of conservatism value ≥ 7 should be considered a native "decreaser" (see Washington Floristic Quality database for eastern and western Washington (http://www1.dnr.wa.gov/nhp/refdesk/communities/fqa.html.)

Native Increaser Species: Native species which dramatically increase due to anthropogenic stressors such as grazing, nutrient enrichment, soil disturbance, etc. Species with a coefficient of conservatism value ≤ 3 should be considered potential native "increasers" (see FQA databases previously cited). However, the simple presence of these species is not enough to indicate that they are acting as increasers. Rather, it is their relative proportion to what is expected that triggers such a designation. This concept tends to work well in wetlands exposed to conspicuous stressors such as livestock grazing where these species tend to dominate or become monocultures (e.g. *Iris missouriensis* or *Juncus arcticus* (=*J. balticus*)). Because presence/absence is not enough to score this submetric it can be a difficult measure for many users. If that is the case, you can ignore this submetric and make a note in the metric Veg 3 comment section with your reasoning.

Table 8. Cover Classes

Cover Class	Range	Midpoint
1	Trace	0.25%
2	0-1%	0.5%
3	1-2%	1.5%
4	2-5%	3.5%
5	5-10%	7.5%
6	10-25%	17.5%
7	25-50%	37.5%
8	50-75%	62.5%
9	75-95%	85%
10	> 95%	97.5

3.5 EIA Metric Ratings and Scores

For each metric, an A, B, C, or D rank is selected. These ranks are informed by rating criteria descriptions contained within this manual, the wetland subgroup descriptions (Rocchio et al., 2016b), field observations, useful GIS data, and any other relevant available data. Field crews are encouraged to assign a single rating, but a range rank may be used (i.e., AB, BC, or CD) in cases where the rank is uncertain. The range rank does not indicate an intermediate rank or "+/-" rank; it indicates that the metric may be one or the other. We also discourage the use of intermediate or plus/minus ranks (e.g., A- , B- or C-) at the metric level, because it may generate a false sense of precision for a rapid assessment. An exception can occur when an actual rating with a description has been provided for the intermediate rating (e.g., there are a few metrics, such as Hydroperiod, where we found it helpful to distinguish C+ from C). Metric ratings should be entered on the EIA field form. Associated scores for each rating are then used for roll-up calculations (Table 9).

Table 9. Metric rating and points. Occasionally, metric ratings are further subdivided (e.g. a B (3.0) and B- (2.5) or a C (2.0) and C- (1.5).

Metric Rating	Points
A	4.0
B	3.0
C	2.0
D	1.0

3.6 LANDSCAPE CONTEXT METRICS

LAN1 Contiguous Natural Land Cover

Definition: A measure of connectivity using the percent of natural habitat directly connected to the AA, including <u>optional</u> submetrics for the inner zone (0–100 m) and outer zone (100–500 m). Note that for large AAs (>50 ha), this metric is assessed at the scale of the entire AA, not for individual assessment points within the AA.

Background: This metric addresses the broader connectivity of the natural land cover by measuring the natural habitat that is directly contiguous to the AA. However, not all organisms and processes require directly contiguous habitat, and organisms perceive "connectivity" differently, so this metric may underestimate contiguous habitat for some organisms.

Apply To: All types.

Measurement Protocol: Select the statement that best describes the contiguous natural land cover within the 500 m zone that is <u>connected</u> to the AA. First, identify the percent of land cover that is directly connected to the AA within the 0-500 m area zone the AA. If you choose to use subzones, measure the inner (100 m) and outer (100-500 m) landscapes separately and then select the rating that best describes the integration of those two measures for the final rating. To measure natural land cover, it is recommended to use NatureServe's Ecological Systems map (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states) as a foundation for measurement. However, the National Land Cover database (http://www.mrlc.gov/nlcd2011.php) may also be used. Ground truthing is also advisable since remote sensing data sources may misinterpret some land cover types. Water is included with terrestrial natural land cover. Where water may be a degrading factor (e.g., a wetland next to a boat club may be exposed to excessive wave action), it can be accounted for in other metrics (i.e., Land Use Index and Buffer Condition). Well-traveled dirt roads and major canals break up unfragmented blocks, but vegetated two-track roads, hiking trails, hayfields, low fences and small ditches may be included. Table 13 provides guidance for distinguishing natural from non-natural land cover). See Figure 2 for an example.

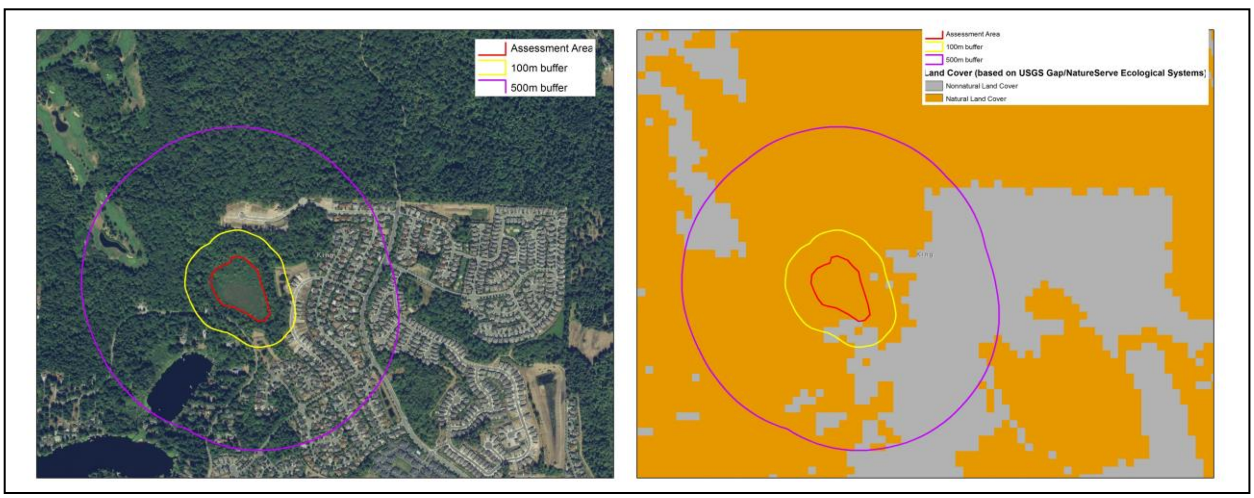


Figure 2. Contiguous Natural Land Cover evaluation based on percent natural vegetation that is directly connected to the AA. LEFT: aerial imagery showing the assessment area (red line), 100 m inner landscape (yellow line), and 500 m outer landscape (purple line). RIGHT: NatureServe's Ecological System map is used to show location of natural and non-natural land cover types (The Ecological System's map shows finer-scale categories which were lumped as natural and non-natural for this exercise). The recent aerial imagery on the left shows that there has been development since the Ecological System's map was produced (or that the Ecological System's map incorrectly classified some areas.) Based on these maps, it appears that over 90% of the natural land cover within the inner landscape is directly connected to the AA and thus would be given an "A" rating. After considering the discrepancies between the two maps, the outer landscape was rated as a "C" (the Ecological Systems map seems to mischaracterize some development on the south of the AA). The overall rating was estimated to be a "C".

Table 10. Contiguous Natural Cover Metric Rating.

	Contiguous Natural Cover	Overall	*Subzones*

Metric Rating			Inner Landscape (0-100 m)	Outer Landscape (100-500 m)
EXCELLENT (A)	**Intact:** Embedded in 90-100% natural land cover that is contiguous with the AA. Connectivity is expected to be high; remaining natural habitat is in good condition (low modification); and a mosaic with gradients.			
GOOD (B)	**Variegated:** Embedded in 60-90% natural land cover that is contiguous with the AA. Connectivity is generally high, but lower for species sensitive to habitat modification; remaining natural habitat with low to high modification and a mosaic that may have both gradients and abrupt boundaries.			
FAIR (C)	**Fragmented**: Embedded in 20-60% natural land cover that is contiguous with the AA. Connectivity is generally low, but varies with mobility of species and arrangement on landscape; remaining natural habitat with low to high modifications and gradients shortened.			
POOR (D)	**Relictual**: Embedded in < 20% natural land cover that is contiguous with the AA. Connectivity is essentially absent; remaining natural habitat generally highly modified and generally uniform.			

LAN2 Land Use Index (0-500 m)

Definition: This metric measures the intensity of human-dominated land uses in the surrounding landscape, including optional submetrics for the inner zone (0–100 m) and outer zone (100–500 m). For AAs based on points, the landscape may largely consist of the same wetland that the point lies within, rather than surrounding habitat; preliminary testing has shown that it may be desirable to extend the zone to 1000 m to ensure that more of the landscape outside the wetland polygon is accounted for (K. Walz pers. comm 2016).

Background: This metric is one aspect of the landscape context of specific stands or polygons of ecosystems. It is based on Hauer et al. (2002) and Mack (2006).

Apply To: All types.

Measurement Protocol: This metric documents the surrounding land use(s) within the inner and outer landscape areas. Ideally, both field data and remote sensing tools (e.g. aerial photography or satellite imagery) are used to identify an accurate percentage of each land use within the landscape area, but remote sensing data alone may also be used. To calculate a Total Land Use

Score, estimate the percent of each Land Use type and then plug the corresponding coefficient (found on the field form) into the following equation:

Sub-land use score = $\sum$ LU x PC/100

LU = Land Use weight for Land Use Type

PC = % of adjacent area in Land Use Type

Do this for each land use separately within the inner landscape (0 – 100 m) and outer landscape (100 - 500 m), then sum the Sub-Land Use Score to arrive at a Total Land Use Score across both areas. For example, if 30% of the Core Landscape area was moderately grazed (0.3 * 6 = 1.8), 10% composed of unpaved roads (0.1 * 1 = 0.1), and 60% was a natural area (e.g., no human land use) (1.0 * 6 = 6.0), the Total Core Landscape Land Use Score = 7.9 (1.8 + 0.1 + 6.0). The combined scores of the Inner and Outer Landscape are then plugged into a weighted calculation of the overall score. That score can then be rated using Table 12. See Figure 3 for an example.

Table 11. Land Use Index Table

Worksheet : Land Use Categories	Weight	Inner Landscape (0-100 m)		Outer Landscape (100-500 m)	
		% Area (0 to 1.0)	Score	% Area (0 to 1.0)	Score
Paved roads / parking lots	0				
Domestic, commercial, or publicly developed buildings and facilities (non-vegetated)	0				
Gravel pit / quarry / open pit / strip mining	0				
Unpaved roads (e.g., driveway, tractor trail, 4-wheel drive, logging roads)	1				
Agriculture: tilled crop production	2				
Intensively developed vegetation (golf courses, lawns, etc.)	2				
Vegetation conversion (chaining, cabling, roto-chopping, clearcut)	3				
Agriculture: permanent crop (vineyard, orchard, nursery, hayed pasture, etc.)	4				
Intense recreation (ATV use / camping / popular fishing spot, etc.)	4				
Military training areas (armor, mechanized)	4				
Heavy grazing by livestock on pastures or native rangeland	4				
Heavy logging or tree removal (50-75% of trees > 30 cm DBH removed)	5				
Commercial tree plantations / holiday tree farms	5				
Recent old fields and other disturbed fallow lands dominated by ruderal and exotic species	5				
Dam sites and flood disturbed shorelines around	5				

water storage reservoirs and motorized boating					
Moderate grazing of native grassland	6				
Moderate recreation (high-use trail)	7				
Mature old fields and other fallow lands with natural composition	7				
Selective logging or tree removal (< 50% of trees > 30 cm DBH removed)	8				
Light grazing or haying of native rangeland	9				
Light recreation (low-use trail)	9				
Natural area / land managed for native vegetation	10				
Total Land Use Score					
A = >9.5, B = 8.0-9.4, C = 4.0-7.9, D = < 4.0 **Total Land Use Rating**					
Combined Score (Inner score x 0.6)+(Outer Score X 0.4)					

Table 12. Metric Rating for Land Use Index

Metric Rating	***Rating Criteria***
EXCELLENT (A)	Average Land Use Score = 9.5-10
GOOD (B)	Average Land Use Score = 8.0-9.4
FAIR (C)	Average Land Use Score = 4.0-7.9
POOR (D)	Average Land Use Score = < 4.0

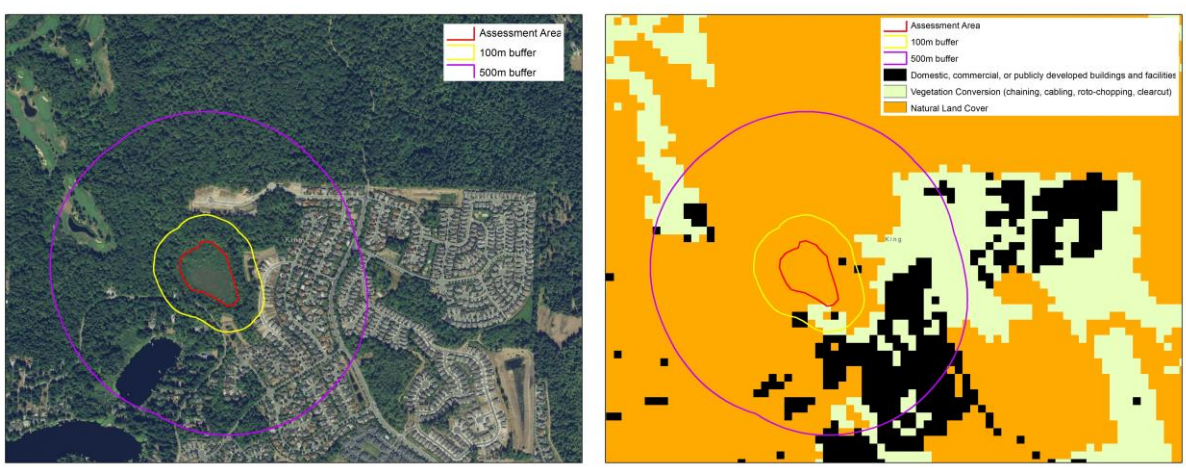


Figure 3. Application of land use coefficients to assess the Land Use Index metric in the inner and outer landscapes. The percent area of each land use is recorded and multiplied by the land use's weight. LEFT: aerial imagery showing the assessment area (red line), 100 m inner landscape (yellow line), and 500 m outer landscape (purple line). RIGHT: NatureServe's Ecological System map shows the various land uses (note: the labels shown on the map reflect those in Table 11 and not those in the original Ecological Systems map. Some interpretation between Table 11 and GIS data may be required.) The recent aerial imagery on the left shows that there has been some recent

development since the Ecological System's map was produced (or that the Ecological System's map incorrectly classified some areas). In fact, most of the area labeled as "Vegetation Conversion" in the southeast portion of the outer landscape is now development. As such, the following estimates were made: Inner landscape: 90% natural land cover/water, 10% roads or development. After consulting Table 11, the weights were plugged into the following formula (0.90*10)+(0.10*0)=9.0, which according to Table 12 is a "B" rating. Outer landscape: 60% natural land cover/water, 35% development, 5% vegetation conversion. After consulting Table 11, the weights were plugged into the following formula (0.60*10)+(0.35*0)+(0.05*3)=6.15, which according to Table 12 is a "C" rating. An overall rating was then calculated by the following formula: (9*0.6)+(6.15*0.4)=7.86, or a "C" rating.

3.7 BUFFER

For rapid assessments, we assess the buffer immediately surrounding the assessment area (within a 100 m zone), using 3 metrics: (B1) Perimeter with Natural Buffer, (B2) Width of Natural Buffer, and (B3) Condition of Natural Buffer. This final metric requires a field visit in combination with aerial photography. Wetland buffers are defined as the natural cover that surrounds a wetland. Note that the Land Use Index (L2) includes an evaluation of all land uses within the buffer zone (0–100 m), so it addresses the condition of the non-natural parts of the buffer.

BUF1 Perimeter with Natural Buffer

Definition: A measure of the overall area and condition of the natural buffer immediately surrounding (100 m radius) the assessment area, using the percent of the perimeter that borders a natural buffer.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) reviewed the critical role of buffers for wetlands. We assess key aspects of buffers within a 100 m zone, but add a surrounding landscape assessment that extends to 500 m from the AA edge (see metrics LAN1 and LAN2 above).

We only include natural habitats as part of the buffer, as these habitats should be most typical of the historical condition of the buffer (Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers). The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and system maps to the evaluation. This definition is also consistent with the use of natural habitats for other EIA metrics.

Apply To: All types.

Measurement Protocol: Estimate the length of the AA perimeter contiguous with a natural buffer. This can be done using remote sensing data and/or field-based observations. If remote sensing data are used, field verification is recommended. Use a 10 m minimum buffer depth width and length. Perimeter includes open water (Table 13;

Figure 4). Rate metric using Table 14.

Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers

Examples of Land Covers Included in Natural Buffers	Examples of Land Covers Excluded from Natural Buffers	Examples of Land Covers Crossing and Breaking Natural Buffers[4]
Natural or ruderal[1] plant communities; open water[2] vegetated levees; old fields; naturally vegetated rights-of-way; rough meadows; natural swales and ditches; native or naturalized rangeland and non-intensive plantations[3]	Parking lots; commercial and private developments; roads (all types), intensive agriculture; intensive plantations; orchards; vineyards; dry-land farming areas; railroads; planted pastures (e.g., from low intensity to high intensity horse paddock, feedlot, or turkey ranch); planted hayfields; lawns; sports fields; traditional golf courses; Conservation Reserve Program pastures	Bike trails; horse trails; dirt, gravel or paved roads; residential areas; bridges; culverts; paved creek fords; railroads; sound walls; fences that interfere with movements of water, sediment, or wildlife species that are critical to the overall functions of the wetland

[1]Ruderal plant communities: plant communities dominated or codominated by nonnative species OR communities dominated by native species, but resulting from past human stressors and possessing no natural analog. For example, areas previously plowed can be revegetated by native vegetation but their composition is unlike other plant communities. Novel ecosystems also fall into this category.

[2]Open Water: Some protocols exclude open water (such as lakes, large rivers, or lagoons) from the buffer because the water quality or water disturbance regimes (natural waves vs. boat traffic waves) may or may not be in good condition. Here we include open water as part of the buffer. If desired, the condition of the open water can be assessed using the Buffer Condition submetric (3c).

[3]Plantations: Logged and replanted areas in which the overstory is allowed to mature and may regain some native component, and in which the understory of saplings, shrubs, and herbs are native or naturalized species and not strongly manipulated (i.e., they are not “row-crop tree plantings” with little to no vegetation in the understory, typical of intensive plantations).

[4]Land cover that breaks natural buffers: These land covers are added to the land covers excluded from natural buffers, so that, collectively, they may contribute to a 5 m break in the buffer.

Table 14. Buffer Perimeter Rating

Metric Rating	Percent of AA with Natural Buffer
EXCELLENT (A)	Natural buffer is 100% of AA perimeter
GOOD (B)	Natural Buffer is 75-99% of AA perimeter
FAIR (C)	Natural Buffer is 25-75% of AA perimeter
POOR (D)	Natural Buffer is < 25% of AA perimeter

BUF2 Width of Natural Buffer Width

Definition: A measure of the average width of natural buffer, extending from the edge of the Assessment Area to a maximum distance of 100 m.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) has reviewed the critical role of buffers for wetlands. We assess key aspects of buffer within a 100 m zone, but add a surrounding landscape assessment that extends to 500 m from the AA edge (see metrics LAN1 and LAN2 above).

We only include natural habitats as part of the buffer, as these habitats would be most typical of the historical condition of the buffer (Table 13. Guidelines for identifying wetland buffers and breaks in natural buffers). The definition of natural habitats corresponds with that of the USNVC (i.e., both native habitat and ruderal habitats, including naturally invaded or degraded native habitats), thereby permitting a direct application of NVC and system maps to the evaluation (see Table 13). This definition is also consistent with the use of natural habitats for other EIA metrics.

Apply To: All types.

Measurement Protocol: Two approaches: (1) Point-based or simple polygon AAs or (2) complex polygon AAs:

Point-based or simple polygon shapes: Metric is adapted from Collins et al. (2006) and USA RAM (2011).

1. Using the most recent aerials (or in GIS), draw eight straight lines radiating out from the approximate center of the AA in eight cardinal directions (N, NE, E, SE, S, SW, W, NW), each extending 100 m beyond the edge of the AA (Figure 5).
2. Measure the length of each line from the edge of the AA perimeter to the outer extent of the natural buffer and record on data form (see example in Table 15).
3. If desired, use the slope multipliers in
4. Table 18 to adjust the rating of upslope buffer widths. Multiply the multipliers by the buffer rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.

4\. Assign a metric score based on the average buffer width (Table 17).

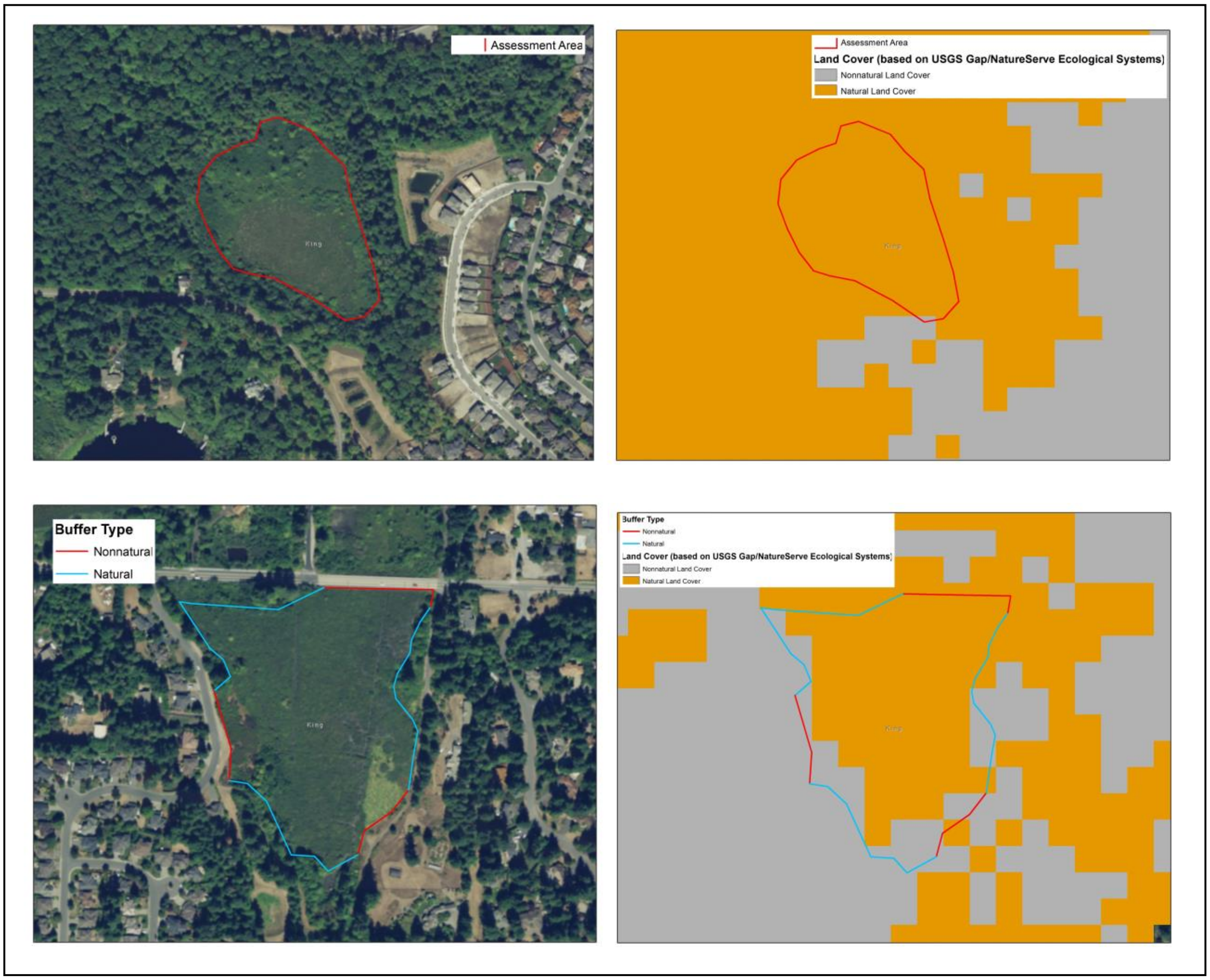


Figure 4. Buffer Perimeter Example. TOP LEFT: aerial imagery showing the assessment area (red line). TOP RIGHT: NatureServe's Ecological System map shows location of natural and non-natural land cover types (The Ecological System's map shows finer-scale categories which were lumped as natural and non-natural for this exercise). The Ecological System's map on the right suggests a small portion of the AA perimeter abuts non-natural land cover; however, the recent aerial imagery on the left suggest this is an error and that, in fact, the entire length of the AA perimeter (red line) abuts natural land cover. As such, it would be given an "A" rating. BOTTOM LEFT: aerial imagery shows portions of the perimeter without a natural buffer (red lines) and portions with a natural buffer (blue lines). BOTTOM RIGHT: NatureServe's Ecological System map is used to show location of natural and non-natural land cover types. Clearly the Ecological Systems map missed the major road on the north end of the AA and also mischaracterized some additional areas. The rating for this AA was estimated to be "C".

Table 15. Buffer Width Calculation (simple polygon example)

Line	Buffer Width (m) (max = 100 m)
1	0
2	0
3	42
4	14
5	100
6	31
7	0
8	43
Average Buffer Width (m)	**28.75**

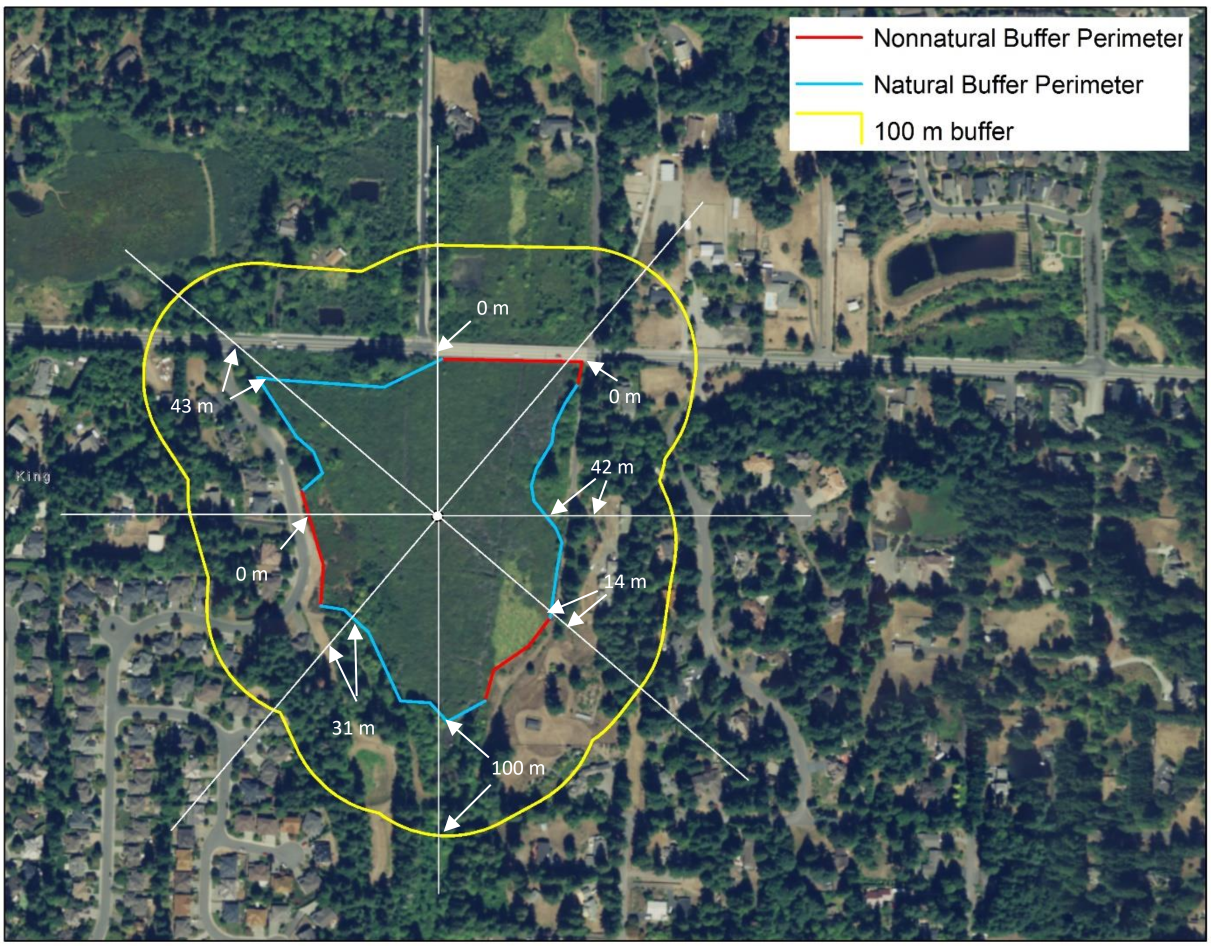


Figure 5. Buffer Width Calculation (point-based or simply polygons). The length of natural buffer is measured by calculating the distance between the edge of the AA and the 100 m buffer line along each of the eight white lines. Then an average is taken. In this example the calculation for average buffer length is (moving clockwise): (0+0+42+14+100+31+0+43)/8=28.75 m (**Table 15**). Consulting Table 17 this translates to a "C" rating.

<u>Complex polygon shapes</u>

1. For wetland polygons lacking a centroid from which eight spokes could reasonably radiate from, draw a line as near to the center of the wetland polygon's long axis as possible where the line follows the broad shape of the polygon, avoiding finer level twists and turns (Figure 6).
2. Once you have determined the length of the line along the wetland's long axis, divide the line by five, creating four equally spaced points along the axis. At each of the four points, draw a line perpendicular to the axis such that it extends out 100 m beyond each side of the AA's perimeter. For some arching wetlands that close back in on themselves, see guidance below to address situations that may arise from interior spokes (i.e., spokes radiating away from the wetland's interior arch).
   a. When two spokes cross one another, eliminate the spoke with the longer natural buffer width and locate a new spoke at the more northerly end of the AA's long axis; extend the axis 100 m beyond the AA perimeter to form new spoke.
   b. When a spoke heads back into the AA in less than 100 m, eliminate the spoke and locate a new spoke at the more northerly end of the AA's long axis.
   c. If two spokes need to be relocated, use both ends of the AA's long axis.
3. For spokes radiating out from the wetland's exterior arch, if the spoke begins to cross a smaller lobe of the system in less than 100 m, allow the spoke to continue in the same direction through the lobe and measure buffer width where the spoke can be extended beyond the lobe for 100 m (Figure 6).
4. For each of the eight spokes, determine the natural buffer width from the wetland's edge until either a non-buffer land cover is encountered in less than 100 m or 100 m of contiguous natural buffer width is measured.
5. Determine the average width of the buffer (Table 16).
6. If desired, use the slope multipliers in
7. Table 18 to adjust the rating of upslope buffer widths. Multiple the multipliers by the buffer rating values to get a new set of rating values. Slope can be estimated in the field or using imagery.
8. Assign a metric score based on the average buffer width (Table 17)

Table 16. Buffer Width Calculation (complex polygon example)

Spoke or Line	Buffer Width (out to a maximum of 100 m)
Single west terminal spoke	10
West exterior spoke	18
West interior spoke	100
West-central exterior spoke	0
West-central interior spoke	0
East-central exterior spoke	0
East-central interior spoke	Not Used
South-east exterior spoke	7
South-east interior spoke	10
Average Buffer Width (m)	**18**

Table 17. Buffer Width Rating

Metric Ratings	Average Natural Buffer Width (m)
EXCELLENT (A)	≥ 100 m, adjusted for slope.
GOOD (B)	75 -99 m, after adjusting for slope.
FAIR (C)	25-75 m, after adjusting for slope.
POOR (D)	< 25 m, after adjusting for slope.

Table 18. Slope Modifiers for Buffer Width

Slope Gradient	Additional Buffer Width Multiplier
5-14%	1.3
15-40%	1.4
> 40%	1.5

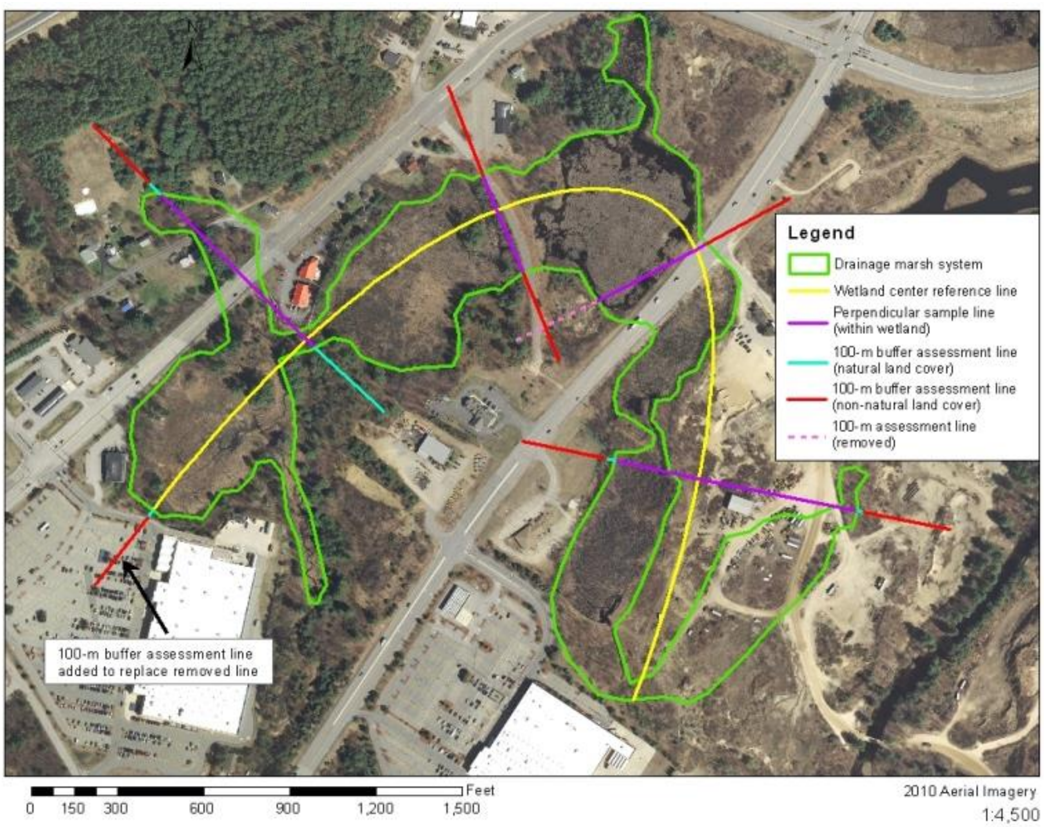


Figure 6. Buffer Width Calculation (complex polygon example). The eight spokes or lines are assessed for the buffer width. For example, the single west terminal spoke has a 10 m buffer. Once measured, average the eight buffer widths to calculate the average width of the buffer. Figure by Bill Nichols, New Hampshire Natural Heritage Program.

BUF3 Condition of Natural Buffer

Definition: A measure of the biotic and abiotic condition of the natural buffer, extending from the edge of the Assessment Area.

Background: The buffer is important to the biotic and abiotic aspects of the wetland. The Environmental Law Institute (2008) has reviewed the critical role of buffers for wetlands. We assess key aspects of the buffer within a 100 m zone.

Apply To: All types.

Measurement Protocol: Estimate the overall biotic and abiotic condition within that part of the perimeter that has a natural buffer. That is, if natural buffer length is only 30% of the perimeter, then assess condition within that 30%. Condition is based on percent cover of native vegetation, disruption to soils, signs of reduced water quality, amount of trash or refuse, various land uses, and intensity of human visitation and recreation, including from foot or boat traffic. The evaluation can be made by scanning an aerial photograph in the office, followed by ground truthing, as needed. Ground truthing could be made systematic by using the eight lines used to assess buffer width (BUF2).

Table 19. Condition of Natural Buffer Rating

Metric Ratings	Natural Buffer Condition
EXCELLENT (A)	Buffer is characterized by abundant (> 95%) cover of native vegetation, with intact soils, no evidence of loss in water quality, and little or no trash or refuse.
GOOD (B)	Buffer is characterized by substantial (75–95%) cover of native vegetation, intact or moderately disrupted soils, minor evidence of loss in water quality, moderate or lesser amounts of trash or refuse, and minor intensity of human visitation or recreation.
FAIR (C)	Buffer is characterized by a low (25–75%) cover of native vegetation, barren ground and moderate to highly compacted or otherwise disrupted soils, strong evidence of loss in water quality, with moderate to strong or greater amounts of trash or refuse, and moderate or greater intensity of human visitation or recreation.
POOR (D)	Very low (< 25%) cover of native plants, dominant (> 75%) cover of nonnative plants, extensive barren ground and highly compacted or otherwise disrupted soils, moderate - great amounts of trash, moderate or greater intensity of human visitation or recreation, OR no buffer at all.

3.8 VEGETATION

For various aspects of the vegetation metrics, variants based on USNVC Formation are used (Table 20).

Table 20. Metric Variants for Vegetation by USNVC Formation

METRIC	VEGETATION	VEGETATION
Metric Variant by NVC Formation Type	V3. Native Plant Species Composition	V4. Vegetation Structure*
Flooded & Swamp Forest Formation	v1*	v1
Freshwater Marsh, Wet Meadow and Shrubland Formation		V3
Salt Marsh Formation		V4
Bog and Fen Formation		V5
Aquatic Vegetation Formation		V6

* Metric can be refined at the Macrogroup or Group level of the NVC, or using Ecological Systems.

VEG1 Native Plant Species Cover

Definition: A measure of the relative percent cover of all plant species in the AA that are native to the region. The metric is typically calculated by estimating total absolute cover of all vegetation within each of the two major strata groups (tree and shrub/sapling + herbaceous) and expressing the total native species cover as a percentage of the total stratum cover. The stratum with the lowest percentage native cover is used as the basis for the score.

Background: This metric has been developed by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al. 2008). Nonvascular species are not included, desirable as that may be in some wetlands (especially bogs and fens), because of the difficulty of species identification and interpretation of what they indicate about ecological integrity.

Apply To: All types.

Measurement Protocol: This metric evaluates the relative percent cover of native species compared to all species (native and nonnative) for each of the three major strata (Native cover divided by / (Native + Nonnative cover) * 100). The protocol consists of a visual evaluation of native vs. nonnative species cover using midpoints of cover classes (on the field form). The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. First, using cover class values in Table 8, estimate the total cover of vegetation by summing species cover across strata and growth forms (e.g., cover of the tree, shrub/regeneration/vine, and herb strata, combining growth forms within the same strata). The total may easily exceed 100%. Next, estimate the total cover of each nonnative species in each stratum (on field form) and subtract these values from the total vegetation cover values to get the total native cover for each stratum. Divide the total native cover by the total vegetation cover and multiply by 100. This method can be used when all species, or only dominant species, are listed. Assign the score in Table 21 based on the stratum with the lowest percent of native plant species cover. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy types or large AAs, more than one plot may be desirable.

Table 21. Metric Ratings for Native Plant Cover (if scoring strata groups, choose lowest score between groups)

Rank	Main Metric Score	*Submetric: Tree Strata*	*Submetric: Shrub/Herb Strata*
Excellent (A) > 99% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Very Good (A-) 95-99% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Good (B) 85-94% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Fair (C) 60-84% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			
Poor (D) < 60% relative cover of native vascular plant species overall, OR in the key layer, either the tree stratum or shrub/herb strata, whichever is lower			

VEG2 Invasive Nonnative Plant Species Cover

Definition: The absolute percent cover of nonnative species that are considered invasive to the ecosystem being evaluated. Generally, an invasive species is defined as "*a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause environmental harm*…" (Executive Presidential Order 1999, Richardson et al. 2000), thus potentially including species native to a region, but invasive to a particular ecosystem in that region. However, here we treat those "native invasives" as "native increasers" under the Native Species Composition metric. Nonvascular species are not included, desirable as that may be in some wetlands (especially bogs and fens), because of the difficulty of species identification and interpretation of what they indicate about ecological integrity.

Background: This metric is a counterpart to "Relative Native Plant Species Cover," but "Nonnative Invasive Plant Species Cover" includes only <u>invasive</u> nonnatives, not all nonnatives. Even here, judgment may be required. For example, some species are native to a small part of a region--or have mixed genotypes of both native and nonnative forms--and are widely invasive (e.g., *Phragmites*). Field crews must be provided with a definitive list of what is considered a nonnative invasive in their project area.

The definition of invasive used here is related to the perceived impact that invasives have on ecosystem condition, or what Richardson et al. (2000) refer to as “transformers”. They distinguish invasives (naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants and thus have the potential to spread over a considerable area) from “transformers” (A subset of invasive plants that change the character, condition, form, or nature of ecosystems over a substantial area relative to the extent of that ecosystem). Although our definition is essentially equal to that of “transformers” in that we are concerned with those naturalized plants that cause ecological impacts, we retain the term “invasive” as the more widely used term. Our use of the term also equates to “harmful non-indigenous plants” of Snyder and Kaufman (2004):

> “Invasive species that are capable of invading natural plant communities where they displace indigenous species, contribute to species extinctions, alter the community structure, and may ultimately disrupt the function of ecosystem processes.”

Invasives are distinguished from “increasers,” which are native species present in an ecosystem that respond favorably to increasing human stressors. For example, *Juncus effusus* and *Juncus arcticus* (=*J. balticus*) are native species which respond favorably to anthropogenic disturbances. Another native increaser is *Typha latifolia*, a native cattail that increases in response to eutrophication. Native increasers are treated under the “Native Species Composition” metric.

Apply To: All types.

Measurement Protocol: A comprehensive list of nonnative invasive species must be established in order to make the application of this metric as consistent as possible. Nonnative invasive species for each wetland type are listed in Subgroup descriptions found in Rocchio et al. (2016b). The protocol uses a visual evaluation of absolute cover of invasive species listed in the appropriate Subgroup description in Rocchio et al. (2016b). The cover of nonnative invasive species is summed to produce the total cover of invasive plant species. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a “rapid” plot, but a single intensive plot can also be taken. If plot data are used for this metric, it is important that the plot is representative of the larger system being assessed. In patchy types or large AAs, more than one plot may be desirable.

Table 22. Invasive Species Metric Rating

Metric Rating	*Invasive Nonnative Plant Species Cover*: ALL WETLANDS
EXCELLENT (A)	Invasive nonnative plant species are absent from all strata or cover is very low (< 1% absolute cover).
GOOD (B)	Invasive nonnative plant species are present in at least one stratum, but sporadic (1-4 % cover).
FAIR (C)	Invasive nonnative plant species somewhat abundant in at least one stratum (4-10% cover).
FAIR/POOR (C-)	Invasive nonnative plant species are abundant in at least one stratum (10-30% cover).
POOR (D)	Invasive nonnative plant species are very abundant in at least one stratum (> 30% cover).

VEG3 Native Plant Species Composition

Definition: An assessment of overall species composition and diversity, including native diagnostic species and native increasers (e.g., "native invasives" of Richardson et al. 2000), and evidence of species-specific diseases or mortality.

Background: This metric evaluates the degree of degradation to the native plant species, including decline in native species diversity and loss of key diagnostic species, as well as shifting dominance caused by positive response to stressors by Native Increasers (a.k.a., "native invasives", aggressive natives, successful competitors). Increaser species are native species in the wetland whose dominance is indicative of degrading ecological conditions, such as heavy grazing or browse pressure (Daubenmire 1968). Native increasers often have FQA coefficients of conservatism ≤ 3. Native decreasers are those species that decline rapidly due to stressors (species sensitive to human-induced disturbance or those species with FQA coefficients of conservatism ≥ 7). Diagnostic species, or the characteristic combination of species, are native plant species whose relative constancy or abundance differentiates one vegetation type from another, including character species (strongly restricted to a type), differential species (higher constancy or abundance in a type as compared to others), constant species (typically found in a type, whether or not restricted), and dominant species (high abundance or cover) (FGDC 2008). Together these species also indicate certain ecological conditions, typically that of minimally disturbed sites. Information on diagnostic species for USNVC types is available from Subgroup descriptions (Rocchio et al. 2016b). Degrading conditions that lead to presence of nonnative invasive species are treated in the "Invasive Plant Species Cover" metric.

Apply To: All types.

Measurement Protocol: The protocol requires a visual evaluation of variation in overall composition. This metric requires the ability to recognize the major/dominant aquatic, wetland, and riparian plants species of each layer or stratum. The field survey method may be either (1) a Site Survey (semi-quantitative) method, in which the observers walk the entire occurrence (or assessment area within the occurrence) and make notes on native and total species cover, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. The plot or transect is typically a "rapid" plot, but a single intensive plot can also be taken. Using criteria in Table 23, assign ratings to submetrics on the field form.

Note: Native increasers can be difficult for many users to assess. This is because the presence of these species is not sufficient to indicate that they are acting as increasers. Rather, it is their relative proportion to what is expected that triggers such a designation. This concept tends to work well in wetlands exposed to conspicuous stressors such as livestock grazing where these species tend to dominate or become monocultures (e.g. *Iris missouriensis* or *Juncus arcticus* (=*J. balticus*)). If you find this submetric difficult to evaluate, make a note in the comment section and skip it.

Table 23. Native Plant Species Composition Rating Criteria

Metric Rating	*Vegetation Composition: ALL WETLANDS*
EXCELLENT (A)	**Native plant species composition (species abundance and diversity) minimally to not disturbed:** i) Typical range of native diagnostic species present; AND, ii) Native species sensitive to anthropogenic degradation (native decreasers) present, AND iii) Native species indicative of anthropogenic disturbance (i.e., increasers, weedy or ruderal species) absent to minor.
GOOD (B)	**Native plant species composition with minor disturbed conditions:** i) Some native diagnostic species absent or substantially reduced in abundance, OR ii) At least some native species sensitive to anthropogenic degradation (native decreasers) present, OR iii) Native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) are present with low cover
FAIR (C)	**Native plant species composition with moderately disturbed conditions:** i) Many native diagnostic species absent or substantially reduced in abundance, OR ii) No native species sensitive to anthropogenic degradation (native decreasers) present, OR iii) Native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) are present with moderate cover.

Metric Rating	*Vegetation Composition: ALL WETLANDS*
POOR (D)	**Native plant species composition with severely disturbed conditions:** i) Most or all native diagnostic species absent, a few may remain in very low abundance, OR ii) Native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) are present in high cover)

VEG4 Vegetation Structure

Definition: An assessment of the overall structural complexity of vegetation layers and growth forms, including presence of multiple strata, age and structural complexity of canopy layer, and evidence of the effects of disease or mortality on structure.

Background: This metric has been drafted by NatureServe's Ecological Integrity Assessment Working Group (Faber-Langendoen et al.2008).

Apply To: All types (variant differs by USNVC Formation).

Measurement Protocol: This metric evaluates the horizontal and vertical structure of the vegetation relative to the reference condition of the dominant growth forms' structural heterogeneity. For forested wetlands, the protocol uses a visual evaluation of variation in overall structure of the tree stratum, including size and density of tree canopy, overall canopy cover, frequency of canopy gaps with regeneration, and number of different size classes of stems. For non-forested systems, an evaluation of the integrity of dominant growth forms is made (e.g. whether shrubs have been removed, killed, or increased or herbaceous layer has been reduced or homogenized by anthropogenic stressors). The field survey data used for estimating structure may consist of either 1) qualitative data where the observers walk the entire AA and make notes on vegetation structure, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects. Metric ratings are scored using Table 24.

Table 24. Vegetation Structure Variant Rating Criteria. Variants are provided in six separate tables by NVC Vegetation Formation (V1: Flooded & Swamp Forest, V3: Freshwater Marsh, Wet Meadow & Shrubland, V4: Salt Marsh V5: Bog & Fen, V6: Aquatic Vegetation.

Metric Rating	*V1: Vegetation Structure Variant: FLOODED & SWAMP FOREST*
EXCELLENT (A)	FLOODED & SWAMP FOREST: <u>Canopy Structure</u>: Canopy a mosaic of patches of different ages or sizes. Gaps also of varying size. Number of medium live stems (30-50 cm /12-20 in DBH) and large live stems (> 50 cm/ > 20 in). DBH well within expected range. <u>Large live trees</u>: Large trees are present in mid- to late-seral stands and only a few if any large cut stumps. Large trees may be absent in early-seral stands, but if so, then large stumps are not present (or few) and evidence of natural disturbance event is present

Metric Rating	*V1: Vegetation Structure Variant: FLOODED & SWAMP FOREST*
	(e.g., large downed wood from wind storms or fire scars). Overall, no evidence of human-related degradation.
GOOD (B)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy largely heterogeneous in age or size. Number of live stems of medium and large size very near expected range. Large live trees: Considering the natural stand development stage, there are more large trees than large cut stumps. Some (10-30%) of the old trees have been harvested. Overall, evidence of human degradation includes minor cutting, browsing, or grazing.
FAIR (C)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy somewhat homogeneous in age or size. Number of live stems of medium and large size moderately below expected range. Large live trees: 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. Overall, evidence of human degradation includes moderate levels of cutting, browsing or grazing.
POOR (D)	FLOODED & SWAMP FOREST: Canopy Structure: Canopy very homogeneous, in age or size. Number of live stems of medium and large size substantially below expected range. Large Live Trees: Considering the natural stand development stage, most, if not all, old trees have been harvested. None or rare old trees present. Overall, evidence of human degradation includes major cutting, heavy browsing or grazing.

Metric Rating	*V3: Vegetation Structure Variant: FRESHWATER MARSH, WET MEADOW & SHRUBLAND*
EXCELLENT (A)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident. Shrub and herb strata contain expected levels of abundance and diversity (some tall and some short) and/or low cover of shrubs or trees, where appropriate. Shrubs (Spiraea or Rosa sp.) cover (< 5%) in wet prairies limited to streambanks or scattered small patches with no evidence of increasing due to lack of natural disturbances such as fire. Overall, no evidence of human-related degradation.
GOOD (B)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. Shrubs (Spiraea or Rosa sp.) cover (5-10%) in wet prairies due to fire suppression. Overall, evidence of degradation includes minor cutting, mowing, browsing, or grazing.
FAIR (C)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate (e.g., levels of grazing, mowing); Shrubs (Spiraea or Rosa sp.) cover (10-25%) in wet prairies due to fire suppression. Overall, evidence of degradation includes moderate levels of cutting, mowing, browsing or grazing.
POOR (D)	FRESHWATER MARSH, WET MEADOW & SHRUBLAND: Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong (e.g., levels of grazing, mowing). Shrubs (Spiraea or Rosa sp.) cover (> 25%) in

Metric Rating	*V3: Vegetation Structure Variant: FRESHWATER MARSH, WET MEADOW & SHRUBLAND*
	wet prairies due to fire suppression. Overall, evidence of human and degradation includes major cutting, mowing, browsing or grazing.

Metric Rating	*V4: Vegetation Structure Variant: SALT MARSH (salt/brackish marsh & shrubland) [Metric variant under development]*
EXCELLENT (A)	SALT MARSH: Vegetation structure is at or near minimally disturbed natural conditions. Overall, little to no structural indicators of degradation evident (e.g. cutting, mowing, browsing, or grazing).
GOOD (B)	SALT MARSH: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Overall, structural indicators of degradation are minor (e.g., cutting, mowing, browsing, or grazing).
FAIR (C)	SALT MARSH: Vegetation structure is moderately altered from minimally disturbed natural conditions. Overall, structural indicators of degradation are moderate (e.g., cutting, mowing, browsing, or grazing).
POOR (D)	SALT MARSH: Vegetation structure is substantially altered from minimally disturbed natural conditions. Overall, structural indicators of degradation are strong (e.g., cutting, mowing, browsing, or grazing).

Metric Rating	*V5: Vegetation Structure Variant: BOG & FEN*
EXCELLENT (A)	BOG & FEN: Peatland is supporting structure with little to no evident influence of negative anthropogenic factors. Overall, no evidence of human-related degradation. Tree structure: Some very wet peatlands may not have any woody vegetation or only scattered stunted individuals. Woody vegetation mortality is due to natural factors. The site is near minimally disturbed natural conditions. *Bogs/acidic fen*: When present, trees are represented by relatively short, stunted, bonsai-like trees with rounded tops, and furrowed bark (even in short, small diameter individuals). *Circumneutral/rich fens*: Tree species, when present, do not form a closed canopy. Shrub / herb structure: Shrub and herb strata contain expected levels of abundance and diversity (some tall and some short). *Bogs/acidic fen*: Shrubs are < 50 cm and open enough to allow for a nearly continuous ground cover of *Sphagnum* and expected feather mosses (e.g. *Pleurozium schreberi*). *Circumneutral/rich fens*: primarily short-statured vegetation (some are dominated by tall sedge species). Shrubs may be present as a mosaic with open areas or if more continuous then open enough for abundance understory of graminoids. Dominant species are active peat-formers (e.g. dense stands of *Carex, Eriophorum*, *Eleocharis quinqueflora*, etc.) Bryophyte structure: *Bogs/acidic fen*: *Sphagnum* is actively growing and abundant. *Sphagnum* is nearly continuous and growing around tree/shrub bases AND in low hummocks, hollows, or other low areas. Areas of degenerating S*phagnum* are expected, but never more than local, small patches and never from anthropogenic stressors such as trampling, hydroperiod shifts or change in water chemistry. *Circumneutral/rich fens:*

Metric Rating	*V5: Vegetation Structure Variant: BOG & FEN*
	There is a nearly continuous cover of actively growing mosses (except in tall sedge fens - which are naturally more vigorous, homogenous, and often with little bryophyte cover).
GOOD (B)	BOG & FEN: Generally, peatland structure has only minor negative anthropogenic influences present, or the site is still recovering from major past human disturbances. Mortality or degradation due to grazing, peat mining, limited timber harvesting, or other anthropogenic factors may be present, though not widespread. The site can be expected to meet minimally disturbed conditions in the near future if negative influences do not continue. Shrubs and herbs show minor alterations from expected conditions. Overall, evidence of degradation includes minor cutting, mowing, browsing, fire, or grazing. <u>Tree structure</u>: *Bogs/acidic fen*: Some trees may have been or killed due to anthropogenic stressors OR a few, young, vigorous trees with straight pointy leaders present. *Circumneutral/rich fens:* Few trees have been cut or killed due to anthropogenic stressors OR tree canopy is starting to close in a few areas due to a shift in hydrology or water chemistry from anthropogenic stressors. <u>Shrub / herb structure</u>: *Bogs/acidic fen*: A few areas of dense and tall shrubs (> 1 m) may occur (dense enough to eliminate *Sphagnum*/moss growth). *Circumneutral/rich fens*: Shrub density is starting to exclude graminoids in some areas due to a shift in hydrology or water chemistry from anthropogenic stressors. A few dense stands of non-peat forming species may be present to locally abundant due to a shift in hydrology or water chemistry from anthropogenic stressors. <u>Bryophyte structure</u>: Some areas are experiencing loss of moss cover due to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.
FAIR (C)	BOG & FEN: Peatland structure has been moderately influenced by negative anthropogenic factors. Expected structural classes are not present. Human factors may have diminished the condition of woody vegetation. The site will recover to minimally disturbed conditions only with the removal of degrading influences and moderate recovery times. Shrubs and herbs moderately altered from expected conditions. Overall, evidence of degradation includes moderate levels of cutting, mowing, browsing, fire or grazing. <u>Tree structure</u>: *Bogs/acidic fen*: Many trees have been cut or killed due to anthropogenic stressors OR many young, vigorous trees with straight pointy leaders present. *Circumneutral/rich fens:* Many trees have been cut or killed due to anthropogenic stressors OR tree canopy is closing in many areas due to a shift in hydrology or water chemistry from anthropogenic stressors. <u>Shrub / herb structure</u>: Shrubs and/or herbaceous cover somewhat reduced or killed due to anthropogenic stressors. *Bogs/acidic fen*: Shrub cover averages > 1 m tall and is so dense that it is reducing *Sphagnum* cover in many areas. *Circumneutral/rich fens*: Shrub density is excluding graminoids in many areas due to a shift in hydrology or water chemistry from anthropogenic stressors. Dominance of active peat-formers (e.g. dense stands of *Carex, Eriophorum*, *Eleocharis quinqueflora*, etc.) is being reduced in favor of non-peat-forming grasses and forbs due to a shift in hydrology or water chemistry from anthropogenic stressors.

Metric Rating	*V5: Vegetation Structure Variant: BOG & FEN*
	<u>Bryophyte structure</u>: Many areas are experiencing loss of moss cover due to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.
POOR (D)	BOG & FEN: Expected peatland structure is absent or much degraded due to anthropogenic factors, such as peat mining. Woody regeneration is minimal and existing structure is in poor condition, unnaturally sparse, or depauperate. Recovery to minimally disturbed condition is questionable without restoration, or will take many decades. Shrubs and herbs substantially altered from expected conditions. Overall, evidence of degradation includes major cutting, mowing, browsing, fire or grazing. <u>Tree structure</u>: *Bogs/acidic fen*: Most to all trees have been cut or killed due to anthropogenic stressors OR dense stands of young, vigorous trees with straight pointy leaders dominate much of the site. *Circumneutral/rich fens:* Many trees have been cut or killed due to anthropogenic stressors OR closed/nearly closed tree canopy dominates much of the site due to a shift in hydrology or water chemistry from anthropogenic stressors. <u>Shrub / herb structure</u>: Shrubs and/or herbaceous cover drastically reduced or killed by anthropogenic stressors. *Bogs/acidic fen*: Tall (averages > 1 m) dense shrubs dominate much of the site and have reduced *Sphagnum* cover in most areas. *Circumneutral/rich fens*: Shrub density is excluding graminoids in most areas and/or cover of active peat-formers (e.g. dense stands of *Carex, Eriophorum*, and moss cover) dramatically reduced and site is now dominated by non-peat-forming grasses and forbs due to a shift in hydrology or water chemistry from anthropogenic stressors. <u>Bryophyte structure</u>: Most areas have lost moss cover due to to increased shrub density, trampling, or a change in hydroperiod/water chemistry. In *Bogs/acidic fen* this is in reference to *Sphagnum*.

Metric Rating	*V6: Vegetation Structure Variant: AQUATIC VEGETATION [Metric variant under development]*
EXCELLENT (A)	AQUATIC VEGETATION: Vegetation structure is at or near minimally disturbed natural conditions. No structural indicators of degradation evident. Expected layers of free-floating (nonrooted and floating on water surface), floating-rooted (rooted with a conspicuous portion of vegetative plant body on water surface), and submergent vegetation (significant portion of vegetative plant body below surface) present.
GOOD (B)	AQUATIC VEGETATION: Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor. Minor changes to expected proportion of free-floating, floating-rooted, and submergent layers.
FAIR (C)	AQUATIC VEGETATION: Vegetation structure is moderately altered from minimally disturbed natural conditions. Structural indicators of degradation are moderate. Moderate changes to expected proportion of free-floating, floating-rooted, and submergent layers.
POOR (D)	AQUATIC VEGETATION: Vegetation structure is greatly altered from minimally disturbed natural conditions. Structural indicators of degradation are strong. Major changes to expected proportion of free-floating, floating-rooted, and submergent layers.

VEG5 Woody Regeneration (optional)

Definition An assessment of tree or tall shrub regeneration.

Background: This metric was developed by NatureServe and WNHP staff. It combines both structural and compositional information, in that regeneration abundance is assessed with respect to native woody species.

Apply To: *Required* for Flooded & Swamp Forest Formation. *Optional* for shrub-dominated types.

Measurement Protocol: This metric evaluates the tree regeneration layer (tree seedlings less than 1.3 m tall and saplings > 1.3 m tall and ≤ 10 cm DBH) and/or the shrub regeneration layer. The protocol is a visual evaluation of tree seedlings and saplings abundance and/or young shrub growth. Information concerning this metric can be gained from tables that describe composition using strata or growth forms (Jennings et al. 2009) (see Table V.2 above). The field survey method for estimating woody regeneration may be either (1) a Site Survey (semi-quantitative) method where the observers walk the entire AA and make notes on regeneration of woody species, or (2) Quantitative Plot Data, where a fixed area is surveyed, using either plots or transects. Metric ratings are scored using Table 26.

Table 25. Woody Regeneration Ratings. The metric is typically applied in forested wetlands, but can be used for shrublands, or any other wetland with woody vegetation.

Metric Rating	*Woody Regeneration: ALL WETLANDS*
EXCELLENT (A)	Native tree saplings and/or seedlings or shrubs common to the type present in expected amounts and diversity; obvious regeneration. *Bogs/acidic fen*: Tree regeneration is minimal and sporadic.
GOOD (B)	Native tree saplings and/or seedlings or shrubs common to the type present, but less common and less diversity than expected. *Bogs/acidic fen*: A few vigorous, young and tall trees may be present and don't appear to be as stressed as expected under peatland conditions.
FAIR (C)	Native tree saplings and/or seedling or shrubs common to the type present, but less common and less diversity; little regeneration. *Bogs/acidic fen*: Abundant vigorous, young, tall trees appear to have recently invaded and don't appear to be as stressed as expected.
POOR (D)	Essentially no regeneration of native woody species common to the type. *Bogs/acidic fen*: Site is dominated by vigorous, young trees that don't appear stressed.

VEG6 Coarse Woody Debris (optional)

Definition An assessment of the coarse woody debris, standing or fallen.

Background: Woody debris plays a critical role in a variety of wetland systems, especially riparian systems.

Apply To: *Required* for Flooded & Swamp Forest Formation. *Optional* for shrub-dominated types.

Measurement Protocol:
Forested wetlands
Pay special attention to the amount of coarse woody debris when surveying the AA. Select the statement from the rating table that best describes the amount of woody debris within the AA. Riverine wetlands that have incised banks, no longer experience flooding, experience overgrazing, or are no longer at a dynamic equilibrium may lack coarse woody debris.

Shrub and Herb wetlands
Note the quantity and distribution of litter compared with the baseline that may be expected in the landscape. Playas are typically low in litter; densely vegetated wetlands can be high in litter. Overgrazing, woody vegetation removal, and the presence of exotic earthworms can reduce and compact litter, while aggressive plant colonization or artificially reduced water levels can result in excessive litter. Excessive litter may choke out new growth and inhibit animal movement. Select the statement on the form that best describes the litter. Litter is often detached from the live plant, but dead plant material at the base of plants (growth from the prior year or before) is also considered litter. Be sure the assessment of litter is not based on seasonality (i.e., when a wetland is surveyed early in the year, the prior years' desiccated vegetation can appear more dense than later in the season because most new growth has yet to occur). Peatlands are dominated by peat-forming species which contribute enough litter and debris to maintain carbon dynamics.

Estimation of coarse woody debris may be based on either 1) qualitative data, where the observers walk the entire AA and make notes on vegetation strata, their cover, and exotic species, using tables such as shown in Table 8.1 or 8.2 above, or 2) quantitative data, where a fixed area is surveyed, using either plots or transects.

Table 26. Coarse Woody Debris Ratings

Metric Rating	*V1: Coarse Woody Debris variant: FLOODED & SWAMP FOREST*
EXCELLENT/GOOD (A/B)	CWD: Wide size-class diversity of CWD (downed logs); CWD in various stages of decay. CWD in various stages of decay Snags: Wide size-class diversity of standing snags. Larger size class (> 30 cm (12 in) DBH and > 2 m (6 ft) long) present with 5 or more snags per ha (2.5 ac), but not excessive numbers (suggesting disease or other problems).
FAIR (C)	CWD: Moderate size-class diversity of downed CWD.

	Snags: Moderate size-class diversity of standing snags. Larger size class present with 1-4 snags per ha, or moderately excessive numbers (suggesting disease or other problems).
POOR (D)	CWD: Low size-class diversity of downed CWD. CWD mostly in early stages of decay. Snags: Low size-class diversity of snags. Larger size class present with < 1 snag per ha, or very excessive numbers (suggesting disease or other problems).

Metric Rating	*V2: Coarse Woody Debris variant: FRESHWATER MARSH, WET MEADOW & SHRUBLAND, BOG & FEN [metric variant under development]*
EXCELLENT (A)	Coarse woody debris, litter and other organic inputs are typical of the system (e.g., playas should have low litter, whereas meadows and marshes have moderate amounts of litter).
GOOD (B)	Standing snags, dead shrubs, down woody debris and litter show minor alterations to system.
FAIR (C)	Standing snags, dead shrubs, down woody debris and litter show moderate alterations to system.
POOR (D)	Standing snags, dead shrubs, down woody debris and litter show substantial alterations to system.

3.9 HYDROLOGY

Ratings for the hydrology metrics are based on HGM Classes (Table 27). The three metrics we use are not strictly independent. Hydrology is a complicated ecological factor to measure during a rapid assessment, and users will find that their evaluation of one metric partly relates to another. A simple way to portray the primary focus of each metric is as follows:

- Water Source: water coming into the wetland.
- Hydroperiod: water patterns within the wetland, regardless of source.
- Connectivity: water exchange between wetland and surrounding systems, regardless of patterns within the wetland.

Table 27. Hydrological metric variants by HGM Class

METRIC	HYDROLOGY		
Metric Variant by Hydrogeomorphic Class	H1. Water Source	H2. Hydroperiod	H3. Hydrologic Connectivity
Riverine (Non-tidal)	V1	V1	V1
Organic Soil Flats, Mineral Soil Flats	V2	V2	V2
Depression, Lacustrine, Slope	V3	V3	V3
Estuarine Fringe (Tidal)	V4	V4	V4

HYD1 Water Source

Definition: An assessment of the direct inputs of water into, or diversions of water away from, the wetland.

Background: Water Source encompasses the forms, or places, of direct inputs of water to the AA, as well as any unnatural diversions of water from the AA. Diversions are considered an impact to natural water sources because they directly affect the hydrology of the AA.

Apply To: All types (variant differs by HGM class).

Measurement Protocol: This metric can be assessed initially in the office using available imagery, and then revised based on the field visit. The metric focuses on direct sources of tidal and non-tidal water, comparing the natural sources to unnatural sources listed in Table 28.

Table 28. List of Water Sources

Overbank flooding	Precipitation	Irrigation via tail water run-off
Alluvial aquifer	Snowmelt	Urban run-off / culverts
Groundwater discharge	Irrigation via direct application	Pipes (directly feeding wetland)
Natural surface flow	Irrigation via seepage	Other:

The office assessment can work outward from the AA to include identification of unnatural water sources, such as adjacent intensive development or irrigated agriculture, nearby wastewater treatment plants, and nearby reservoirs. These sources identified in the office can then be checked in the field. Assign metric rating based on criteria in Table 29.

Table 29. Water Source Variant Rating Criteria. Separate metric ratings are provided for Riverine (Non-tidal), Organic and Mineral Soil Flats, Depression, Lacustrine, & Slope, and Estuarine Fringe (Tidal).

Metric Rating	*V1: Water Source variant: RIVERINE (Non-tidal) Wetlands*
EXCELLENT (A)	Water source is natural; site hydrology is dominated by precipitation, groundwater, or overbank flow. There is no indication of direct artificial water sources. Land use in the local drainage area of the wetland is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
GOOD (B)	Water source is mostly natural, but wetland directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed or agricultural land (< 20%) in the immediate drainage area of the wetland, some road runoff, small storm drains, or other minor point source discharges emptying into the wetland.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources. Indications from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin, or moderate point source discharges into or adjacent to the site, such as many small storm drains, or a few large ones. The key factors to consider are whether the wetland is located in a topographic position that supported wetlands before development AND whether the wetland is still connected

Metric Rating	*V1: Water Source variant: RIVERINE (Non-tidal) Wetlands*
	to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).
POOR (D-)	Water source contains a substantial amount of inflow from anthropogenic sources. Indications of anthropogenic sources include > 60% developed or agricultural land adjacent to the wetland and major point source discharges into or adjacent to the wetland.

Metric Rating	*V2: Water Source variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	Water source is natural and site hydrology is dominated by precipitation. There is no indication of direct artificial water sources. Land use in the local drainage area of the site is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
GOOD (B)	Water source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources, or is ditched, causing peatland to dry out more quickly. Indications of anthropogenic input include developed land or agricultural land (< 20%) in the immediate drainage area of the site; or the presence of small storm drains, ditches, or other local discharges emptying into the site; road runoff; or the presence of scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the site.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin, or the presence of many small storm drains, or a few large ones. The key factors to consider are whether the wetland is located in a topographic position that supported wetlands before development AND whether the wetland is still connected to its natural water source (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).
FAIRLY POOR (C-)	Water source is moderately impacted by increased inputs into the peatland, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include > 20% developed or agricultural land adjacent to the site, and the presence of major point sources that discharge into or adjacent to the site.
POOR (D)	Water source is substantially impacted by impoundments or diversions of water or other inputs into or withdrawals directly from the site, its encompassing wetland, or from areas adjacent to the site or its wetland.

Metric Rating	*V3: Water Source variant: OTHER HGM (DEPRESSION, LACUSTRINE, SLOPE)*
EXCELLENT (A)	Water source is natural: Site hydrology is dominated by precipitation, groundwater, or natural runoff from an adjacent freshwater body. There is no indication of direct artificial water sources. Land use in the local drainage area of the site is primarily open space or low density, passive uses. Lacks point source discharges into or adjacent to the site.
GOOD (B)	Water source is mostly natural, but site directly receives occasional or small amounts of inflow from anthropogenic sources. Indications of anthropogenic input include developed land or agricultural land (< 20%) in the immediate drainage area of the site, small storm drains or other local discharges emptying into the site, road runoff, or scattered homes along the wetland that probably have septic systems. No large point sources discharge into or adjacent to the site.
FAIR (C)	Water sources are moderately impacted by anthropogenic sources, but are still a mix of natural and non-natural sources. Indications of moderate contribution from anthropogenic sources include developed land or irrigated agriculture that comprises 20–60% of the immediate drainage basin or many small storm drains or a few large ones. The key factors to consider are whether the wetland is located in a topographic position supported wetland before development AND whether the wetland is still receiving a modified source of water (e.g., modified ponds on a floodplain that are still connected to alluvial aquifers, natural stream channels that now receive substantial irrigation return flows).
POOR (D)	Water source is primarily from anthropogenic sources (e.g., urban runoff, direct irrigation, pumped water, artificially impounded water, or other artificial hydrology. Indications of substantial artificial hydrology include > 60% developed or agricultural land adjacent to the site and the presence of major point sources that discharge into or adjacent to the site.

Metric Rating	*V4: Water Source: ESTUARINE FRINGE (Tidal) Wetlands*
EXCELLENT (A)	Tidal and non-tidal water sources are natural with no artificial alterations to natural salinity; no indication of direct artificial water sources (e.g., no tide gates, land use in the local drainage area of the wetland is primarily open space or low density, passive uses). Lacks point source discharges into or adjacent to the wetland.
GOOD (B)	Tidal and non-tidal water sources are mostly natural, with minor alterations to natural salinity. Site directly receives occasional or small continuous amounts of inflow from anthropogenic sources; indicators include < 20% of core landscape is agricultural or developed land, road runoff, storm drains, or other minor discharges emptying into the wetland.
FAIR (C)	Tidal and non-tidal water sources are moderately impacted by human activity; indicators of anthropogenic input include 20-60% developed or agricultural land adjacent to the site, including direct irrigation or pumped water, moderate amounts of road runoff, moderately sized storm drains, and/or moderate point source discharges into or adjacent to the wetland.
POOR (D)	Tidal and non-tidal water sources are substantially impacted by human activity. Indicators of anthropogenic input include > 60% developed or agricultural land adjacent to the site,

Metric Rating	*V4: Water Source: ESTUARINE FRINGE (Tidal) Wetlands*
	large amounts of road runoff, large-sized storm drains, and major point source discharges into or adjacent to the wetland.

HYD2 Hydroperiod

Definition: An assessment of the characteristic frequency and duration of inundation or saturation of a wetland during a typical year.

Background: Hydroperiod integrates the inflows and outflows of water and varies by major wetland type. For tidal wetlands, there are many hydroperiod cycles corresponding to different periodicities in the orbital relationships among the earth, moon, and sun, creating a variety of tidal patterns at semi-daily, daily, semi-weekly, monthly, seasonal, and annual timeframes. For non-tidal wetlands with fluctuating hydroperiods, such as depressional, lacustrine, riverine, and mineral flats wetlands, cycles are governed by seasonal or annual patterns of rainfall and temperature. For non-tidal wetlands with more stable, saturated hydroperiods, such as groundwater-fed slope wetlands, these seasonal patterns are often overridden by groundwater flows. Lagoons can be episodically subjected to tidal inundation, but may otherwise have similar hydroperiods to lacustrine systems (Collins et al. 2006).

Apply To: All types (variant differs by HGM class).

Measurement Protocol: This metric evaluates recent changes in the hydroperiod, and the degree to which these changes affect the structure and composition of the wetland plant community. Common indicators are presented for the different wetland classes. A basic understanding of the natural hydrology or channel dynamics of the wetland type being evaluated is required to apply this metric.

<u>Measurement Protocols for Tidal Wetlands (Estuarine)</u>

Collins et al. (2006) describe the hydroperiod of estuaries:

> "The volume of water that flows into and from an estuarine wetland due to the changing stage of the tide is termed the "tidal prism". This volume of water consists of inputs from both tidal (i.e., marine) and non-tidal (e.g., fluvial or upland) sources. The timing, duration, and frequency of inundation of the wetland by these waters is termed the tidal hydroperiod. Under natural conditions, increases in tidal prism result in increases in sedimentation, such that increases in hydroperiod do not persist. For example, estuarine marshes tend to build upward in quasi-equilibrium with sea level rise. A decrease in tidal prism usually results in a decrease in hydroperiod. In lagoons, freshwater inputs are substantial and tidal prisms are altered by

barriers to tidal inputs, which may occasionally be breached by occasional winds driving overwash across the tidal barrier or by seepage through the tidal barrier, etc."

To score this metric, visually survey the AA for field indicators of alterations to the estuarine hydroperiod (i.e., a change in the tidal prism; Collins et al. 2006), then use the Variant 4 Hyperiod Rating Table:

Condition	Hydroperiod Field Indicators for Evaluating Tidal Wetlands (Estuarine)
Stressors to tidal prism	• Changes in the relative abundance of plants indicative of either high or low marsh. • A preponderance of shrink cracks or dried pannes is indicative of decreased hydroperiod. • Inadequate tidal flushing may be indicated by algal blooms or by encroachment of freshwater vegetation. • Dikes, levees, ponds, ditches, and tide control structures are indicators of an altered hydroperiod resulting from management for flood control, salt production, waterfowl hunting, boating, etc.

Measurement Protocols for Non-Tidal Wetlands

Riverine (non-tidal): To score this metric, visually survey the AA for field indicators of aggradation or degradation (Table 30). After reviewing the entire AA and comparing the conditions to those described in the table, determine whether the AA is in equilibrium, aggrading, or degrading, then assign a metric rating based on criteria in Table 33.

Table 30. Riverine Hydroperiod Field Indicators (adapted from Collins et. al. 2006)

Condition	Hydroperiod Field Indicators for Evaluating Riverine Wetlands
Indicators of Channel Equilibrium	• The channel (or multiple channels in braided systems) has a well-defined usual high water line, or bankfull stage, that is clearly indicated by an obvious floodplain. A topographic bench represents an abrupt change in the cross-sectional profile of the channel throughout most of the site. • The usual high water line or bankfull stage corresponds to the lower limit of riparian vascular vegetation. • The channel contains embedded woody debris of the size and amount consistent with what is available in the riparian area. • There is little or no active undercutting or burial of riparian vegetation.
Indicators of Active Degradation (Erosion)	• Portions of the channel are characterized by deeply undercut banks with exposed living roots of trees or shrubs. There are abundant bank slides or slumps, or the banks are uniformly scoured and unvegetated.

Condition	Hydroperiod Field Indicators for Evaluating Riverine Wetlands
	• Riparian vegetation may be declining in stature or vigor, and/or riparian trees and shrubs may be falling into the channel. • The channel bed lacks any fine-grained sediment. • Recently active flow pathways appear to have coalesced into one channel (i.e., a previously braided system is no longer braided).
Indicators of Active Aggradation (Sedimentation)	• The channel through the site lacks a well-defined usual high water line. • There is an active floodplain with fresh splays of sediment covering older soils or recent vegetation. • There are partially buried tree trunks or shrubs. • Cobbles and/or coarse gravels have recently been deposited on the floodplain. • There are partially buried, or sediment-choked, culverts.

Non-Riverine (non-tidal): Assessment of the hydroperiod for all non-riverine wetlands should be initiated with an office-based review of diversions or augmentations of flows or alteration of saturated conditions to the wetland. Field indicators are listed in Table 31 and should be used to help assign a metric rating based on criteria in Table 33.

Table 31. Non-riverine, non-tidal Hydroperiod Field Indicators (adapted from Collins et. al. 2006).

Condition	Hydroperiod Field Indicators for Evaluating Non-Riverine, Non-tidal Freshwater Wetlands
Reduced Extent and Duration of Inundation or Saturation	• Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland. • Evidence of aquatic wildlife mortality. • Encroachment of terrestrial vegetation. • Stress or mortality of hydrophytes. • Compressed or reduced plant zonation. • Organic soils occurring well above contemporary water tables.
Increased Extent and Duration of Inundation or Saturation	• Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps). • Diversions, ditching, or draining into the wetland. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation. • Extensive fine-grain deposits on the wetland margins.

Organic Soil Flats. Bogs have a very stable, saturated hydroperiod, or a much reduced cycle of saturation and partial drying. Because drying is limited to the upper layers of peat, bogs are rarely subject to fires, which can burn woody vegetation and upper peat layers when they do occur. The hydroperiod can be altered by ditches, which further increase drying of the peat layer, or by increased runoff into the system. If weakly minerotrophic (and not truly ombrotrophic), as occurs in poor fens, runoff can lead to nutrient enrichment. Surface removal of vegetation through peat mining may also alter the hydrology of the remainder of the bog by reducing evapotranspiration. Field indicators of alteration are show in Table 32 and should be used to assign metric rating based on criteria in Table 33.

Table 32. Organic Soil Flat Hydroperiod Field Indicators (adapted from Collins et. al. 2006).

Condition	Hydroperiod Field Indicators for Evaluating Organic Soil Flat
Reduced Extent and Duration of Saturation	• Upstream spring boxes, diversions, impoundments, pumps, ditching, or draining from the wetland. • Water withdrawal (regional or local wells) • Evidence of aquatic wildlife mortality. • Encroachment of terrestrial vegetation. • Encroachment of young, tall, vigorous trees • Stress or mortality of hydrophytes. • Drying or mortality of non-vascular species (e.g. *Sphagnum*) • Compressed or reduced plant zonation. • Dense, tall shrubs shading out underlying mosses • Organic soils occurring well above contemporary water tables.
Increased Extent and Duration of Saturation	• Berms, dikes, or other water control features that increase duration of ponding (e.g., pumps). • Diversions, ditching, or draining into the wetland. • Late-season vitality of annual vegetation. • Recently drowned riparian or terrestrial vegetation (e.g. Beaver created impoundment)

Table 33. Hydroperiod Metric Rating Criteria.

Metric Rating	*V1: Hydroperiod variant: RIVERINE (Non-tidal)*
EXCELLENT (A)	Hydroperiod (flood frequency, duration, level, and timing) is characterized by natural patterns, with no major hydrologic stressors present. The channel/riparian zone is characterized by equilibrium conditions, with no evidence of severe aggradation or degradation (based on the field indicators listed in Table 13.1).
GOOD (B)	Hydroperiod inundation and drying patterns (flood frequency, duration, level, and timing) deviate slightly from natural conditions due to presence of stressors such as: flood control dams upstream or downstream, small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). The channel/riparian zone is characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching an equilibrium form (based on the field indicators listed in Table 30).
FAIR (C)	Hydroperiod filling or inundation and drying patterns (flood frequency, duration, level, and timing) deviate moderately from natural conditions due to presence of stressors such as: flood control dams upstream or downstream moderately affect hydroperiod ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for

Metric Rating	*V1: Hydroperiod variant: RIVERINE (Non-tidal)*
	base stream flow, but not flood flow; moderate pugging by livestock that could channelize or divert water; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. The channel/riparian zone is characterized by severe aggradation or degradation (based on the field indicators listed in Table 30).
POOR (D)	Hydroperiod filling or inundation and drawdown (flood frequency, duration, level, and timing) deviate substantially from natural conditions because of high intensity alterations such as: flood control dams upstream or downstream moderately affect hydroperiod; a 4-lane highway; diversions > 3ft. deep that withdraw a significant portion of flow; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not connected to any natural seasonal fluctuations, but the hydroperiod supports natural functioning of the wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. Riverine wetlands may run dry during critical times. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. The channel is concrete or artificially hardened (see field indicators in Table 30).

Metric Rating	*V2: Hydroperiod variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	Hydroperiod is characterized by natural patterns of filling, inundation, saturation, and drying or drawdowns. There are no major hydrologic stressors that impact the natural hydroperiod (see field indicators listed in Table 31 and Table 32)
GOOD (B)	Hydroperiod filling or inundation patterns deviate slightly from natural conditions due to presence of stressors such as: small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. Outlets may be slightly constricted. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). Minor altered inflows or drawdown/drying (e.g., ditching) (see field indicators listed in Table 31 and Table 32)
FAIR (C)	Hydroperiod filling or inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow, but not flood flow; moderate pugging by livestock that could channelize or divert water; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. Moderately altered by increased runoff, or drawdown and drying (e.g., ditching). (see field indicators listed in Table 31 and Table 32)

Metric Rating	*V2: Hydroperiod variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
POOR (D)	Hydroperiod filling or inundation and drawdown deviate substantially from natural conditions from high intensity alterations such as: a 4-lane highway; large dikes impounding water; diversions > 3 ft. deep that withdraw a significant portion of flow; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not connected to any natural seasonal fluctuations, but the hydroperiod supports natural functioning of the wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. Substantially altered by increased inflow from runoff, or significant drawdown and drying (e.g., ditching-see field indicators listed in Table 31 and Table 32)

Metric Rating	*V3: Hydroperiod variant: DEPRESSION, LACUSTRINE, SLOPE (including Playas)*
EXCELLENT (A)	Hydroperiod characterized by natural patterns associated with inundation – drawdown, saturation, and seepage discharge. There are no major hydrologic stressors that impact the natural hydroperiod (see field indicators listed in Table 31).
GOOD (B)	Hydroperiod filling or inundation patterns deviate slightly from natural conditions due to presence of stressors such as: small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions. Outlets may be slightly constricted. Playas are not significantly impacted, pitted, or dissected. If wetland is artificially controlled, the management regime closely mimics a natural analog (it is very unusual for a purely artificial wetland to be rated in this category). Some alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 31).
FAIR (C)	Hydroperiod filling or inundation and drying patterns deviate moderately from natural conditions due to presence of stressors such as: ditches or diversions 1–3 ft. deep; two lane roads; culverts adequate for base stream flow but not flood flow; moderate pugging by livestock that could channelize or divert water; shallow pits within playas; or moderate flow additions. Outlets may be moderately constricted, but flow is still possible. If wetland is artificially controlled, the management regime approaches a natural analog. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels. Moderate alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 31).
POOR (D)	Hydroperiod filling or inundation and drawdown of the AA deviate substantially from natural conditions due to high intensity alterations such as: a 4-lane highway; large dikes impounding water; diversions > 3 ft. deep that withdraw a significant portion of flow; deep pits in playas; large amounts of fill; significant artificial groundwater pumping; or heavy flow additions. Outlets may be significantly constricted, blocking most flow. If wetland is artificially controlled, the site is actively managed and not

Metric Rating	*V3: Hydroperiod variant: DEPRESSION, LACUSTRINE, SLOPE (including Playas)*
	connected to any natural season fluctuations, but the hydroperiod supports natural functioning of the wetland. Hydroperiod is dramatically different from natural. Upstream diversions severely stress the wetland. Riverine wetlands may run dry during critical times. If wetland is artificially controlled, hydroperiod does not mimic natural seasonality. Site is actively managed for filling or drawing down without regard for natural wetland functioning. Significant alteration to the natural patterns associated with inundation – drawdown, saturation, and seepage discharge (see field indicators listed in Table 31).

Metric Rating	*V4: Hydroperiod variant: ESTUARINE FRINGE (Tidal*)
EXCELLENT (A)	Area is subject to the full tidal prism, with two daily tidal minima and maxima. Storm tides, tidal river flooding and onshore wind-maintained high tides causing short-term changes in tidal amplitude are within the expected norm. Lagoons: Area subject to natural inter-annual tidal fluctuations (range may be severely muted or vary seasonally), and is episodically fully tidal by natural breaching or overwash due to fluvial flooding, storm surge or wind-driven tides (extreme highs or lows).
GOOD (B)	Area is subject to somewhat reduced, or muted tidal prism, although two daily minima and maxima are observed. Lagoons: Area is subject to full tidal range more often than would be expected under natural circumstances due to artificial breaching of the tidal barrier.
FAIR (C)	Area is subject to moderately muted tidal prism, with tidal fluctuations evident only in relation to extreme daily highs or spring tides. Lagoons: Area is subject to full tidal range less often than would be expected under natural circumstances due to management of the breach to prevent its opening.
POOR (D)	Area is subject to substantially muted tidal prism; there is inadequate drainage, such that the marsh tends to remain flooded during low tide. Lagoons: Area appears to have no episodes of full tidal exchange.

HYD3 Hydrologic Connectivity

Definition: An assessment of the ability of the water to flow into or out of the wetland, or to inundate adjacent areas.

Background: Metric is adapted from Collins et al. (2006), with additional metric variants added.

Apply To: All types (variant differs by HGM class).

Measurement Protocol: Scoring of this metric is based solely on field observations. No office work is required. The metric is assessed in the field by observing signs of alteration to horizontal water movement within the assessment area. For riverine wetlands and riparian habitats, Hydrologic Connectivity is assessed in part based on the degree of alteration of flooding regimes (e.g., channel entrenchment). Entrenchment varies naturally with channel confinement. Channels in steep canyons naturally tend to be confined, and tend to have small entrenchment ratios indicating less hydrologic connectivity. Assessments of hydrologic connectivity based on entrenchment must therefore be adjusted for channel confinement based on the geomorphic setting of the riverine wetlands. Prevention of river flooding by human-created levees and dikes, or impairments caused by rivershore rip-rap, are other ways in which changes to hydrological connectivity can be assessed (Collins et al. 2006). Natural levees may form as part of river dynamics, and may be breached during natural flooding events, also altering connectivity. Their form is distinct from human-created levees, helping to minimize misidentification. Assign metric rating using appropriate variant rating criteria in Table 34.

Table 34. Hydrologic Connectivity Variant Rating Criteria

Metric Rating	*V1: Hydrologic Connectivity variant: RIVERINE (Non-tidal)*
EXCELLENT (A)	Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel is not unnaturally entrenched.
GOOD (B)	Minimally disconnected from floodplain. Up to 25% of stream banks are affected due to dikes, rip rap and/or elevated culverts. Channel is somewhat entrenched (overbank flow occurs during most floods).
FAIR (C)	Moderately disconnected from floodplain due to multiple geomorphic modifications. Between 25-75% of stream banks are affected (e.g., dikes, tide gates, rip rap, concrete, and elevated culverts). Channel is moderately entrenched (overbank flow only occurs during moderate to severe floods).
POOR (D)	Channel is severely entrenched and entirely or extensively disconnected from the floodplain; > 75% of stream banks are affected due to dikes, tide gates, rip rap, concrete, and elevated culverts. Channel is substantially entrenched (overbank flow never occurs or only during severe floods).

Metric Rating	*V2: Hydrologic Connectivity variant: ORGANIC SOIL FLATS, MINERAL SOIL FLATS*
EXCELLENT (A)	No or very little direct connectivity to groundwater. Precipitation is the dominant or only source. Surrounding land cover / vegetation does not interrupt surface flow. No artificial channels feed water to wetland.
GOOD (B)	Minor hydrological connectivity, as caused by human activity (e.g., ditching). Surrounding land cover / vegetation does not interrupt surface flow. Artificial channels may feed minor amounts of excess water to wetland.
FAIR (C)	Moderate connectivity caused by human activity (e.g., ditching). Surrounding land cover / vegetation may interrupt surface flow. Artificial channels may feed moderate amounts of excess water to wetland.
POOR (D)	Substantial to full connectivity caused by human activity. Surrounding land cover / vegetation may dramatically restrict surface flow. Artificial channels may feed significant amounts of excess water to wetland.

Metric Rating	*V3: Hydrologic Connectivity variant: DEPRESSION, LACUSTRINE, SLOPE*
EXCELLENT (A)	No unnatural obstructions to lateral or vertical movement of ground or surface water, or if perched water table, then impermeable soil layer (fragipan or duripan) intact. 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.
GOOD (B)	Minor restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Less than 25% of the site is restricted by barriers to drainage. If perched, impermeable soil layer partly disturbed (e.g., from drilling or blasting). 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. Artificial channels may feed minor amounts of excess water to wetland.
FAIR (C)	Moderate restrictions to the lateral or vertical movement of ground or surface waters by unnatural features, such as levees or excessively high banks. Between 25-75% of the site is restricted by barriers to drainage. If perched, impermeable soil layer moderately disturbed (e.g., by drilling or blasting). Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment. Artificial channels may feed moderate amounts of excess water to wetland.
POOR (D)	Essentially no hydrologic connection to adjacent wetlands or uplands. Most or all water stages are contained within artificial banks, levees, sea walls, or comparable features. Greater than 75% of wetland is restricted by barriers to drainage. If perched, impermeable soil layer strongly disturbed. Artificial channels may feed significant amounts of excess water to wetland.

Metric Rating	*V4: Hydrologic Connectivity variant: ESTUARINE FRINGE (Tidal)*
EXCELLENT (A)	Tidal channel sinuosity reflects natural processes; absence of channelization. Marsh receives unimpeded tidal flooding. Total absence of tide gates, flaps, dikes, culverts, or human-made channels.
GOOD (B)	Tidal channel sinuosity minimally altered: Marsh receives essentially unimpeded tidal flooding, with few tidal channels blocked by dikes or tide gates, and human-made channels are few. Culvert, if present, is of large diameter and does not significantly change tidal flow, as evidenced by similar vegetation on either side of the culvert.
FAIR (C)	Tidal channel sinuosity moderately altered: Marsh channels are frequently blocked by dikes or tide gates. Tidal flooding is somewhat impeded by small culvert size, as evidenced in obvious differences in vegetation on either side of the culvert.
POOR (D)	Tidal channel sinuosity extensively altered: Tidal channels are extensively blocked by dikes and tide gates; evidence of extensive human channelization. Tidal flooding is totally, or almost totally, impeded by tidal gates or obstructed culverts.

3. 10 SOIL / SUBSTRATE

Conducting rapid assessment of soil condition in wetlands is challenging, and here we limit the assessment to visible evidence of soil surface or soil profile alterations that degrade the soil structure.

Note: Wetlands naturally have varying water quality states, including a range of natural pH and salinity. Their water quality can also differ dramatically over the course of the growing season as runoff increases or decreases and water levels rise and fall. Two water quality metrics, surface water turbidity/pollutants and algal growth, have been tested but were found to be too difficult to assess to be practical for a rapid assessment (Faber-Langendoen et al. 2012a).

Table 35. Soil metric variants by USNVC Formation

Metric Variant by NVC Formation Type	S1. Soil Surface Condition
Flooded & Swamp Forest Formation	v1
Freshwater Marsh, Wet Meadow and Shrubland Formation	v1 or v2 (freshwater tidal)
Salt Marsh Formation	v2
Bog and Fen Formation	V1
Aquatic Vegetation Formation	V1

SOI1 Soil Condition

Definition: An indirect measure of soil condition based on stressors that increase the potential for erosion or sedimentation, assessed by evaluating intensity of human impacts to soils on the site.

Background: This metric is partly based on one developed by Mack (2001) and the NatureServe Ecological Integrity Working Group (Faber-Langendoen et al. 2008). This metric has also been called "Substrate / Soil Disturbance."

Apply To: All types (variant differs by USNVC formation).

Measurement Protocol: Prior to fieldwork, aerial photography of the site can be reviewed to determine if any soil alterations have occurred, but the primary assessment is based on field observations of the AA. Assign metric rating based on appropriate variant rating criteria in Table 36.

Table 36. Soil Condition Variant Rating Criteria

Metric Rating	***V1: Soil Surface Condition variant: ALL FRESHWATER NON-TIDAL WETLANDS*** (FLOODED & SWAMP FOREST, FRESHWATER MARSH, WET MEADOW & SHRUBLAND, BOG & FEN, AQUATIC VEGETATION)
EXCELLENT (A)	Little bare soil OR bare soil and soil disturbed areas are limited to naturally caused disturbances such as flood deposition or game trails OR soil is naturally bare (e.g., playas). No disturbances are evident from trampling, erosion, soil compaction, ruts, sedimentation, invasive earthworms, or boat traffic. *Peatlands*: peat surface almost entirely covered by bryophytes or dense graminoid growth. Any bare areas of peat are due to natural disturbances such as animal trails, windthrow, ponded water, etc.

GOOD (B)	Small amounts of bare or disturbed soil are present, but the extent and impact is minimal. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance is limited to only several centimeters (a few inches) and does not show evidence of ponding or channeling of water. *Peatlands*: Bare peat may be present but not widespread and results from grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.
FAIR (C)	Moderate amounts of bare or disturbed soil are present and the extent and impact is moderate. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance may extend 5–10 cm (2–4 inches), with localized deeper ruts, and shows some evidence of ponding or channeling of water. *Peatlands*: Ground cover has as much bare peat as moss or graminoid cover due to grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.
POOR (D)	Substantial amounts of bare or disturbed soil are present, with extensive and long lasting impacts. Examples include disturbance from cattle (trampling or heavy grazing that leads to erosion), compaction or trampling by machinery, ruts or other disturbances from ATV or other vehicular activity, sedimentation due to human causes, invasive earthworms, or effects of boat traffic. The depth of disturbance extends > 10 cm (4 inches); deeper ruts may be widespread and show some evidence of extensively altering hydrology (e.g., ponding or channeling of water). *Peatlands*: Ground cover is almost all bare peat due to grazing, limited timber harvesting, trampling, anthropogenic fire or other anthropogenic factors.

Metric Rating	***V2: Soil Surface Condition variant: ESTUARINE WETLANDS*** (MANGROVE, SALT MARSH, and tidal variants of FRESHWATER MARSH, WET MEADOW & SHRUBLAND)
EXCELLENT (A)	Excluding mud flats, bare or disturbed soils are naturally occurring and largely limited to salt pannes.
GOOD (B)	Small amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).
FAIR (C)	Moderate amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).

Metric Rating	*V2: Soil Surface Condition variant: ESTUARINE WETLANDS* (MANGROVE, SALT MARSH, and tidal variants of FRESHWATER MARSH, WET MEADOW & SHRUBLAND)
POOR (D)	Substantial amounts of bare or disturbed soil areas caused by rafts of anthropogenic debris (killing marsh vegetation and creating artificial pannes), ditch spoils impounding water and forming artificial pannes, trampling by livestock, and erosion of marsh and channel banks due to excavation by marine traffic and/or altered current/tidal patterns resulting from deficient culverts (leading to erosion).

3.11 SIZE

The role of size in EIAs varies depending on the application. Inventory or monitoring programs that focus on the condition of wetlands across watersheds or jurisdictions, with an emphasis on statistical design, often rely on a point based sampling approach (e.g. a 0.5 ha AA). In this case, the overall wetland size is typically not used to evaluate the wetland. Conversely, programs that focus on identifying wetlands as entire polygons, with an emphasis on the condition of the polygon, more typically consider the size of the wetland as important to its overall integrity. Size does interact with landscape context, such that small occurrences embedded in entirely natural landscapes do not, necessarily, have less ecological integrity than a larger example in the same landscape. Conversely, a large occurrence in a fragmented landscape is likely to be more buffered from landscape stressors than a small one in a similarly fragmented landscape. Thus, a scorecard should give careful consideration to the appropriate manner in which to score size, taking into account this suite of contextual factors.

SIZ1 Comparative Size (Patch Type)

Definition: A measure of the current absolute size (ha) of the entire wetland type polygon or patch. The metric is assessed either with respect to expected patch-type sizes for the type across its range, or as a comparative size based on size distribution.

Background: This metric accounts for one aspect of the size of specific occurrences of a wetland type. Assessors are sometimes hesitant to use patch size as part of an EIA out of concern that a small, high quality example will be down-ranked unnecessarily. We address these concerns, to a degree, by providing an absolute patch-type scale, so that types that typically occur as small patches (seeps & springs) can use a different rating than types that may occur over large, extensive areas (e.g., marshes or boreal bogs/fens). Size is also more accurately assessed at finer scales of classification (e.g., Systems or Groups, rather than Formations).

Apply To: All types (variant differs by patchy type). Not used for point-based, fixed area AAs.

Measurement Protocol:

(1) Determine Spatial Size. It is important to know the spatial pattern typical of the wetland type being assessed (Table 37). This should be based on knowledge of the typical sizes of mid- to broad-scale ecological types (Formations, Groups, Systems) found in excellent condition. Table 40 shows the patterns for Washington wetland types.

Table 37. Patch type definitions that characterize the spatial patterning of ecosystems (ecological community and system types) (Comer et al. 2003).

PATCH TYPE	DEFINITION
Matrix	Ecosystems that form extensive and contiguous cover, occur on the most extensive landforms, and typically have wide ecological tolerances. Disturbance patches typically occupy a relatively small percentage (e.g., < 5%) of the total occurrence. In undisturbed conditions, **typical occurrences range in size from 2,000–10,000 ha (100 km^2) (5000 – 25,000 ac) or more.**
Large Patch	Ecosystems that form large areas of interrupted cover and typically have narrower ranges of ecological tolerances than matrix types. Individual disturbance events tend to occupy patches that can encompass a large proportion of the overall occurrence (e.g., > 20%). Given common disturbance dynamics, these types may tend to shift somewhat in location within large landscapes over time spans of several hundred years. In undisturbed conditions**, typical occurrences range from 50–2,000 ha (125-5,000 ac).**
Small Patch	Ecosystems that form small, discrete areas of vegetation cover, typically limited in distribution by localized environmental features. In undisturbed conditions, **typical occurrences range from 1–50 ha (3 – 125 ac).**
Linear	Ecosystems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions**, typical occurrences range in linear distance from 0.5–100 km (1 – 60 mi).**

(2) Rate Size As Informed by Patch Type**.** Use Table 40 to assign a Spatial Pattern Size Metric Rating based on the wetland's patch type. Compare this to the Comparative Size Metric Rating from Table 38. Essentially, the rating from Table 40 is the same as Table 38.

For fragmented occurrences made up of several disjunct AAs, the Comparative Size Metric is scored based on the aggregate of all AAs AND the single largest one. If these are different, assign a range rating (e.g. if the aggregate results in a 'B' rating but the largest patch would only receive a 'C' rating on its own, the resulting rating is 'BC'; if they both come out as 'B', then the overall score is also 'B'.

Table 38. Comparative Size Metric Rating: Comparative.

Metric Rating	*Comparative Size: ALL WETLANDS*
EXCELLENT (A)	Very large size compared to other examples of the same type, based on current and historical spatial patterns (and meeting the requirements for all, or almost all, of the area-sensitive indicator species dependent on the system, if within range)

Metric Rating	*Comparative Size: ALL WETLANDS*
GOOD (B)	Large size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for some of the area-sensitive indicator species; i.e., they are likely to be absent, if within range[1]).
FAIR (C)	Medium to small size compared to other examples of the same type, based on current and historical spatial patterns (and not meeting the requirements for several to many of the area-sensitive indicator species, if within range[1]).
POOR (D)	Small to very small size, based on current and historical spatial patterns (and not meeting the requirements for most to all area-sensitive indicator species, if within range[1]).

[1] if known, record the area-dependent species that are missing.

SIZ2 Change in Size (optional)

Definition: A measure of the current size of the wetland divided by the historical wetland size (within most recent period of intensive settlement, or 200 years), multiplied by 100.

Background: This metric is one aspect of the size of specific occurrences of a wetland type, it assesses the relative proportion of the AA that has been converted or destroyed compared to its original extent.

Apply To: All types (variant differs by patchy type). Not used for point-based, fixed area AAs.

Measurement Protocol: Relative size can be measured in GIS using aerial photographs, orthophoto quads, National Wetland Inventory maps, or other data layers. Field assessments of current size may be required since it can be difficult to discern the historical area of the wetland from remote sensing data. However, use of old aerial photographs may also be helpful, as they may show the historical extent of a wetland. Relative size can also be estimated in the field using 7.5 minute topographic quads, NPS Vegetation maps, National Wetland Inventory maps, or a global positioning system. Wetland boundaries are not delineated using jurisdictional methods (U.S. Army Corps of Engineers 1987); rather, they are delineated by ecological guidelines for delineating the boundaries of the wetland type, based on a standard wetland classification. The definition of the "historical" timeframe will vary by region, but generally refers to the intensive Euro-American settlement that began in the 1600s in the eastern United States and extended westward into the 1800s. If the historical time frame is unclear, use a minimum of a 50-year time period--long enough to ensure that the effects of wetland loss are well-established and the wetland has essentially adjusted to the change in size. Assign the rating based on Table 39.

Table 39. Change in Size Metric Rating

Metric Rating	*Change in Size: ALL WETLANDS*
EXCELLENT (A)	Occurrence is at, or only minimally reduced[1] (< 5%) from its original, natural extent. See note below for interpretation of "reduction."

GOOD (B)	Occurrence is only somewhat reduced (5-10%) from its original natural extent.
FAIR (C)	Occurrence is modestly reduced (10-30%) from its original natural extent.
POOR (D)	Occurrence is substantially reduced (> 30%) from its original natural extent.

[1]Note: Reduction in size for metric ratings A-D can include conversion or disturbance (e.g., changes in hydrology due to roads, impoundments, development, human-induced drainage; or changes caused by recent cutting). Assigning a metric rating depends on the degree of reduction.

Table 40. Spatial Pattern Size Metric Rating: Area by Spatial Pattern of Type.

Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (hectares)*					
Spatial Pattern Type	**Large Patch (ha)** No large patch wetlands are known to occur in Washington.	**Medium-Small Patch (ha)** (salt marsh, intertidal)	**Small Patch (ha)** (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	**Very Small Patch (m^2)** (seep/spring, horizontal wet sparse, vernal pool)	**Very Small Patch (m)** (vertical wet sparse)	**Linear (length in km)** (riparian)
EXCELLENT (A)	> 125	> 50	> 10	> 300 m^2	> 20 m high	> 5 km
GOOD (B)	25-125	10-50	2-10	200-300 m^2	10-20 m high	1-5 km
FAIR (C)	5-25	2-10	0.5-2	100-200 m^2	5-10 m high	0.1-1 km
POOR (D)	< 5	< 2	0.5	< 100 m^2	< 5 m high	< 0.1 km

OR

Metric Rating	*COMPARATIVE SIZE BY PATCH TYPE (acres)*					
Spatial Pattern Type	**Large Patch (ac)** No large patch wetlands are known to occur in Washington.	**Medium-Small Patch (ac)** (salt marsh, intertidal)	**Small Patch (ac)** (forested/shrub swamp, greasewood flat; marsh/meadow, peatland, aquatic bed, playa, interdunal, mudflat, and eelgrass)	**Very Small Patch (m^2)** (seep/spring, horizontal wet sparse, vernal pool)	**Very Small Patch (m)** (vertical wet sparse)	**Linear (length in km)** (riparian)
EXCELLENT (A)	> 300	> 125	> 25	> 300 m^2	> 20 m high	> 3 mi
GOOD (B)	60-300	25-125	5-25	200-300 m^2	10-20 m high	0.6-3 mi
FAIR (C)	12-60	5-25	1-5	100-200 m^2	5-10 m high	0.06-0.6 mi
POOR (D)	< 12	< 5	1	< 100 m^2	< 5 m high	< 0.06 mi

4.0 Calculate EIA Score and Determine Wetland of High Conservation Value Status.

4.1 Ecological Integrity Assessment Scorecard

The major components of the EIA include three primary rank factors (landscape context, on-site condition, and size) which are subdivided into six major ecological factors of landscape, buffer, vegetation, hydrology, soils, and size. Together these are the components that capture the structure, composition, processes, and connectivity of an ecological system. Whether one needs to roll up scores is dependent on the project objective. Land managers may only be interested in the metric scores, as they provide insight into management needs, goals, and measures of success. On the other hand, if the goal is to compare or prioritize sites for conservation, restoration, or management actions, then an overall EIA score/rank may be needed. Primary and major ecological factor scores/ranks can be helpful for understanding current status of primary ecological drivers. Details on the scorecard are provided in Faber-Langendoen et al. (2016b).

Landscape context metrics address the "outer workings" while on-site condition metrics measure the "inner workings" of a wetland. A third primary rank factor, the size of an ecosystem patch or occurrence, helps to characterize patterns of diversity, area-dependent species, and resistance to stressors. Addressing all of these characteristics and processes will contribute not only to understanding the current levels of ecological integrity, but to the resilience of the ecosystem in the face of climate change and other global stressors.

A point-based approach is used to facilitate integration of metrics into an overall rating. Undue emphasis should not be placed on numerical scoring--it is the overall rating that matters. Although metric ratings and scores are primarily based on a four part scale (Table 9), when two or more metrics are used to score a major ecological factor, a 7-part scale (A+, A-, B+, B-, C+, C-, D) can be informative. A "rounded" 4 part scale (A, B, C, D) can still be applied (Table 41).

Table 41. Ratings and Points for Ecological Integrity, Primary Rank Factors, and Major Ecological Factors.

EIA and Factor Rating*	*7 Part Scale*	*Metric Rating*	*4 Part Scale*
A+	3.8 - 4.00	A (Excellent)	3.5 - 4.0
A-	3.5 - 3.79		
B+	3.0 - 3.49	B (Good)	2.5 - 3.49
B-	2.5 - 2.99		
C+	2.0 - 2.49	C (Fair)	1.5 - 2.49
C-	1.5 - 1.99		
D	1 - 1.49	D (Poor)	1.0 - 1.49

*This scale is applied to the overall EIA, as well as Primary Rank Factors and Major Ecological Factors.

4.2 Calculate Major Ecological Factor (MEF) Scores and Ratings

Below are instructions on how to calculate each Major Ecological Factor score. Once scores are calculated, their associated ratings can be found Table 42.

Table 42. Conversion of Major Ecological Factor Scores/Ratings

Score/Rating Conversions for Major Ecological Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.2.1 Landscape Context MEF Score/Rating

To calculate the Landscape Context MEF score, take the average of LAN1 and LAN2 metrics. Enter the score and associated rating on the field form.

4.2.2 Buffer MEF Score/Rating

The Buffer MEF score is calculated by first taking the geometric mean of BUF1 and BUF2 scores. Then the geometric mean of that result and BUF3 is used as the Buffer MEF score. A geometric mean gives greater weight to the lower of the two values. Enter the score and associated rating on the field form.

4.2.3 Vegetation MEF Score/Rating

For non-forested wetland types, the Vegetation MEF score is calculated by taking the average of VEG1+VEG2+VEG3+VEG4. Enter the score and associated rating on the field form.

For forested wetland types, Vegetation MEF score is calculated by taking the average of VEG1+VEG2+VEG3+VEG4+VEG5+VEG6. Enter the score and associated rating on the field form.

4.2.4 Hydrology MEF Score/Rating

The Hydrology MEF score is calculated by taking the average of HYD1+HYD2+HYD3. Enter the score and associated rating on the field form.

4.2.5 Soils MEF Score/Rating

The Soil MEF score is simply the score for SOI1. Enter the score and associated rating on the field form.

4.2.6 Size MEF Score/Rating

The Size MEF score is either simply the score for SIZ1 or, if also using SIZ2, then the average of SIZ1 and SIZ2. Enter the score and associated rating on the field form.

4.3 Calculate Primary Factor Scores

Below are instructions on how to calculate each of Primary Factor score. Once scores are calculated, their associated ratings can be found in Table 45.

Table 43. Conversion of Primary Factor Scores/Ratings

Score/Rating Conversions for Primary Factors							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.3.1 Landscape Context Primary Factor Score/Rating

The Landscape Context Primary Factor score is calculated by the following formula: (Buffer MEF score*0.77) + (Landscape Context MEF score*0.33). Enter the score and associated rating on the field form.

4.3.2 Condition Primary Factor Score/Rating

The Condition Primary Factor score is calculated by the following formula: (Vegetation MEF score*0.55) + (Hydrology MEF score*0.35) + (Soil MEF score*0.10). Enter the score and associated rating on the field form.

4.3.3 Size Primary Factor Score/Rating

The Size Primary Factor score is equivalent to the Size MEF score. Enter the score and associated rating on the field form.

4.4 Calculate Overall Ecological Integrity Assessment Score/Rating

The overall Ecological Integrity Assessment (EIA) score is calculated using only Landscape Context and Condition Primary Factor scores with the following formula: (Condition Primary Factor score*0.7) + (Landscape Context Primary Factor score*0.3). The associated rating for the score is found in Table 44. Enter the score and associated rating on the field form.

Table 44. Conversion of Overall Ecological Integrity Assessment Scores/Ratings

Score/Rating Conversions for Overall Ecological Integrity							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

Size is not used for the EIA score, as the role of patch size in assessing ecological integrity is not as straightforward as landscape context and condition. For some ecosystem types, patch size can vary widely for entirely natural reasons (e.g., a forest type may have very large occurrences on rolling landscapes, and be restricted in other landscapes to small occurrences on north slopes or ravines). Thus, smaller sites are not necessarily a result of degradation in ecological integrity. On the other hand, size overlaps with landscape context as a factor, where the more fragmented the landscape surrounding a wetland is, the more size becomes important in reducing edge effects or buffering the overall stand.

Thus, whereas from an EIA rating perspective, we can develop vegetation, soil, hydrology, and landscape metric ratings based on ecological considerations (e.g., we can establish the ecological criteria for which buffers are effective), it is harder to do so for size. Instead, Size is used as an additional factor to help prioritize sites for conservation actions (see below).

4.5 Calculate The Element Occurrence Rank

Ecological Integrity Assessment (EIA) scores and Element Occurrence Ranks (EORANKS) are closely related. The EIA score provides a succinct assessment of the current ecological condition and landscape context of a wetland. For conservation purposes, we often want to do more than that; namely, we want to establish its conservation value. The Element Occurrence (EO) is a core part of Natural Heritage Methodology and is defined as follows:

> *An **Element Occurrence** (EO) is an area of land and/or water in which a species or ecosystem (natural community, vegetation type or Ecological System) element is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential continued (or historical) presence and/or regular recurrence at a given location. For ecosystem types ("elements"), the EO may represent a single stand or patch or a cluster of stands or patches of an ecosystem. (NatureServe 2002).*

In the context of this document, an EO is a stand of a wetland Subgroup or USNVC plant association. Thus, the EORANK is important for determining whether a site meets the Wetland of High Conservation Value criteria (see below).

For the EORANK approach, EIAs are foundational, but more is needed to determine the practical conservation value for an ecosystem. In particular, size plays a more substantial role in the EORANK process than in other applications of EIAs. This is because for many conservation purposes, larger observations are considered more important and more likely to retain their integrity than smaller observations. For some types, diversity of animals or plants may be higher in larger occurrences than in smaller occurrences that are otherwise similar. Larger occurrences often have more microhabitat features and are more resistant to hydrologic stressors or invasion by exotics, because they buffer their own interior portions. Thus, size can serve as a readily measured proxy for some ecological processes and for the diversity of interdependent assemblages of plants and animals. Even here, caution is needed, for although size helps identify higher diversity sites, higher diversity *per se* is not always tied to ecological integrity (i.e., sites vary naturally with respect to levels of diversity and size).

To calculate EORANK, points are added to the EIA score based on the wetland's patch size (Table 40) and Size Primary Factor rating (Table 45). The associated rating for the score is found in Table 46. Enter the score and associated rating on the field form.

Table 45. Point Contribution of Size Primary Factor Score

Size Primary Factor Rating	Very Small/Small Patch	Large Patch	Matrix
A = Size meets A ranked rating	+ 0.75	+ 1.0	+1.5
B = Size meets B ranked rating	+ 0.25	+ 0.33	+0.5
C = Size meets C ranked rating	- 0.25	- 0.33	-0.5
D = Size meets D ranked rating	- 0.75	-1.0	-1.5

Table 46. Conversion of EORANK Scores/Ratings

Score/Rating Conversions for EORANK							
Rank	A+	A-	B+	B-	C+	C-	D
Score	3.8 - 4.00	3.5 - 3.79	3.0 - 3.49	2.5 - 2.99	2.0 - 2.49	1.5 - 1.99	1 - 1.49

4.6 Determine Wetland of High Conservation Value Status

Using the conservation status rank and the EORANK of the AA, refer to Table 47 to determine whether the wetland meets the Wetland of High Conservation criteria.

Table 47. Decision Matrix to Determine Ecosystem Element Occurrences

Global / State Conservation Status Rank Combination	Ecological Integrity Assessment Rank			
	A (+ or -) Excellent integrity	B (+ or -) Good Integrity	C (+ or -) Fair integrity	D (+ or -) Poor integrity
G1S1, G2S1, GNRS1, GUS1				
G2S2, GNRS2, G3S1, G3S2, GUS2				
GUS3, GNRS3, G3S3, G4S1, G4S2, G5S1, G5S2, any SNR				
G4S3, G4S4, G5S3, G5S4, G5S5, GNRS4, GNRS5, GUS4, GUS5				
Red Shading = Element Occurrence				

4.7 Using EIA for Wetland Mitigation

The EIA, as presented in this document, is intended to help identify Wetlands of High Conservation Value (WHCV) or for non-regulatory or proactive conservation, restoration, or management actions. Before using EIA for regulatory activities such as wetland mitigation, the ways in which landscape context and size metrics affect mitigation transactions require careful consideration. Consultation with the Washington Dept. of Natural Resources, Natural Heritage Program is strongly recommended before employing EIA in regulatory contexts not related to WHCV status.

5.0 Stressor Checklist

A stressor is an anthropogenic perturbation within the AA or surrounding landscape that can negatively affect the condition and function of the wetland. Stressors are *direct threats* and are further defined as "the proximate (human) activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes." Identifying stressors within the AA or its buffer can help determine causes of the AA's degradation. Stressors may be characterized in terms of ***scope*** and ***severity***. Scope is defined as the proportion of the AA that can reasonably be expected to be affected by the stressor with continuation of current circumstances and trends. Severity is the degree of degradation within the scope from the stressor, which can reasonably be expected with continuation of current circumstances and trends.

Step 1 Rate Scope and Severity of Stressors: Stressors are rated if they are observed or inferred to occur, but are not assessed if they are projected to occur in the near term, but do not yet occur. Record and estimate the scope and severity of applicable stressors (**Error! Reference source not found.**) in the AA or its buffer. Things to consider when filling out the form:

- Stressor checklists must be completed for all 4 categories (Buffer, Vegetation, Soils/Substrate, and Hydrology).
- Buffer perimeter is the entire perimeter <u>**around the AA,**</u> up to a distance of 100 m. Rely on imagery in combination with what you can field check.
- Assess buffer perimeter stressors and their effects within the buffer perimeter itself (NOT how buffer stressors may impact the AA).
- Stressors for Vegetation, Soils, and Hydrology are assessed across the <u>AA</u>.
- Some stressors may overlap (e.g., 10 [low impact recreation] may overlap with 26 [indirect soil disturbance]); choose the one with the highest impact and note overlap.
- Stressors are rated if they are observed or inferred to occur in the present (i.e., within a 10 year timeframe), <u>or</u> occurred anytime in the past with effects that persist into the present.

Step 2 Determine Impact Rating of Each Stressor: The impact rating of each stressor is based on the combination of its scope and severity score (Table 49). Enter the corresponding impact rating score in the "Impact" cell for each stressor. If no stressors are present or their impact is presumed to be minimal, check the appropriate box on the stressor form.

Step 3 Determine Overall Stressor Impact Rating for Stressor Categories: For each category (i.e. Buffer, Vegetation, Hydrology, and Soils), sum the total impact scores and enter the corresponding impact rating and point value (Table 50) in the appropriate cell at the bottom of the field form. For example, if the summed impact scores across all stressors in the Buffer category was 8, then the impact rating is High with a corresponding point value of 3.

Step 4 Determine Human Stressor Impact (HSI) Rating for AA: Next, using the algorithms on the field form, calculate overall impact scores based on each stressor category's impact points. HSI scores are calculated for three different metrics: (1) Total HSI (all stressor categories are used); (2) Onsite HSI (Buffer stressors are excluded); and (3) Abiotic HSI (Vegetation stressors are excluded). HSI scores can be converted to a rating using

STRESSOR RATING Summary for Categories	Sum of Stressor Impact Scores	Stressor Rating	Pts
1 or more Very High, **OR** 2 or more High, **OR** 1 High + 1 or more Medium **OR** 3 or more Medium	10+	Very High	4
1 High, **OR** 2 Medium **OR** 1 Medium + 3 or more Low	7 – 9.9	High	3
1 Medium + 1-2 Low **OR** 4 -6 Low	4 – 6.9	Medium	2
1 to 3 Low	1 – 3.9	Low	1
0 stressors	0 – 0.9	Absent	0

Table 51.

Table 48. Stressor Scoring Categories.

Assess for up to next 20 yrs.	Threat Scope (% of AA affected)	Assess for up to next 20 yrs.	Threat Severity within the Scope (degree of degradation of AA)
1 = Small	Affects a small (1-10%) proportion	1 = Slight	Likely to only slightly degrade/reduce
2 = Restricted	Affects some (11-30%)	2 = Moderate	Likely to moderately degrade/reduce
3 = Large	Affects much (31-70%)	3 = Serious	Likely to seriously degrade/reduce
4 = Pervasive	Affects most or (71-100%)	4 = Extreme	Likely to extremely degrade/destroy or eliminate

Table 49. Stressor Impact Ratings.

Stressor Impact Calculator		Scope			
		Pervasive	Large	Restricted	Small
Severity	Extreme	Very High=10	High=7	Medium=4	Low=1
	Serious	High=7	High=7	Medium=4	Low=1
	Moderate	Medium=4	Medium=4	Low=1	Low=1
	Slight	Low=1	Low=1	Low=1	Low=1

Table 50. Conversion of Total Impact Scores to Stressor Category Ratings/Points.

STRESSOR RATING Summary for Categories	Sum of Stressor Impact Scores	Stressor Rating	Pts

1 or more Very High, **OR** 2 or more High, **OR** 1 High + 1 or more Medium **OR** 3 or more Medium	10+	**Very High**	**4**
1 High, **OR** 2 Medium **OR** 1 Medium + 3 or more Low	7 – 9.9	**High**	**3**
1 Medium + 1-2 Low **OR** 4 -6 Low	4 – 6.9	**Medium**	**2**
1 to 3 Low	1 – 3.9	**Low**	**1**
0 stressors	0 – 0.9	**Absent**	**0**

Table 51. Conversion of Human Stressor Index (HSI) Scores to Ratings.

HSI Score	HSI Site Rating
3.5-4.0	Very High
2.5-3.4	High
1.5-2.4	Medium
0.5-1.4	Low
0.0-0.4	Absent

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