WASHINGTON NATURAL HERITAGE PROGRAM

Assessing the Condition of Spatial Priority Areas in the Columbia Plateau Ecoregion

Prepared for
U.S Fish and Wildlife Service
Portland, Oregon

Prepared by
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Natural Resources

Piloting a Strategic Approach to Landscape Conservation Design in the Columbia Plateau Ecoregion

Phase 2: Assessing the Condition of Spatial Priority Areas.

December 30, 2014

Prepared for:

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Executive summary

This project is part of a larger effort to design a sustainable landscape for wildlife and ecological systems in the Columbia Plateau ecoregion. Another goal of this effort is to test and describe different approaches to doing "Landscape Conservation Design" (LCD) and working towards articulating a toolkit of approaches for LCD. This report documents a task related to further develop and testing of this toolkit as applied to priority areas in the Columbia Plateau). This project focuses on a rapid assessment method of several potential areas across a large landscape.

This assessment project builds from these previous ALI efforts (ALI 2013 and ALI 2014) by providing decision support for strategy development. This project was developed to help address the knowledge deficit that satellite or aerial information does not provide accurate information about key metrics of condition, particularly information related to abundance of native vs. non-native species and structural metrics of habitat. The general question for this project is: can a field-based approach be developed that allows for both standardized assessment of condition and a rapid, comprehensive evaluation of relatively large areas. The project concentrates on Priority Areas delineated by USFWS for the Arid Land Initiative (ALI) (ALI 2013) (Figure 1). The objectives of the assessments are to:

1. Develop and test a rapid-field assessment protocol to assess the condition of landscape scale conservation priorities.
2. Synthesize Ecological Integrity Assessment (EIA) data to determine the overall ecological integrity of conservation targets within a subset of priority areas.
3. Develop a monitoring protocol for the conservation partners in the region based upon the EIA This report documents the methods and results for two of those activities: (1) development and testing of a rapid-field protocol and (2) assessment of ecological integrity of conservation targets in priority areas.

The goal of the sample design was to have an adequate number and distribution of sample sites per priority area to provide meaningful information to decision makers about the condition of the area. The operational framework revolves around roads as efficient vectors for field assessors to evaluate condition from a distance. Roads are the mechanism with which the landscape can be evaluated, thus roads are a key element of the sample design. Roads were intersected and dissected with the 500 acre hexagons used in the spatial prioritization. Sampling a representative example of each selected priority area was the goal of the project. High and Medium-high priority areas in Douglas and Lincoln County were selected to test the roadside methodology. Two areas on the Columbia WRA were sampled to include locations in the central Columbia Basin and on USFWS Refuges.

Forty-three on-site (within the visual field) Level-2 EIA samples were compared to their roadside EIA assessments. Thirty-two Shrubsteppe/Steppe targets locations were compared and eleven Riparian/Wetland locations were compared. EIA condition ranks across all samples, regardless of target, indicate 72% accuracy for all comparisons (total correct calls when roadside rank equals on-site rank) / total points). Low sample size and incomplete rank samples limit conclusions but results indicate general agreement in assigned usually within a single rank and overall agreement of 67%. The intermediate

roadside EIA provided a reasonable estimate, typically within a single rank, of the condition of the landscape when compared to on-site EIAs (see section 5.1). Overall, roadside EIAs tended to result in higher ranks (i.e., suggested higher ecological integrity) than level-2 ranks. These results indicate that observations from a distance will usually give similar assessments of ecological integrity of both Shrubsteppe/Steppe and riparian/wetland environments but typically with a more favorable impression of the general condition. Individual metric accuracy varies when using the roadside EIA. The two soil surface metrics may not need to be included in Roadside EIAs due to low rate of visibility. The vegetation Shrubsteppe/Steppe level-2 metrics as assessed from the Roadside appear to be more reliable estimators of site condition. The low sample size and the lack of any A rank and only one D ranked site limits conclusive inferences for comparison of riparian/wetland targets. The variability suggests more sampling is needed. Separating riparian and depressional wetlands might better provide an understanding of the relationship between roadside and level-2 EIAs. Overall distribution of ranks in both roadside and legacy surveys indicate C as the most common condition. Roadside ranks proportionally indicated more B ranks and legacy ranks proportionally indicated more D and ruderal vegetation. Both assessment data bases are incomplete samples and some areas are more comprehensively sampled than others.

Extrapolation of roadside condition assessments to the entire landscape of the Priority Areas needs further exploration. The general assumption behind this project is that with a proper density of sample points, the general condition of the priority areas will be reasonably estimated. However, we don't have rigorous estimates of what the "proper density" should be. For this study, we chose a density that was a compromise between budget and ability to cover as much area as possible. This will always be a tradeoff in any sampling scheme. Further research is needed to answer the question "how much sampling is enough" to arrive at a stable estimate of condition for an area. Also, as discussed above, the roadside bias is not known. Future work could address whether there are significantly different results by sampling areas 100+ meters from any road. In application of the EIA, recording estimates of raw data used to rank metrics (e.g., cover of invasive species, native species, total vegetation cover, cover of roads/trails, etc) rather than the EIA rank categories are more direct measures that will allow EIA class values to be derived in the office. Estimating cover values might help in level 1 mapping and assessment

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1. Introduction

This project is part of a larger effort to design a sustainable landscape for wildlife and ecological systems in the Columbia Plateau ecoregion. Another goal of this effort is to test and describe different approaches to doing "Landscape Conservation Design" (LCD) and working towards articulating a toolkit of approaches for LCD. This report documents a task related to further develop and testing of this toolkit as applied to priority areas in the Columbia Plateau). This project focuses on a rapid assessment method of several potential areas across a large landscape.

1.1 Background

Multiple state, federal and private entities are already taking conservation actions in many locations across eastern Washington's arid lands. To address the challenges posed by landscape conservation in eastern Washington, a group of interested entities came together to form the Arid Lands Initiative (ALI) in 2009. The ALI core team began by articulating a shared vision for conserving a whole, functioning landscape across eastern Washington, which would support biological and socio-economic values. With the help of experts and stakeholders, the ALI assessed the health of the ecosystems and species that characterize eastern Washington's arid lands, and found a clear picture that encourages action across this landscape. Although these systems and species have undergone varying degrees of degradation, compromising their ability to provide wildlife habitat and economic goods and services, their recovery and restoration is still achievable.

The ALI, through a number of facilitated discussions, has identified the key components of a coordinated strategy to achieve the ALI's shared vision. These foundational strategy components are:

- Shared biological priorities that capture what we are striving to conserve. ALI selected eight focal systems and species whose successful conservation is the foundation for achieving our shared vision;
- Shared strategic priorities that articulate what actions are necessary to conserve these focal systems and species, and whose coordination at a landscape scale is critical for achieving our shared vision; and
- Shared spatial priorities, which represent the areas where these actions need to be implemented first, in order to conserve those systems and species in ways that add up at the landscape scale.

This assessment project builds from these previous ALI efforts (ALI 2013 and ALI 2014) by providing decision support for strategy development. Through prioritization efforts, the ALI has identified core areas and connectivity zones that will maintain a sustainable ecosystem for plants and wildlife. However, there is still a lack of knowledge of how to develop an investment portfolio of strategies across the landscape. Existing data do not adequately map landscape condition to inform which strategy (restoration vs. protection vs. grazing, etc) belongs where, and furthermore, the level of investment that is needed to maintain or improve landscape functionality.

This project was developed to help address this knowledge deficit. Satellite or aerial information does not provide accurate information about key metrics of condition, particularly information related to abundance of native vs. non-native species and structural metrics of habitat. Although field-based

assessment techniques tend to be expensive and time consuming, there is a tremendous benefit of having trained ecologists visit an area and provide an assessment of condition and limiting factors. One assessment option is to have a trained ecologist perform a rapid assessment of an area and provide a narrative assessment of what they learned. However, this does not provide a standardized body of information that can be used to monitor over time. There is a gap in our toolkit of assessment techniques for large landscape conservation.

1.2 Project Objective

The general question for this project is: can a field-based approach be developed that allows for both standardized assessment of condition and a rapid, comprehensive evaluation of relatively large areas. The project concentrates on Priority Areas delineated by USFWS for the Arid Land Initiative (ALI) (ALI 2013) (Figure 1). The objectives of the assessments are to:

1. Develop and test a rapid-field assessment protocol to assess the condition of landscape scale conservation priorities.
2. Synthesize Ecological Integrity Assessment (EIA) data to determine the overall ecological integrity of conservation targets within a subset of priority areas.
3. Develop a monitoring protocol for the conservation partners in the region based upon the EIA framework.

The project tasks were to:

1. Develop a sampling framework for data collection and to serve as a long-term monitoring framework
2. Develop a roadside EIA to expedite data collection over a large landscape. The goal was to produce a rapid-assessment method that is intermediate in effort between a Level 1 (remote sensing) and Level 2 (rapid, onsite assessment).
3. Verify accuracy of roadside EIA by collecting Level 2 (rapid, onsite) EIA data to determine accuracy of roadside assessments.
4. Determine observer variability of roadside EIAs.
5. Collect roadside EIA data and summarize ecological integrity of conservation targets from sample points in a subset of ALI Priority Areas
6. Discuss and outline how the above efforts provide a framework and baseline data for a long-term monitoring network of Priority Areas.

This report documents the methods and results for two of those activities: (1) development and testing of a rapid-field protocol and (2) assessment of ecological integrity of conservation targets in priority areas.

The Ecological Integrity Assessment (EIA) approach was used to assess ecological condition (Faber-Langendoen et al. 2008, 2012; Rocchio and Crawford 2011). The existing Ecological System classification was used to identify natural vegetation (Comer et al. 2003; Rocchio and Crawford 2008). This report provides a summary of the methods and results of these efforts. This report also summarizes the lessons

learned about the effort to develop a rapid-field tool for assessing ecological integrity of large areas and about the limitations of remote (adjacent or roadside) site evaluations.

Data collected and synthesized results are in the accompanying Microsoft excel spreadsheet that contains Metadata for EIA and legacy data assessments.

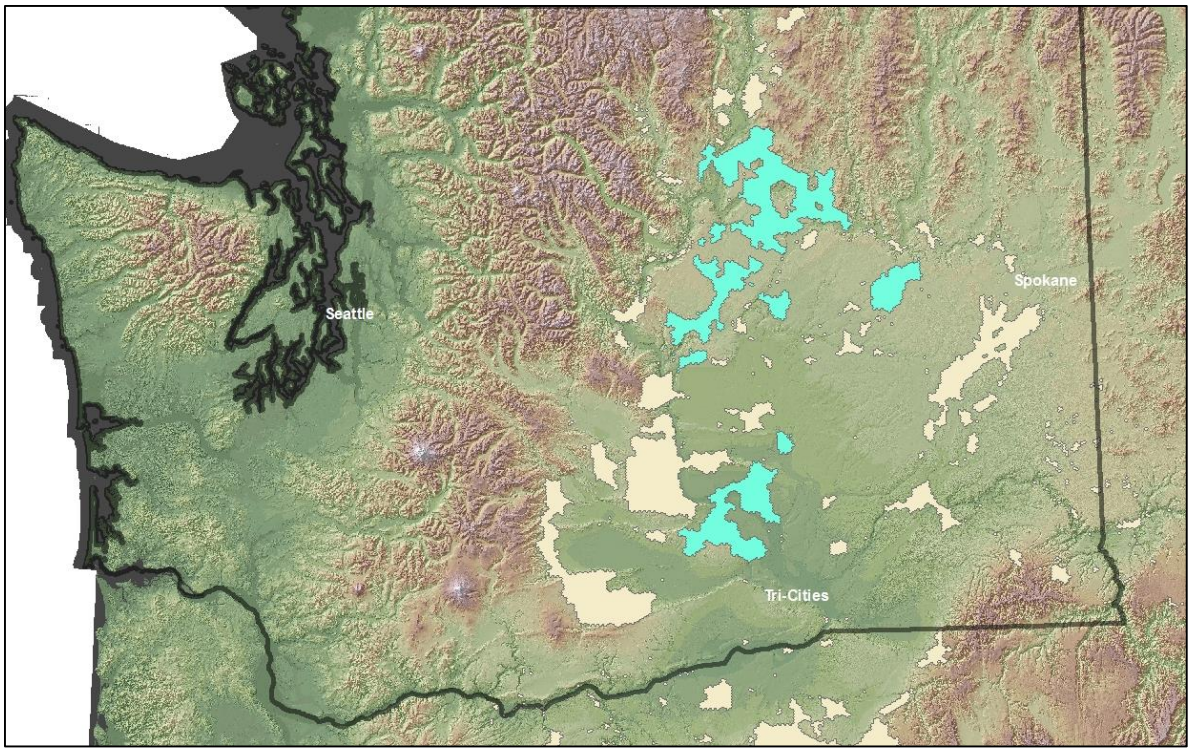


Figure 1. Location of all ALI Priority Areas in Washington. Blue polygons = project areas; tan polygons = other priority areas.

2. Ecological Integrity Assessment

An objective of this pilot project is to assess the ecological condition of vegetation types in a subset of Priority Areas in the Columbia Basin of Washington state. One approach for assessing ecological condition is the Ecological Integrity Assessment methods developed by NatureServe and the Natural Heritage Network (Faber-Langendoen et al. 2008, 2012). The EIA is designed to assess current ecological integrity of a site based on the natural range of variation of the ecosystem or vegetation type in question. Up-dated existing EIAs were used in this pilot project (Washington Natural Heritage Program http://www1.dnr.wa.gov/nhp/refdesk/communities/eia_list.html).

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

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

In general, EIA methodology is applied at three scales, or levels:

- Level 1 Remote Assessments rely almost entirely on Geographic Information Systems (GIS) and remote sensing data shed (Faber- Langendoen et al. 2008).
- Level 2 Rapid Assessments use relatively rapid field-based metrics that are a combination of qualitative and narrative-based rating with quantitative or semi-quantitative ratings. Field observations are required for many metrics, and observations will typically require professional expertise and judgment (Fennessy et al. 2007).
- Level 3 Intensive Assessments require more rigorous, intensive field-based methods and metrics that provide higher-resolution information on the integrity of occurrences within a site.

Table 1.Basic Ecological Integrity Ranks

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

By using the EIA framework, we can establish restoration goals and benchmarks for key ecological attributes of habitats. The data collected using the EIA framework can also support conservation action effectiveness monitoring.

This project will make use of the Level 2 protocols to determine whether the current ecological integrity of the priority areas will meet conservation goals. Because of logistics involved with landscape scale sampling, we developed and tested the accuracy of an intermediate approach between Level 1 (remote) and Level 2 (on-site) EIA protocols. This intermediate approach utilized both remote-sensing data and field-based observations adjacent to the priority areas along roads. Given logistics, it was not possible to sample all priority areas in 2014. Therefore, we focused our sampling in priority areas that contain sagebrush steppe, riparian zones or depressional wetlands. Our collection of EIA field data was also augmented by existing condition assessments in the ecoregion. Together, this provided a number of data points to further enhance our understanding of conservation priority areas in the region.

3. Conservation Targets

3.1 Assessment Units

Assessment and interpretation of ecological integrity depends on understanding the structure, composition, and processes that govern the wide variety of ecosystem types. This project used the Ecological Systems classification (Comer et al. 2003) to sort out the ecological variability that may affect ecological integrity. Additionally, EIAs are prepared for ecological systems. Washington ecological systems are described in Rocchio and Crawford (2008) and are available on-line at http://www1.dnr.wa.gov/nhp/refdesk/communities/ecol_systems.html.

3.2.1 Ecological Systems

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

3.2.2 ALI Targets

The conservation targets for this assessment are, at the broadest categorization, ecosystems including sagebrush steppe and grasslands, wetlands, riverine habitat, cliffs and caves, dunes, and species groups including grouse and burrowing animals (Table 2).

3.2.3 ALI Priority Areas

Priority areas were identified using criteria from a conservation action planning process completed by the Arid Lands Initiative (ALI). Results in ALI (2013) provide a spatial design of priority areas that met ALI goals and objectives. The 2013 report used Marxan to identify a portfolio of sites that could protect a suite of representative habitats and species. Using a "medium-goal" level, the portfolio encompassed 20% of the ecoregion. That spatial assessment of ALI conservation goals and objectives identified a collection of priority areas, based upon landscape-scale data, where protection and restoration could be implemented locally, while also meeting landscape-scale goals. This was meant to be a starting point that will allow this landscape-scale conservation initiative to work from a common design. Evaluation of a subset of those areas begins the process toward conservation action.

3.2.4 Project Targets

The Arid Lands Initiative grouped ecological systems into seven targets for their planning efforts, two targets of which are used in this project: Shrubsteppe and Steppe and Riparian and Wetlands (Table 2). The project target of 'Shrubsteppe and Steppe' is a shortened name equivalent to ALI's 'Shrub steppe and Grassland' target while the project target of 'Riparian/Wetland' includes ALI's targets of 'Riverine Systems' and 'Depressional Wetlands' that have similar EIA metrics (Table 2).

Table 2. Relationships between project targets, Arid Lands Initiative targets and ecological systems.

Project Assessment Target	ALI Nested Target	NatureServe Ecological System	NatureServe Code
Shrubsteppe / Steppe	Shrub steppe and Grasslands	Columbia Basin Foothill and Canyon Dry Grassland	CES304.993
		Columbia Basin Palouse Prairie	CES304.792
		Columbia Plateau Low Sagebrush Steppe	CES304.080
		Columbia Plateau Steppe and Grassland	CES304.083
		Inter-Mountain Basins Big Sagebrush Shrubland	CES304.777
		Inter-Mountain Basins Big Sagebrush Steppe	CES304.778
		Inter-Mountain Basins Montane Sagebrush Steppe	CES304.785
		Inter-Mountain Basins Semi Desert Shrub Steppe	CES304.735
		Inter-Mountain Basins Semi-Desert Grassland	CES304.787
		Northern Rocky Mountain Lower Montane, Foothill, and Valley Grassland	CES306.040
Not assessed	Scabland	Columbia Plateau Scabland Shrubland	CES304.770
		Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	CES306.994
Riparian/Wetland	Riverine Systems	Columbia Basin Foothill Riparian Woodland and Shrubland	CES304.768
		Inter-Mountain Basins Wash	CES304.781
	Depressional Wetlands	Columbia Plateau Vernal Pool	CES304.057
		Inter-Mountain Basins Alkaline Closed Depression & Playa	CES304.998 & CES.304.786
		Modoc Basalt Flow Vernal Pool	CES204.996
		North American Arid West Emergent Marsh	CES300.729
		Northern Columbia Plateau Basalt Pothole Ponds [Provisional]	CES304.058
		Inter-Mountain Basins Greasewood Flat	CES304.780
		Columbia Plateau Wet Meadow	none

Project Assessment Target	ALI Nested Target	NatureServe Ecological System	NatureServe Code
Not assessed	Dunes	Inter-Mountain Basins Active and Stabilized Dune	CES304.775
Not assessed	Cliffs, Talus and Caves.	Inter-Mountain Basins Cliff and Canyon	CES304.779
Not assessed	Transitional Woodlands	East Cascades Oak-Pine Forest and Woodland	CES204.085
		Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	CES306.805
		Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	CES306.030
		Northern Rocky Mountain Foothill Conifer Wooded Steppe	CES306.958

4. Methods

4.1 Sample Design and Selection

The goal of the sample design was to have an adequate number and distribution of sample sites per priority area to provide meaningful information to decision makers about the condition of the area. The operational framework revolves around roads as efficient vectors for field assessors to evaluate condition from a distance. Roads are the mechanism with which the landscape can be evaluated, thus roads are a key element of the sample design. The roads layer produced by the OR/WA regional office of the BLM was used as the roads layer. This layer is updated regularly and is commonly referred to as the most comprehensive existing roads layer in the region.

Roads were intersected and dissected with the 500 acre hexagons used in the spatial prioritization. Sampling a representative example of each selected priority area was the goal of the project. Sampling included as many priority areas as could be assessed with available funding. Within the High and Medium-high priority areas (ALI 2013), 500-acre hexagons that intersected roads were selected for sampling. Within those selected hexagons, a point was placed at the mid-point of a road segment in the hexagon. These sample points were the targeted locations for roadside EIA assessment. USFWS staff provided sample points for all priority areas. To minimize travel, High and Medium-high priority areas in Douglas and Lincoln County were selected to test the roadside methodology. Two areas on the Columbia WRA were sampled to include locations in the central Columbia Basin and on USFWS Refuges. Nine priority areas were evaluated in this project (Figure 2).

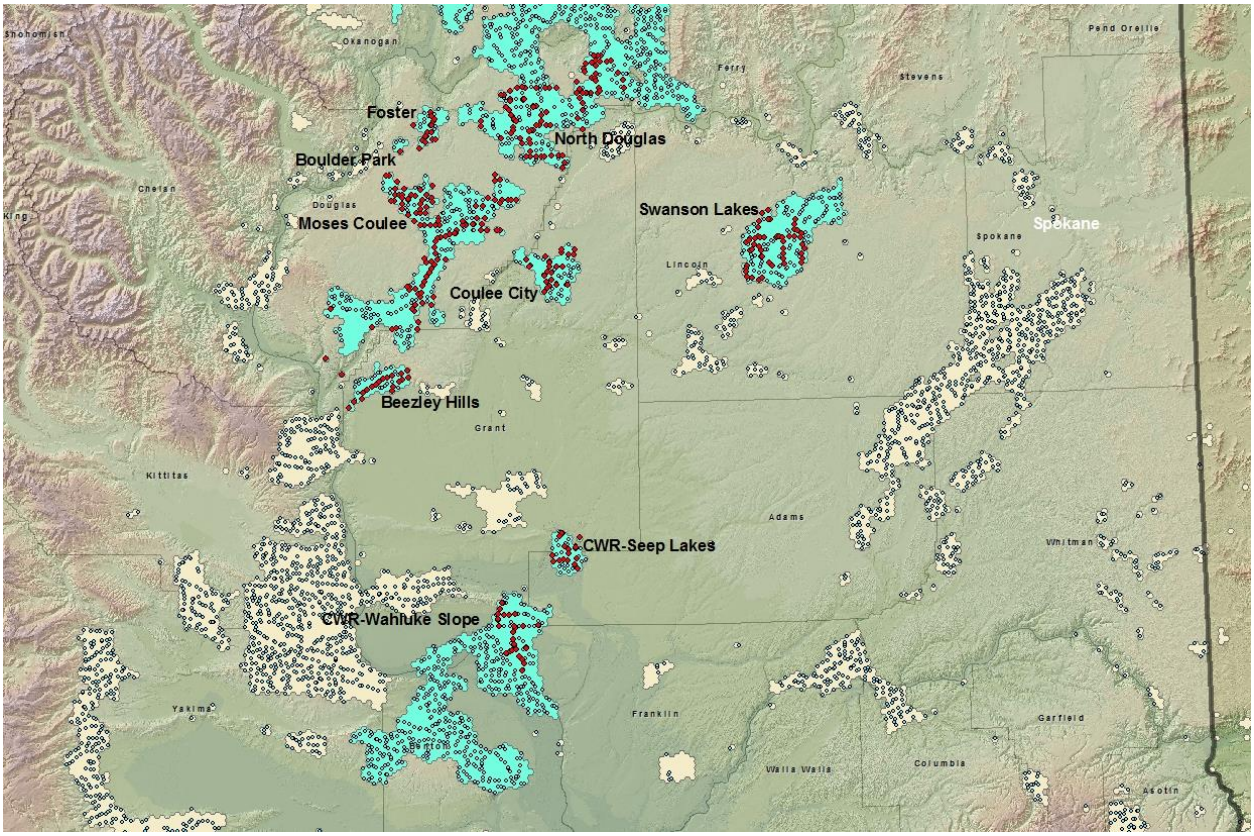


Figure 2 Location of Roadside Points (red), un-sampled points (blue) and labeled Priority Areas sampled (blue).

4.2 Field Protocol

Rex Crawford, John Fleckenstein, and Joe Rocchio sampled roadside locations during the summer of 2014.

4.2.1 Sampling Procedure

Sample points supplied by USFWS were printed on paper field maps and loaded onto field GPS units (Ashtech Mobile Mapper 10) and used to navigate to each sample point. The points were accessed by driving or, by foot travel on publically accessible roads if closed to vehicles and less than 10- minute walk. Gated or otherwise inaccessible points were not sampled. At a roadside point, the evaluator either sampled one side of the road or both sides of a road as a single point if both sides were virtually identical or each side of road when different targets. The sample area included all areas of conservation targets visible from the roadside and that were no more than 500 m from the road or fence line (excluding road side and fence line effects). If the observable sample area included more than one target, the assessment points could be moved along the road, no more than 100m, in order to visually assess the target at the point. When a mosaic of upland non-project targets and project targets (Table 2)) was present, only the shrubsteppe-steppe target was assessed and detailed in the comment field. EIA metrics were scored for Shrubsteppe/Steppe or Riparian/wetland targets or both, if present at a point. Non-project targets were

recorded as present when targets were absent at a point. Photographs of the visual sample area were recorded at each location. Of 403 roadside observations including targets, non-target, and land use points, 313 were of project targets.

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

The following was recorded at each point:

Id. Hexagon point identifier

Pointid. Id plus unique alpha value if points were placed on each side of road.

Observer.

Obs-distan. The estimated limit of the visual assessment area (not to exceed 500 m).

Target. Dominant land cover in the visual assessment area

- Agriculture- Dryland crops, hayfields, fallow fields, orchards, etc.
- CRP – temporary (several yrs) perennial grass cover (native and non-native species) with and without shrubs, no human use. If it looks like CRP put it here.
- Development – buildings, driveways, trash, landscaping, etc
- Lithosol – scabland vegetation on shallow soils or deep gravel. NO EIA for this project.
- Other – does not fit list
- Riparian – native vegetation associated with a stream that is subject to overbank flooding. EIA
- Ruderal shrubsteppe – Basically it looks like shrubsteppe or steppe/grassland but is not natural vegetation. Includes exotic-dominated with native shrubs that aren't CRP. NO EIA for this project.
- Ruderal wetland – wetlands dominated by exotics with few if any natives present. NO EIA for this project.
- Shrub-steppe – native Shrubsteppe/Steppe /grasslands on deeper soil EIA
- Transitional Forest – Upland vegetation with over 10% cover of trees in visual assessment area. NO EIA for this project.
- Vernal pool – intermittently flooded (most but not necessarily every year) wetlands dominated by annual plants. EIA
- Wetland – native wetland and riparian vegetation. EIA

Roadside. Approximate cardinal direction of side of road being assessed.

Photos. Identifiers used for photos of visual assessment area.

Metric ratings. Depending on the target present at the assessment point, a series of metrics were rated. Instructions were supplied to indicate which metric ratings apply to ecological system present. Appendix A lists the metrics, their ratings and ecological system (target) to which they apply.

4.2.1 Accuracy Assessment of Roadside Level-2 EIA

To test the accuracy of the roadside-based EIA, an on-site (100 or 200 sq. meter plot) level-2 EIA was applied to the visual field of the roadside assessed points. Crawford or Rocchio sampled all level-2 EIA points. The goal was to represent the range of ecological conditions of the target (from very degraded to minimally impacted) by sampling between 12-20 points across the stressor gradient. This was accomplished by first targeting supplied sampled points. If those points did not reflect the entire disturbance gradient then additional sample points were subjectively targeted to attempt to capture the full gradient of ecological conditions. EIA ranks were used as the measure of relative disturbance. Thus, A-ranks would reflect minimally disturbed intact sample points while D-ranks would reflect very degraded sample points. The Shrubsteppe/Steppe target was compared with 32 points and only 11 riparian/wetlands were sampled due to their rarity on the landscape, the likelihood of them not being near roadsides, and overall paucity of high-ranked examples. The on-site Level 2 EIA was then compared to the roadside-based EIA to indicate accuracy and utility of the latter. Comparisons of each metric, roadside and on-site level-2 were made to indicate which metrics are best estimated from the roadside.

Observer variation was addressed by comparing the metric ratings and EIA scores of two observers (Crawford and Fleckenstein) at 6 target points and at two non-target points.

4.2.2 Accuracy of Priority Area Condition using Roadside Level-2 EIA

To evaluate how well the Roadside level-2 EIA indicates the overall condition of a priority area, the range of EIA condition ranks from the roadside EIA was compared to the range of ranks indicated in legacy data with the priority areas included in the project. Legacy data is information collected from Washington Department of Natural Resources (DNR) land across the Columbia Basin by the Washington Natural Heritage program during 2006-2008. The method of data collection used for this dataset does not allow a direct comparison of metrics or the calculated EIA score. However, because the same or similar factors were considered to assign an A through D rank in the legacy survey, a comparison of results gives some ballpark indication of similarity.

The DNR land survey was a reconnaissance evaluation that recorded the approximate percentage of the parcel in natural or semi-natural condition (not agriculture or developed), the approximate percent cover of exotic species, shrubs and native herbaceous species, the approximate percentage of that area occupied by each observed ecological system with an assigned condition rank on an A through D scale. Legacy surveys characterized condition after a reconnaissance walk-through of parcels up to a square mile. No roadside samples occurred within those parcels. For this project, an observation of a target's ecological system with an assigned rank, regardless of area occupied was used in the comparison. Of 550

legacy observations of target ecological systems, 130 occur in the nine priority areas evaluated in this project.

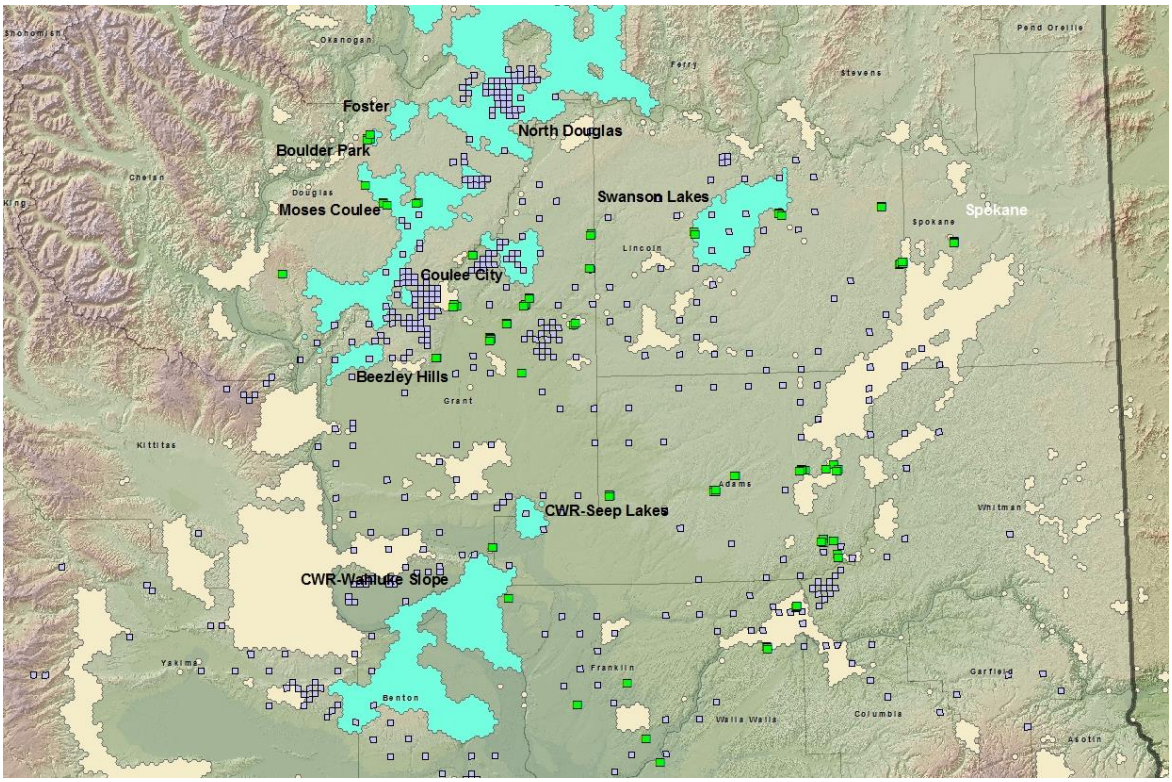


Figure 3. Location of Priority Areas (sampled blue polygons) and DNR Legacy Data. Green squares 2008 data, purple squares 2006-2007 data.

4.3 Office Procedures

All data were entered into excel spreadsheets for evaluation. Data collected and synthesized results are in the accompanying Microsoft excel spreadsheet that contains Metadata for EIA and legacy data assessments. <when known, but in location here for ScienceBase>

4.3.1 Classification of Project Targets

Roadside classification of sample points was checked for consistency with recorded auxiliary information (comment fields, cover of native shrubs, bunchgrass and invasive exotic species) at each point. Legacy data was grouped into project targets (ALI targets) by clustering the appropriate ecological systems as indicated in the original survey data. A cursory check of for consistency with auxiliary information (comment fields, cover of native shrubs, native herbaceous and exotic species) collected at each point was conducted. Obvious misclassifications or questionable determinations were changed or deleted based on Rex Crawford's experience. Most classification issues in both data sets revolved around

distinguishing between "Ruderal vegetation" and "D" rank natural vegetation. Legacy data listed as invasive annual grassland and invasive annual grass with shrubs were called Ruderal Shrubsteppe/Steppe.

4.3.2 EIA Condition Scores

Ecological Integrity is scored on a 1 to 4 scale, where 4 or "A rank" represents reference conditions in a minimally disturbed state, that is, where the ecosystem is experiencing very few to no stressors, has full buffering capacity and is able to resist or fully recover from disturbance. An EIA score of 1 or "D rank" is a highly altered ecosystem that has a high level of stress, little buffer or resistance capacity, and may not recover at all from continued application of stressors. This scaling rationale is also used when ranking individual metrics or determining roll-up scores for Rank Factors (i.e. Condition, Landscape Context, or Size). For this project each of the 313 roadside assessment points received a single, EIA Condition score based on the metric scores recorded.

To calculate overall ecological integrity scores for a given sample point, each applicable EIA metric was assigned a letter rank in the field. These ranks were converted to a numerical score (A=4, B=3, C=2, D=1). These scores were averaged to create a combined Vegetation Condition Score (metrics related to vegetation structure and composition), Soils or Physiochemical Condition Score (metrics related to soils, natural disturbance regimes, physical patch types, or water quality) for all sites and for wetlands, a Hydrology Score (metrics related to water source, hydrological regime and connectivity). For uplands, Vegetation and Soils scores were averaged into a single EIA Condition score for each assessed sample point. EIA numeric scores are converted back to ranks as follows: A=3.5-4.0, B = 2.5-3.4, C=1.5-2.4, D=1.0-1.4. Landscape and Size Scores were not calculated because the samples are point observations rather than areal polygons or occurrences.

Legacy data condition ranks were assigned on an A to D scale with occasional intermediate ranks, i.e. AB, BC, and CD. For this project the following rank determination was used: A = A; AB and B = B; BC and C = C; and DC and D = D.

4.3.3. Accuracy and Observer Comparison

Both roadside and on-site accuracy assessments and between observer comparisons were accomplished by filling contingency tables of agreement or not. Contingency tables were developed for overall condition ranks, target ranks (average of all metric scores) and for each metric.

5. Results and Discussion

Data collected and synthesized results are included in the accompanying Microsoft Excel spreadsheet that contains Metadata, Roadside, accuracy and observer comparison EIA scores and DNR legacy data.

5.1 Accuracy Assessment of Roadside Level-2 EIA

Forty-three on-site (within the visual field) Level-2 EIA samples were compared to their roadside EIA assessments. Thirty-two Shrubsteppe/Steppe targets locations were compared and eleven Riparian/Wetland locations were compared. EIA condition ranks across all samples, regardless of target, indicate 72% accuracy for all comparisons (total correct calls when roadside rank equals on-site rank) / total points). Roadside assessments tended to falsely rank higher than the level-2, for example, four level-2 B-rank sites assigned A-rank and four level-2 C ranks were seen as B from the road (Table 3). All misclassified ranks are within one rank of the level-2 rank. Shrubsteppe/Steppe target comparisons followed the same pattern as overall target comparisons (Table 4). Few (11) Riparian/Wetland locations were evaluated due to low availability for sampling on the landscape. Five B- and C-ranks each and one D-Rank level-2 EIA sites were compared. Riparian/wetland condition ranks indicate 100% accuracy for B-rank samples, 60% accuracy for C-rank samples, comparisons and the one D-rank level-2 EIAs was incorrectly ranked as C-rank (Table 3).

Table 3. Contingency table of paired Level 2 and Roadside EIA ranks for all targets.

EIA Condition of All Targets							
		Roadside					
		A	B	C	D	Total	Correct Call
Level-2	A	3				3	100%
	B	4	14	3		21	67%
	C		4	12		16	75%
	D			1	2	3	67%
	Total	7	18	16	2	43	
	False Positive	57%	22%	25%	0%		

Table 4. Contingency table of paired Level 2 and Roadside EIA ranks for Shrubsteppe/Steppe targets.

EIA Condition of Shrubsteppe/Steppe							
		Roadside					
		A	B	C	D	Total	Correct Call
Level-2	A	3				3	100%
	B	4	9	3		16	56%
	C		2	9		11	82%
	D				2	2	100%
	Total	7	11	12	2	32	
	False Positive	57%	18%	25%	0%		

Table 5. Contingency table of paired Level 2 and Roadside EIA ranks for Riparian/Wetland targets.

EIA Condition of Riparian/Wetland							
		Roadside					
		A	B	C	D	Total	Correct Call
Level-2	A						
	B		5			5	100%
	C		2	3		5	60%
	D			1		1	0%
	Total		7	4		11	
	False Positive		29%	25%			

Evaluation of individual metrics indicates which ones are more reliable as part of the roadside EIA. The Shrubsteppe/Steppe metrics *Relative Cover of Native Species* and *Fire-Sensitive Shrub Cover* both show accuracies of 81% for all ranks and *Relative Bunchgrass Cover* was only slight less accurate with 78% correctly ranked (Table 6). All ranks errors appear within one rank of the Level-2 (baseline) rank for these metrics. The remaining vegetation metrics had at least a single two-rank difference between level-2 and roadside rank. Roadside metrics of these metrics were usually lower (i.e., less integrity) than the level-2 rank. *Invasive Species Cover* was correctly recognized over 77% of the time, however, of 6 A-rank level-2 sites one roadside assessment was two-rank error of C rank. The *Invasive Species Cover* roadside assessment falsely ranked 4 sites (A, B and 2 D level-2) as C; usually higher ranks than level-2. *Vegetation Composition* correctly ranked was 65%; 1 of 3 C-ranks were correct and a two-rank error of a level-1 B was ranked D for the road. Roadside assessments falsely ranked 4 sites (A, 2 B and D level-2) as C; overall roadside assessment errors were equally lower and higher than level-2 ranks. The two ground surface metric differed in their categorization. *Soil Surface Condition* was the worst metric estimated from the roadside with only A-ranks correctly identified (14 of 17), B and C-ranks were never identified correctly (0 of 6); overall roadside assessment errors were equally lower and higher than level-2 ranks. *Soil Crust*, on the other hand, was correctly ranked as A, B or C 75% of the time while only half of the D-rank sites were correct, it being seen as B or C.

Table 6. Contingency table of paired Level 2 and Roadside EIA metric ranks for Shrubsteppe/Steppe targets.

Shrubsteppe/Steppe EIA Metric Ratings							
		Roadside					
		Invasive Species Cover					
		A	B	C	D	Total	Correct Call
Level-2	A	5		1		6	83%
	B	3	9	1		13	69%
	C		1	3		4	75%
	D			2	6	8	75%
	Total	8	10	7	6	31	
	False Positive	37%	10%	57%	0%		

Native Species Relative Cover

		A	B	C	D		
Level-2	A	4	1			5	80%
	B		15	3		18	83%
	C		1	5	1	7	71%
	D				2	2	100%
	Total	4	17	8	3	32	
	False Positive	0%	22%	37%	33%		

Vegetation Composition

		A	B	C	D		
Level-2	A	2		1		3	67%
	B	4	12	2	1	19	63%
	C			1	2	3	33%
	D			1	6	7	86%
	Total	6	12	5	9	32	
	False Positive	67%	0%	80%	33%		

Soil Surface Condition

		A	B	C	D		
Level-2	A	14	1	1	1	17	82%
	B	2		1		3	0%
	C		3			3	0%
	D						
	Total	16	4	2	1	23	
	False Positive	12%	100%	100%	100%		

Soil Crust

		A	B	C	D		
Level-2	A	4	1			5	80%
	B		2	1		3	67%
	C		1	3		4	75%
	D		1	1	2	4	50%
	Total	4	5	5	2	16	
	False Positive	0%	60%	40%	0%		

Fire-Sensitive Shrub Cover

		A	B	C	D		
Level-2	A	5				5	100%
	B	1	4	1		6	67%
	C		1	8	3	12	67%
	D				8	8	100%
	Total	6	5	9	11	31	

	False Positive	17%	20%	11%	27%		
	Bunchgrass Relative Cover						
		A	B	C	D		
Level-2	A	6				6	100%
	B	1	8	2		11	73%
	C		1	4	3	8	50%
	D				7	7	100%
	Total	7	9	6	10	32	
	False Positive	14%	11%	33%	30%		

In contrast to upland assessments, riparian/wetland metrics *Vegetation Composition and Soil Surface Condition* were 100% accurate for all ranks assessed (Table 7). All Level-2 B and D rank sites of *Native Species Relative Cover* were correctly recognized but only 4 of 7 C-rank sites were correct; one site was a two-rank A error. Roadside ranks ranked higher than level-2. *Invasive Species Cover* was the worst ranked metric assessed from the road, all less than 36% correct (B ranks only 17%) and three sites differed by more than two ranks from the true rank. Invasive species were falsely ranked B and C, 14% and 25% respectively and typically ranked lower from the roadside. *Vegetation Structure* and *Hydrologic Connectivity* showed accuracies of over 60%. The other hydrologic metrics, *Water Source* and *Hydroperiod* ranked correctly for A thru C ranks and completely misclassified D-ranks.

Table 7. Contingency table of paired Level 2 and Roadside EIA metric ranks for Riparian/Wetland targets.

	Riparian/Wetland Metric Ratings						
	Roadside						
	Invasive Species Cover						
		A	B	C	D	Total	Correct Call
Level-2	A					0	
	B		1	4	1	6	17%
	C		1	1	3	5	20%
	D						
	Total		2	5	4	11	
	False Positive		50%	75%	100%		
	Native Species Relative Cover						
		A	B	C	D		
Level-2	A					0	
	B		1			1	100%
	C	1	2	4		7	57%
	D				3	3	100%
	Total	1	3	4	3	11	
	False Positive	100%	67%	0%	0%		

Vegetation Composition

		A	B	C	D		
Level-2	A	1				1	100%
	B		1			1	100%
	C			6		6	100%
	D				3	3	100%
	Total	1	1	6	3	11	
	False Positive	0%	0%	0%	0%		

Soil Surface Condition

		A	B	C	D		
Level-2	A	2				2	
	B		3			3	100%
	C			3		3	100%
	D						
	Total	2	3	3		8	
	False Positive	0%	0%	0%			

Vegetation Structure

		A	B	C	D		
Level-2	A					0	
	B		3	2		5	60%
	C		1	3		4	75%
	D				2	2	100%
	Total		4	5	2	11	
	False Positive		25%	40%	0%		

Water Source

		A	B	C	D		
Level-2	A	6				6	100%
	B	1	2			3	67%
	C			1		1	100%
	D		1			1	0%
	Total	7	3	1		11	
	False Positive	14%	33%	0%			

Hydroperiod

		A	B	C	D		
Level-2	A	3				3	100%
	B	1	3			4	75%
	C			2		2	100%
	D			2		3	0%
	Total	4	3	4		11	

	False Positive	25%	0%	50%			
		Hydrologic Connectivity					
		A	B	C	D		
Level-2	A	5				5	100%
	B		2			2	100%
	C			1		1	100%
	D		1		2	3	67%
	Total	5	3	1	2	11	
	False Positive	0%	33%	0%	0%		

The low sample size and no A rank and one D rank site limits conclusive inferences for comparison of riparian/wetland targets. Recognizing this limitation, the overall riparian/wetland condition rank accuracy is similar to Shrubsteppe/Steppe, the roadside assessment. This is particularly troublesome for the metric *Invasive Species* (an important indicator of condition) in riparian/wetland where few roadside sites rank the same as Level-2 by overestimating the cover of invasive species thus assigning a lower rank.

5.2 Observer Comparison of Roadside Assessment

Most of the roadside assessments were done by two observers whose overall rank distributions were similar (Table 8). To give an indication of differences in observer assessment of metrics and roll-up into condition, Crawford performed roadside assessments at six Shrubsteppe/Steppe targets locations previously assessed by Fleckenstein. Low sample size and incomplete rank samples limit conclusions but results indicate general agreement in assigned usually within a single rank and overall agreement of 67% (Table 9). Two mutual observations of ruderal Shrubsteppe/Steppe are excluded from the following discussion because if the difficulty of distinguishing ruderal vegetation from severely degraded vegetation If ruderal were considered D rank then accuracy increases to 75%. *Fire-sensitive Shrub cover* ranks were in 100% agreement; *Vegetation Composition* and *Relative Cover of Bunchgrasses* were in high agreement (80%) while Invasive species were similar to overall agreement around 67%. The metrics in least agreement between observers (less than 50%) are *Native Species Relative Cover* and *Soil Surface.*

Table 8. Roadside EIA rank distribution by observers.

		Roadside Overall EIA ratings by Observer				
Observer	Total observations	A	B	C	D	Non target
Crawford	159	6%	25%	44%	3%	23%
Fleckenstein	242	5%	27%	39%	8%	21%

Table 9. Roadside EIA rating and metric comparisons between two observers.

Rating Comparison Between Observers

Crawford

EIA Condition Rating

		A	B	C	D	total	Agree
Fleckenstein	A	1	1			2	50%
	B		2			2	100%
	C					0	
	D			1	1	2	50%
	Total	1	3	1	1	6	
	Agree	100%	67%	0%	100%		

Invasive Species Cover

		A	B	C	D		Agree
Fleckenstein	A	1	1			2	50%
	B		1			1	100%
	C			1		1	50%
	D			1		1	100%
	Total	1	2	2	0	5	
	Agree	100%	50%	50%			

Native Species Relative Cover

		A	B	C	D		Agree
Fleckenstein	A	1	1			2	50%
	B		1			1	100%
	C		1			1	0%
	D			1		1	0%
	Total	1	3	1	0	5	
	Agree	100%	33%	0%			

Vegetation Composition

		A	B	C	D		Agree
Fleckenstein	A	1	1			2	50%
	B		2			2	100%
	C					0	
	D				1	1	100%
	Total	1	3	0	1	5	
	Agree	100%	67%		100%		

	Soil Surface Condition						
		A	B	C	D		Agree
Fleckenstein	A	1	1			2	50%
	B					0	
	C					0	
	D			1		1	0%
	Total	1	1	1	0	3	
	Agree	100%	0%	0%			

	Fire-Sensitive Shrub Cover						
		A	B	C	D		Agree
Fleckenstein	A	2				2	100%
	B					0	
	C			2		2	100%
	D				1	1	100%
	Total	2	0	2	1	5	
	Agree	100%		100%	100%		

	Bunchgrass Relative Cover						
		A	B	C	D		Agree
Fleckenstein	A	1	1			2	50%
	B		2			2	100%
	C					0	
	D				1	1	100%
	Total	1	3	0	1	5	
	Agree	100%	67%		100%		

5.3 Observation Points and Condition Ranks in Project Area

A primary purpose of the project is to determine the overall ecological integrity of conservation targets within a subset of Priority Areas in Washington's Columbia Basin. In this section, available data is summarized by conservation target and by Priority Area. The section includes a comparison of assessment results gathered for this project and legacy condition assessments conducted by the Washington Natural Heritage program of DNR land in the project area. Both assessment data bases due to limited project time are incomplete samples and some areas are more comprehensively sampled than others. Conclusions from these data about individual priority areas need to be tempered by these limitations.

5.3.1 Project Target Ranks

A total of 943 target assessments were available, 443 occurred in Priority Areas (Roadside 313 assessments; 130 DNR legacy assessments) and 550 legacy assessments outside the Priority Areas. The

ecological condition of the nine Priority Areas included in this study is indicated by summarizing the EIA ranks for two targets from both roadside and level-2 EIAs and legacy condition ranks (Figure 4). Overall condition was fair (C ranks) in 53% of the sample points and good to excellent in 34% of sample points. Poor (D-rank) condition sample points represented 13% of the samples. Legacy data from locations not in the project Priority Areas suggest ecological conditions outside the project Priority Areas are in more degraded condition, e.g., they have a higher proportion of poor condition (D rank) samples in comparison to the project area (Figure 5). Roadside assessments indicated better overall condition than all legacy data, e.g. proportionally more A and B ranks and fewer D ranks (Figure 5 and 6).

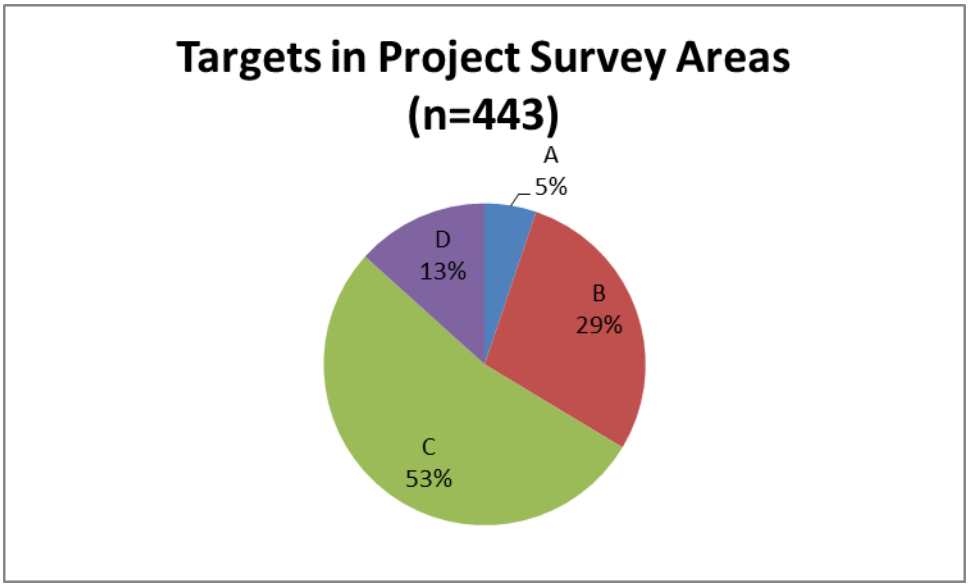


Figure 4. Proportion of EIA ranks in all Priority Areas averaged from Roadside and DNR Legacy data.

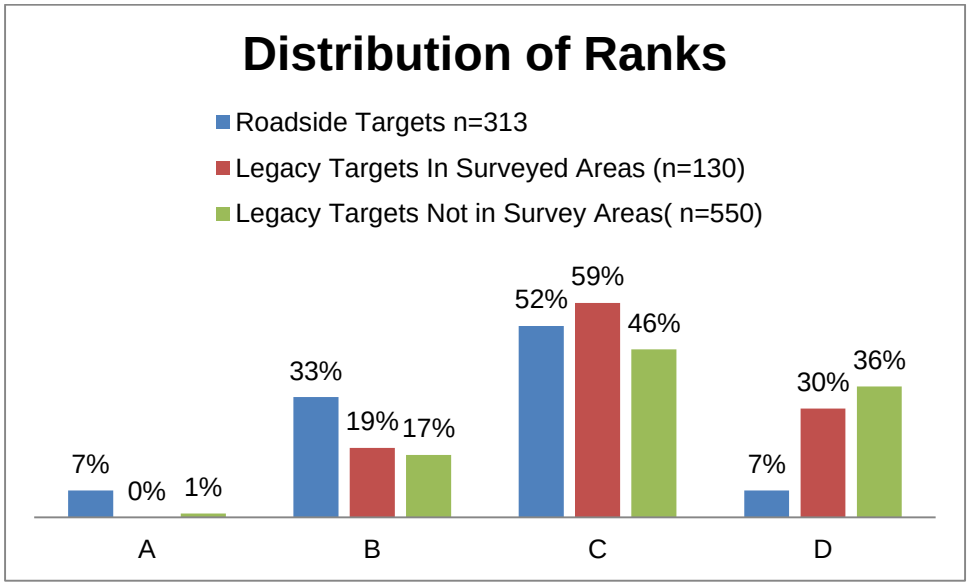


Figure 5. EIA Rank distribution from all information sources in project Priority Areas and other sites in Columbia Basin.

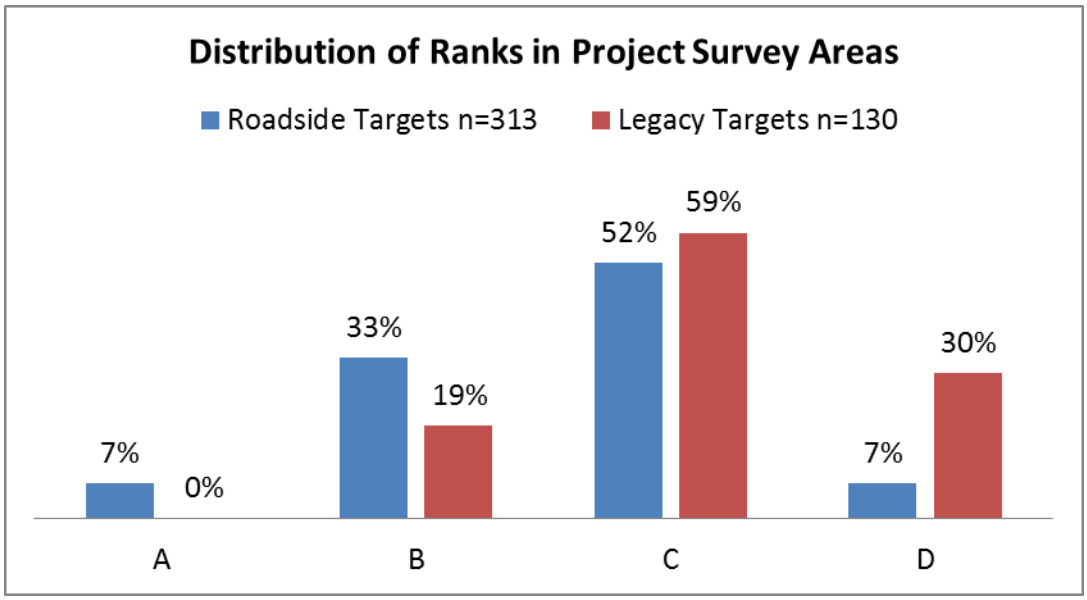


Figure 6. Comparison of Roadside and DNR Legacy EIA Ranks in all project Priority Areas.

Within the project area, the range of condition ranks of Shrubsteppe/Steppe target is roughly similar between roadside and legacy data (Figure 7). Roadside data showed a higher proportion of good (B-rank) points and much lower proportion of poor (D-rank) sample points than legacy data (Figure 7). Range of condition rank of riparian/wetland target between roadside and legacy data was somewhat similar in the proportion of fair (C-rank) sample points but the proportion of poor (D-rank) sample points varied substantially (Figure 8). Legacy data included only C and D ranks (Figure 8).

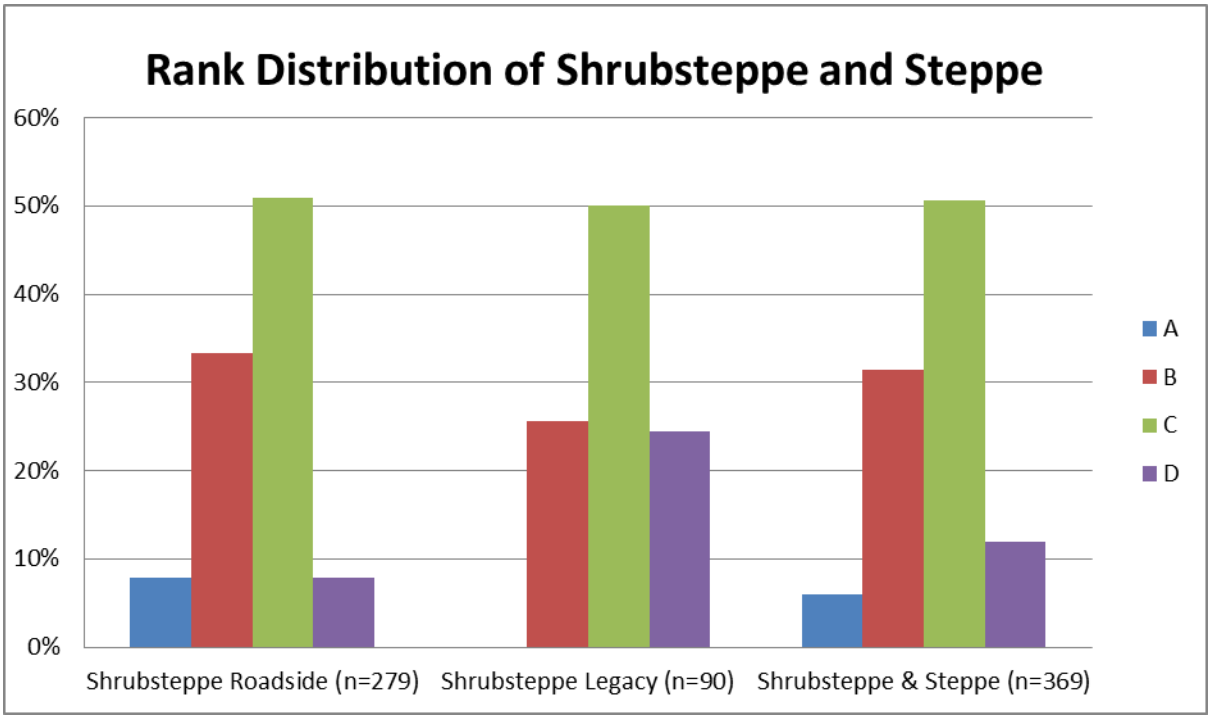


Figure 7. Comparison of Roadside and DNR Legacy Shrubsteppe/Steppe EIA Ranks in all project Priority Areas.

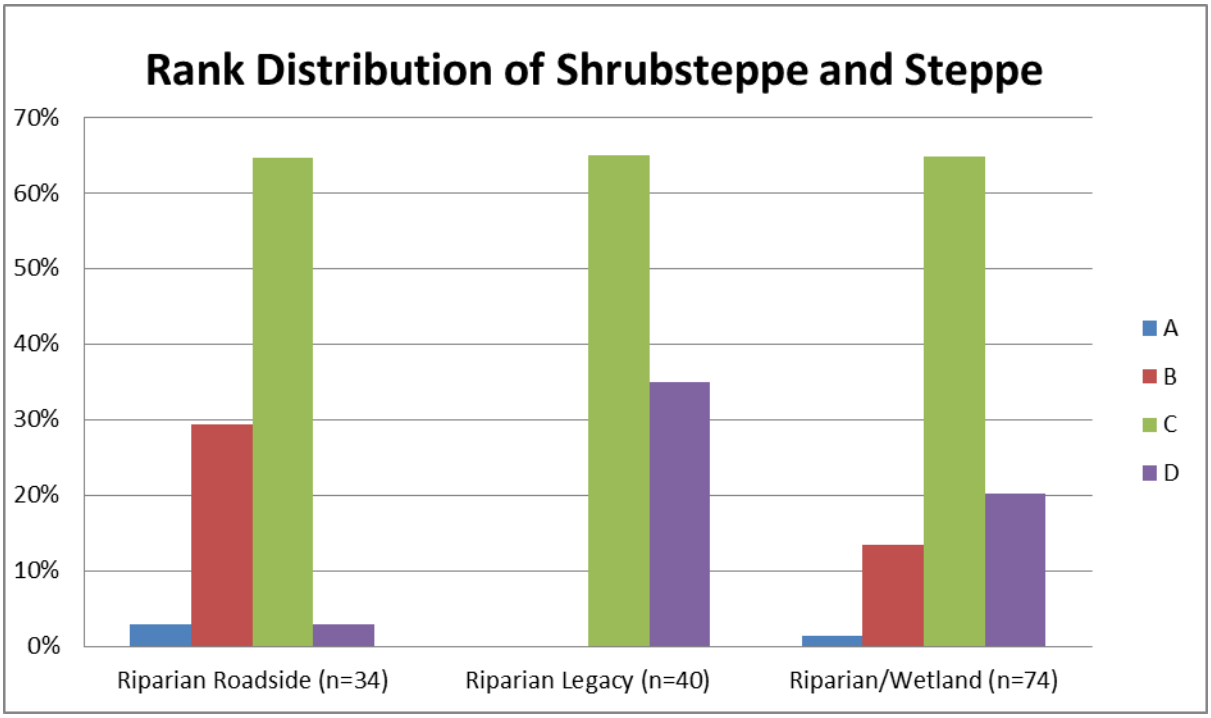


Figure 8. Comparison of Roadside and DNR Legacy Riparian/Wetland EIA Ranks in all project Priority Areas.

5.3.2 Ruderal Vegetation

Ruderal vegetation is defined by the National Vegetation Classification as "semi-natural vegetation that typically results from prior intensive human land use followed by appearance of vegetation that is dominated by spontaneously growing plants that require no human input for their maintenance and have no apparent natural analog; e.g., "old field" vegetation assemblages that do not occur without prior, intensive human activity" (http://esa.org/vegweb2/wp-content/uploads/2013/08/USNVC-FAQ_V1-Aug-2013.pdf.) This vegetation may be difficult to distinguish from D-rank vegetation particularly from the roadside. Its presence generally indicates poor ecological condition of an area. Both roadside and legacy surveys recognized ruderal vegetation in similar proportions, roadside 6% less than and legacy 6% more than 50% (Figure 9). Ruderal in both surveys was primarily based on the dominance of exotic species and some evidence that the site had prior intensive human land use. Figures 10 and 11 show the distribution of samples points across datasets including ruderal shrubsteppe/steppe and ruderal riparian/wetlands. Proportional of ruderal vegetation generally follows D-ranks.

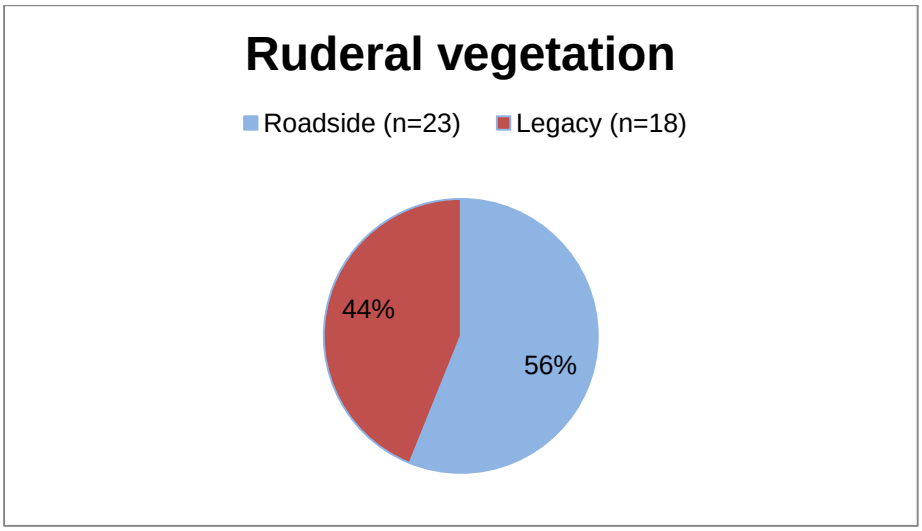


Figure 9. Number of observations of Roadside and DNR Legacy ruderal vegetation in in all project Priority Areas.

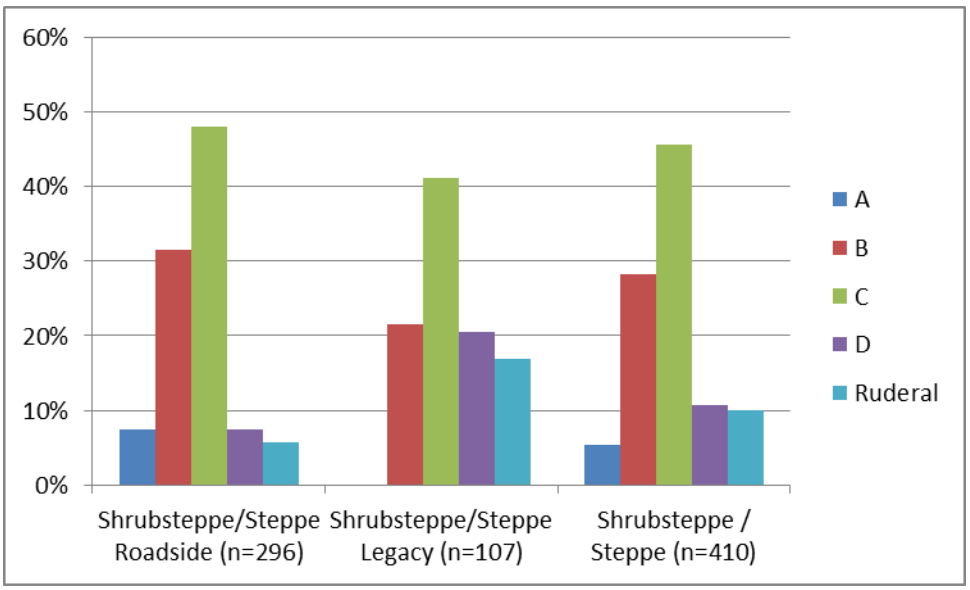


Figure 10. Comparison of Roadside and DNR Legacy Shrubsteppe/Steppe EIA Ranks and ruderal vegetation in all project Priority Areas.

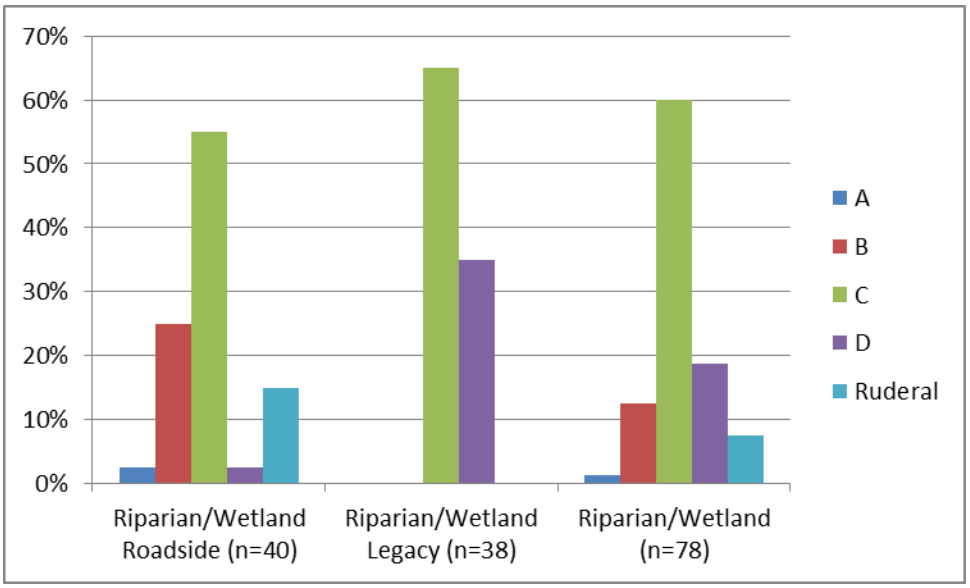
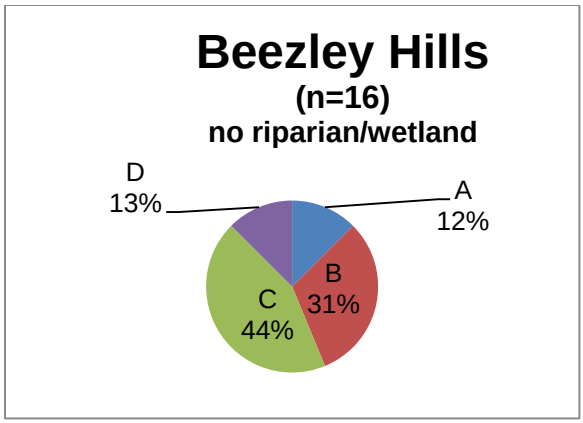
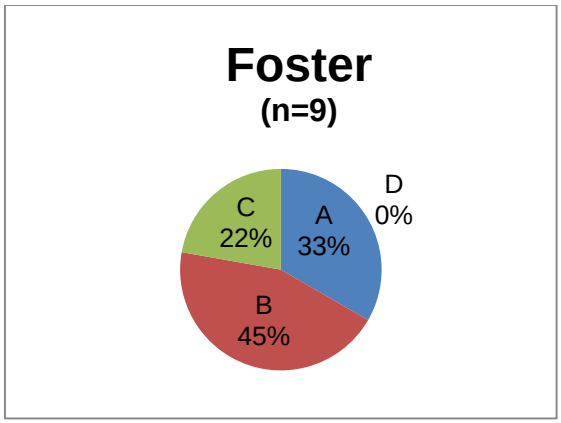


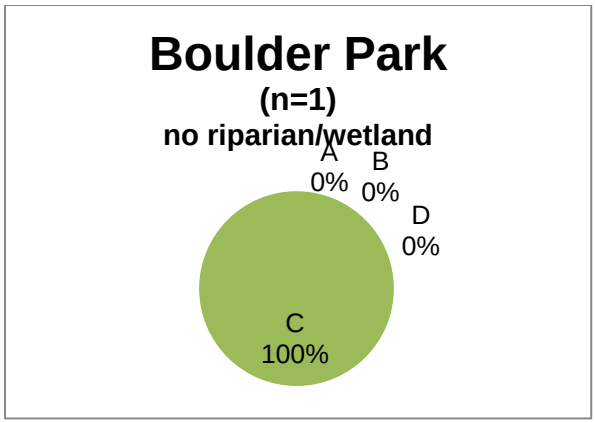
Figure 11 Comparison of Roadside and DNR Legacy Riparian/Wetland EIA Ranks and ruderal vegetation in all project Priority Areas.

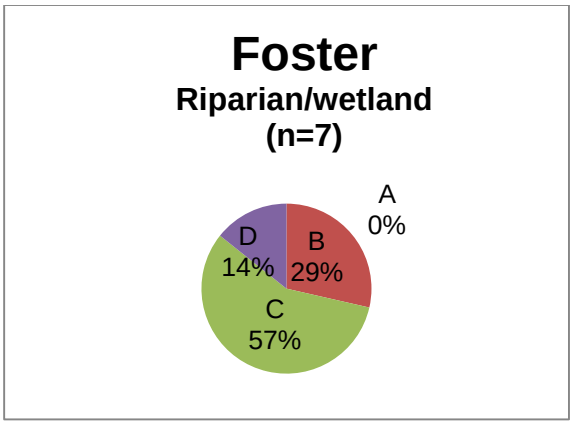
5.2 Ecological Integrity Assessments in Priority Areas

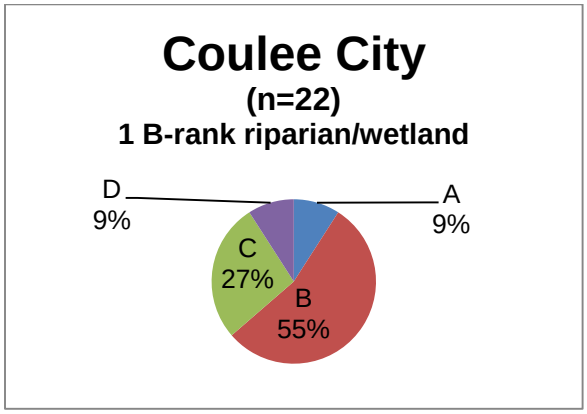
Roadside Assessment of Shrubsteppe/Steppe survey results for each Priority Area are summarized in the charts below (Figure 12). Riparian/Wetland rank distributions are included as a separate graphic unless observations are 2 or less; in those cases, ranks appear in a separate text box. Comparisons with legacy assessments are in Table 10.

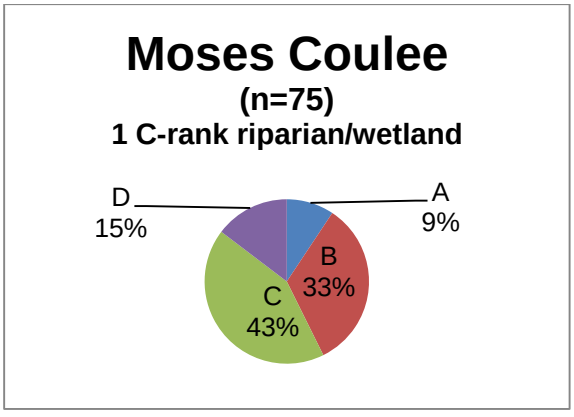

Beezley Hills
(n=16)
no riparian/wetland
D
13%
A
12%
B
31%
C
44%

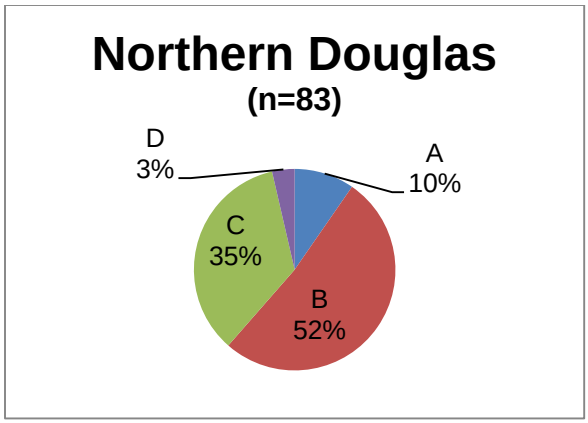

Foster
(n=9)
D
0%
C
22%
A
33%
B
45%

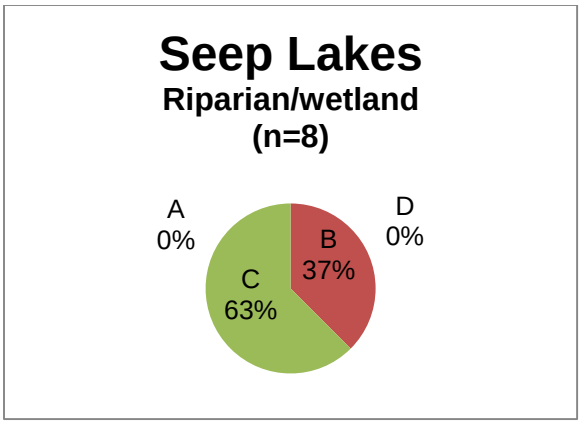

Boulder Park
(n=1)
no riparian/wetland
A
0%
B
0%
D
0%
C
100%

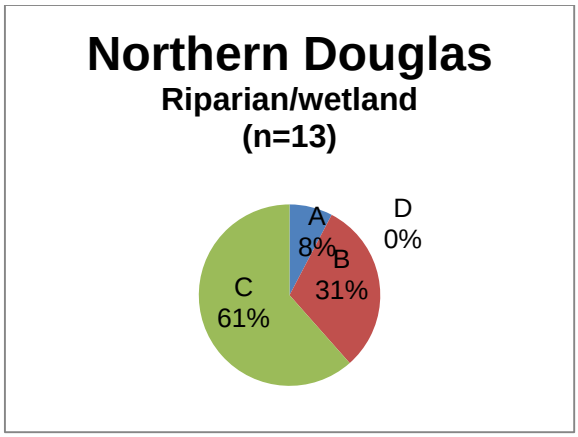

Foster
Riparian/wetland
(n=7)
A
0%
D
14%
B
29%
C
57%

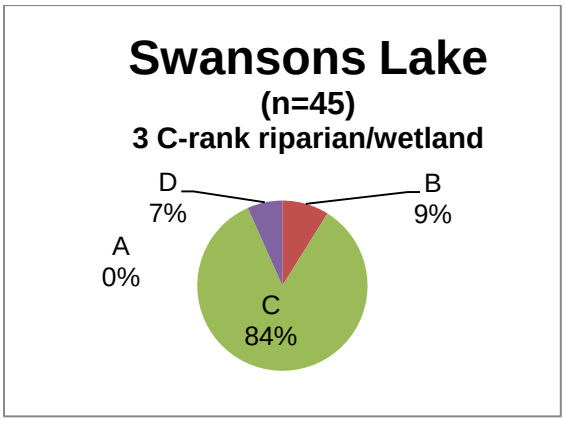

Coulee City
(n=22)
1 B-rank riparian/wetland
D
9%
A
9%
C
27%
B
55%

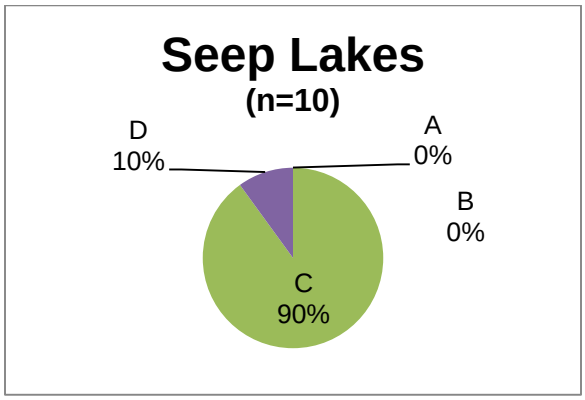

Moses Coulee
(n=75)
1 C-rank riparian/wetland
D
15%
A
9%
B
33%
C
43%











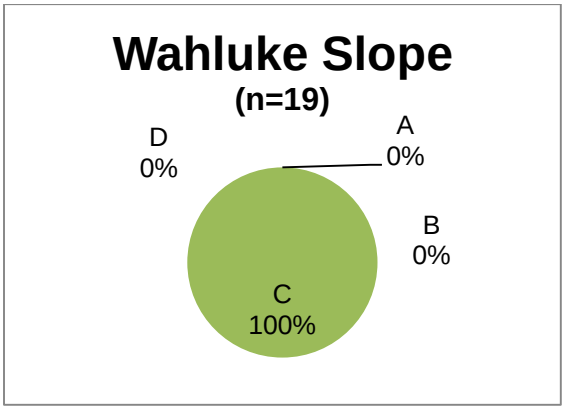


Figure 12. Proportion of roadside condition ranks assigned to samples in individual Priority Areas. Charts are Shrubsteppe/Steppe unless labeled otherwise; Riparian/Wetland rank distributions are included as a separate graphic unless observations are 2 or less; in those cases, ranks appear in a separate text box

6. Conclusions and Lessons Learned

Ecological Integrity Assessment (EIA) is a procedure used to estimate the condition of sites by ranking and summarizing metrics appropriate to given ecological systems. Originally EIA was developed to be applied at three different scales: Level-1 uses remotely sensed data, typically aerial imagery, landscape maps, GIS modeled relationships, etc., Level-2 uses on-site rapidly assessed ecological information, i.e. plant species abundances, soil characteristics, site disturbance, and Level-3 gathers intensive field plot data. This project evaluated an intermediate assessment between levels 1 and 2, a rapid on-site evaluation from travel corridors (i.e., roadsides) that gives finer-grain information than available from Level-1 GIS layers and more coarse-grain than Level-2 on-site evaluations. The roadside EIA allows an efficient application of EIA metrics over a larger area and over land with restricted access.

6.1 Roadside EIA

The intermediate roadside EIA provided a reasonable estimate, typically within a single rank, of the condition of the landscape when compared to on-site EIAs (see section 5.1). Forty-three on-site Level-2 EIA target samples within the visual field of roadside sample points were compared to roadside EIA assessments with 72% overall accuracy (that is when roadside rank equals on-site rank). Thirty-two Shrubsteppe/Steppe target locations were compared and eleven riparian/wetland locations were compared. All misclassified roadside ranks are within one rank of the level-2 rank. Riparian/wetland locations overall showed lower accuracy than Shrubsteppe/Steppe. Overall, roadside EIAs tended to result in higher ranks (i.e., suggested higher ecological integrity) than level-2 ranks. These results indicate that observations from a distance will usually give similar assessments of ecological integrity of both Shrubsteppe/Steppe and riparian/wetland environments but typically with a more favorable impression of the general condition.

Individual metric accuracy varies when using the roadside EIA. The Shrubsteppe/Steppe metrics *Relative Cover of Native Species, Fire-Sensitive Shrub Cover* and *Relative Bunchgrass Cover* showed the least agreement with Level 2 EIA ranks. *Invasive Species Cover* from the roadside agreed with level-2 over two/thirds of the time and was usually rated as a lower rank and one level-2 A-rank was rated C from the road. *Vegetation Composition* was correctly ranked over 60%. *Soil Crust* was difficult to see from the road; only half of the Shrubsteppe/Steppe sites received a rank for this metric. It still was accurate 69% of the time and did not tend to over and under ranked. Level-2 assigned A to 17 of 23 *Soil Surface Condition* ratings with the roadside assessment correctly rating 82% of the time. Level-2 *Soil Surface Condition* B through C ratings was never correct from the road. In conclusion, the two soil surface metrics may not need to be included in Roadside EIAs due to low rate of visibility. The vegetation Shrubsteppe/Steppe level-2 metrics as assessed from the Roadside appear to be more reliable estimators of site condition.

The low sample size and the lack of any A rank and only one D ranked site limits conclusive inferences for comparison of riparian/wetland targets. Recognizing this limitation, the overall riparian/wetland condition rank accuracy is similar to Shrubsteppe/Steppe, the roadside assessment. Only 2 of 11 roadside assessment ratings match level-2 ratings of *Invasive Species* in riparian/wetland and eight underrated the site although all but one was within one rank of level-2. The other vegetation metrics were better with

accuracies of 100% and two 73%. The variability suggests more sampling is needed. Separating riparian and depressional wetlands might better provide an understanding of the relationship between roadside and level-2 EIAs.

6.2 Priority Area Assessment

Comparing roadside ranks with the legacy ranks (summary of condition ratings from previous surveys) was used to give some indication of how well roadside assessments can be generalized to a larger area (Figures 10 and 11; Table 10). The overall condition of Priority Areas was estimated by displaying the frequency distribution of condition ranks from the roadside EIA and from legacy data (2006-2008 area evaluation of DNR land by NHP staff). Legacy surveys characterized condition after a reconnaissance walk-through of parcels up to a square mile. No Roadside samples were located within those parcels. Overall distribution of ranks in both roadside and legacy surveys indicate C as the most common condition. Roadside ranks proportionally indicated more B ranks (as might be expected from results in Section 6.1) and legacy ranks proportionally indicated more D and ruderal vegetation. Both assessment data bases are incomplete samples and some areas are more comprehensively sampled than others. Merging the available on-the-ground data from legacy, roadside and on-site EiA will give the best available, albeit fuzzy, picture of condition of a priority area. Conclusions from these data about individual priority areas need to be tempered by their limited sample sizes.

Table 10. Comparison of the distribution of the number observations of EIA ranks and ruderal vegetation in all project Priority Areas. RS=roadside L= DNR legacy.

		Count of Condition Rank									
Target	Priority Area	A		B		C		D		Ruderal	
		RS	L	RS	L	RS	L	RS	L	RS	L
Shrubsteppe/ Steppe	Beezley	2		5	3	7	2	2			
	Boulder Park				3	1					
	Coulee City	2		12		6	10	2	5	2	8
	Foster	3		4		1					
	Moses Coulee	7		25	14	32	9	11	7	2	
	Northern Douglas	8		43	1	29	18	3	3	2	7
	Seep Lakes					9		1		3	
	Swanson lake			4	2	38	5	3	7		3
	Wahluke Slope					19	1			8	
Riparian/ Wetland	Boulder Park						1				
	Coulee City			1			11		3	1	
	Foster			2		5		1			
	Moses Coulee					1	6		4		
	Northern Douglas	1		4		8	3		5	1	
	Seep Lakes			3		5				3	
	Swanson lake					3	5		2	1	
	total	23	0	103	23	164	71	23	36	23	18

6.3 Overall Condition of Priority Areas

Providing an overall assessment of the condition of priority areas is an objective of this project. Table 11 sums all roadside and legacy ranks for each area and rolls them up into a single overall score (see section 4.3.2). These results, taken at face value, indicate that Foster Creek and Boulder Park are the highest condition areas and Swanson Lake is the lowest, although the latter is still a C rank. Comparison among priority areas for this project needs to seriously consider the number of samples per area and the samples per area size.

Table 11. Priority Area condition ranks and overall condition rank.

Priority Area	Rank				Total Sites	Total Score	Overall Rank
	A	B	C	D			
Foster	3	6	6	1	16	2.69	BC
Boulder Park	0	3	2	0	5	2.60	BC
Beezley	2	8	9	2	21	2.48	CB
Northern Douglas	9	48	58	11	126	2.44	CB
Moses Coulee	7	39	48	22	116	2.27	CB
Coulee City	2	13	27	10	52	2.13	C
Seep Lakes	0	3	14	1	18	2.11	C
Wahluke Slope	0	0	20	0	20	2.00	C
Swanson lake	0	6	51	12	69	1.91	C

6.4 Monitoring Network

The roadside EIA protocol and procedures provides a baseline for monitoring over the long-term as outlined in Rocchio and Crawford (2011) for all EIA levels. Periodically relocating samples along publicly accessible roads and repeating measurement of the metrics and the EIA ranks will give a basis for detecting trends in landscape condition. The sample locations established during this protocol development project can serve as the start of building a more comprehensive network of monitoring locations that address specific needs of each area as well as the whole of the Columbia Basin.

6.5 Caveats and Limitations

There are some key caveats and limitations with this study. One important caveat is that all samples are taken from the roadside. While an effort was made to assess the area outside of the immediate roadside, there still could be impacts from the proximity of the road. It is not clear if the condition of the area assessed is generally the same as the area further beyond the visual limit of the observer. It is not known whether the summary of all points tells us **only** about the roadside conditions of the priority area or anything beyond the visual area into the whole priority area.

Another limitation of this project was that it focused only on "priority core areas" of the ALI spatial design. It did not sample any areas within connectivity zones. Connectivity is an important part of the ALI design. There might be a need to develop a set of metrics that are more tailored towards connectivity. Finally, this assessment work focused on vegetative and soil conditions of ecological systems. It did not consider any wildlife characteristics.

6.6 Lessons Learned for Future Work

This project was a pilot to test whether a rapid, roadside protocol would work for assessing the condition of priority areas. Some of the key lessons learned are:

1. Remote roadside EIAs provide a reasonable estimate, within a single rank, of the condition of the area in the view of a roadside or fence-side observer. Rank estimates within a single rank are also found in between-observer comparisons although more sampling is needed to clarify this.

2. Extrapolation of roadside condition assessments to the entire landscape of the Priority Areas needs further exploration. The general assumption behind this project is that with a proper density of sample points, the general condition of the priority areas will be reasonably estimated. However, we don't have rigorous estimates of what the "proper density" should be. For this study, we chose a density that was a compromise between budget and ability to cover as much area as possible. This will always be a tradeoff in any sampling scheme. Further research is needed to answer the question "how much sampling is enough" to arrive at a stable estimate of condition for an area. Also, as discussed above, the roadside bias is not known. Future work could address whether there are significantly different results by sampling areas 100+ meters from any road.

3. Observers for this project noted that the range of conditions of the roadside vegetation may have not been fully represented with the protocol used, that is, by sampling one or two points at random locations on road lengths through hexagons. Changing the sample design from random locations to assessing pre-drawn polygons or to observer-determined stretches of a travel corridor could improve roadside assessment of an area.

4. In application of the EIA, recording estimates of raw data used to rank metrics (e.g., cover of invasive species, native species, total vegetation cover, cover of roads/trails, etc) rather than the EIA rank categories are more direct measures that will allow EIA class values to be derived in the office. Estimating cover values might help in level 1 mapping and assessment.

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8. Appendix

Appendix A. Ecological Systems and Condition Metrics used in Roadside Ecological Integrity Assessments. Complete EIAs include landscape and size metrics not used here.

Applicable Ecological Systems	Metric Code	Metric	"A" Excellent Rating	"B" Good Rating	"C" Fair Rating	"D" Poor Rating
All	M08	Absolute Cover of Invasive Species	None or minimal (0-3 %) present.	Invasive species present, but sporadic (4-10% cover).	Invasive species prevalent (10-30% absolute cover).	Invasive species abundant (>30% absolute cover).
All	M10	Relative Cover of Native Plant Species	Cover of native plants 99-100%. In forests, only consider understory native species.	Cover of native plants 85-99%. In forests, only consider understory native species.	Cover of native plants 60 to 85%. In forests, only consider understory native species.	Cover of native plants <60%. In forests, only consider understory native species.
M10a thru M10d record mid-pt of cover class for native trees, native shrubs, native herbs, and exotic plants. **M10e = sum of cover class mid-points for M10a 10b & 10c** **M10f = 10e / 10d +10e**					**Cover class(mid-pt)** **<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)** **95-100 (97.5)**
All	M12	Native Vegetation Composition	Vegetation composition minimally to not disturbed: i) Typical range of native diagnostic species present, including those native species sensitive to anthropogenic degradation, AND ii) Native species indicative of anthropogenic disturbance (i.e., increasers, weedy or ruderal species) absent to minor.	Vegetation composition with minor disturbed conditions: i) Some native diagnostic species absent or substantially reduced in abundance, AND ii) Some native species indicative of anthropogenic disturbance (increasers, weedy or ruderal species) are present but minor in abundance.	Vegetation composition with moderately disturbed conditions: i) Many native diagnostic species absent or substantially reduced in abundance, AND ii) Species are still largely native and characteristic of the type, but they also include increasers, weedy or ruderal species.	Vegetation 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 from entire strata may be absent or species are dominated by ruderal ("weedy") species, or comprised of planted stands of non-characteristic species, or unnaturally dominated by single species.
M12 Comments: **Shrubsteppe native increasers** big sagebrush, rabbitbrush, horsebrush Mesic site - Hesperostipa comata, Balsamorhiza. Lupinus, Achillea. Dry site- Balsamorhiza. Lupinus, Achillea. **Wetland native increasers** Baltic rush, cattail, purple iris, big sagebrush, high cover of most natives where few other natives present.						

Forested Riparian	M14a	Vegetation Structure	Canopy a mosaic of small patches of different ages or sizes, including old trees and canopy gaps containing regeneration, AND number of live stems of medium size (30-50 cm / 12-20"dbh) and large size (>50 cm / >20" dbh) well within expected range. In riparian areas, woody species are of sufficient size to provide future LWD to stream or floodplain.	Canopy largely heterogeneous in age or size, but with some gaps containing regeneration or some variation in tree sizes, AND number of live stems of medium and large size within or very near expected range. In riparian areas, woody species are of sufficient size to provide future LWD to stream or floodplain.	Canopy somewhat homogeneous in age or size, AND number of live stems of medium and large size below but moderately near expected range. In riparian areas, woody species are mostly not sufficient size to provide future LWD to stream or floodplain.	Canopy very homogeneous, in size or age OR number of live stems of medium and large size well below expected range. In riparian areas, woody species are not of sufficient size to provide future LWD to stream or floodplain.
Wet Meadow, Marsh, Shrubland	M14b	Vegetation Structure	Vegetation structure is at or near minimally disturbed natural conditions. Little to no structural indicators of degradation evident. 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.	Vegetation structure shows minor alterations from minimally disturbed natural conditions. Structural indicators of degradation are minor (e.g. levels of grazing, mowing). Shrubs (Spiraea or Rosa sp.) cover (5-10%) in wet prairies due to fire suppression.	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.	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 wet prairies due to fire suppression.
Aquatic Bed	M14e	Vegetation Structure	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.	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.	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.	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.

Forested Swam	M14f p	Vegetation Structure	Swamp is dominated by conifers or mixture of conifers/hardwoods; 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 (e.g., large downed wood from wind storms or fire scars).	Swamps are dominated by conifers or mixture of conifers/hardwoods. 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.	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.	Considering the natural stand development stage, most, if not all, old trees have been harvested. None or rare old trees present.
Forested Swamp or Riparian	M15	Coarse Woody Debris (wetland)	A wide size-class diversity of downed coarse woody debris (logs) and standing snags present and common or frequently observed.	Moderate to small size-classes of downed coarse woody debris (logs) and standing snags are more prevalent;	Coarse woody debris (logs) and standing snags are of a small size class	Coarse woody debris (logs) and standing snags are absent to or rarely observed
Forested Swamp or Riparian	M16	Woody Regeneration	Native tree saplings and/or seedlings or shrubs common to the type present in expected amounts and diversity; obvious regeneration.	Native tree saplings and/or seedlings or shrubs common to the type present but less amounts and diversity than expected.	Native tree saplings and/or seedling or shrubs common to the type present but low amounts and diversity; little regeneration.	No, or essentially no regeneration of native woody species common to the type.
HGM: Riverine	M17b	Water Source	Water source is natural, site hydrology is dominated by precipitation, groundwater, and natural runoff from an adjacent freshwater body. System may naturally lack water at times, such as in the growing season. 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.	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, or the presence of small storm drains 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.	Water source contains a large component of urban runoff, direct irrigation, pumped water, 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.	Bare soil areas substantial and contribute to altered hydrology or other long-lasting impacts. Deep ruts from Off-road-vehicles or machinery may be present, or livestock soil trampling and/or trails are widespread. Water will be channeled or ponded. The site will not recover without restoration and/or long recovery times.

Flats (Greasewood)	M17c HGM:	Water Source	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.	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.	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.	Water source is substantially impacted by impoundments or diversions of water or other input into or withdrawals directly from the site, its encompassing wetland, or from areas adjacent to the site or its wetland.
HGM: Nonriverine (freshwater	M17d)	Water Source	Water source is natural: site hydrology is dominated by precipitation, groundwater, natural runoff from an adjacent freshwater body, or the system naturally lacks water in some periods. 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.	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, or the presence of small storm drains 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.	Water source is primarily urban runoff, direct irrigation, pumped water, 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.	Water source exists but has been substantially diminished by known impoundments or diversions of water or other withdrawals directly from the site, its encompassing wetland, or from areas adjacent to the site or its wetland, OR water sources has been severely altered to the point where they no longer support much vegetation (e.g., flashy runoff from impervious surfaces).
HGM: Riverine	M18b <u>see indicator list at bottom of form</u>.	Hydroperiod	Most of the channel/riparian zone characterized by equilibrium conditions, with no evidence of severe aggradation or degradation (based on the field indicators—see bottom of sheet).	Most of the channel/riparian zone characterized by some aggradation or degradation, none of which is severe, and the channel seems to be approaching equilibrium (based on the field indicators—see bottom of sheet).	Most of the channel/riparian zone characterized by severe aggradation or degradation (based on the field indicators—see bottom of sheet).	Most of the channel is concrete or artificially hardened (based on the field indicators—see bottom of sheet).

HGM: Flats (Greasewood)	M18c	Hydroperiod	Stable, saturated hydrology, or naturally damped cycles of saturation and partial drying. There are no major hydrologic stressors that impact the hydroperiod.	Minor altered inflows or drawdown/drying discharge due to stressors such as small ditches or diversions; berms or roads at/near grade; minor pugging by livestock; or minor flow additions.	Moderately altered by increased runoff, or drawdown and drying due to stressors such as ditches/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.	Substantially altered by increased inflow from runoff, or significant drawdown and drying due to stressors such as a 4-lane highway; large dikes impounding water; diversions >3ft. deep that withdraw a significant portion of flow; large amounts of fill; significant artificial groundwater pumping or heavy flow additions.
Nonriverine (freshwater)	M18d HGM:	Hydroperiod	Natural patterns associated with inundation – drawdown, saturation, and seepage discharge. There are no major hydrologic stressors that impact the hydroperiod.	Some alteration to the natural patterns associated with inundation, drawdown, saturation, and seepage discharge due to 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 due to human activity. *If wetland hydrology is artificially controlled*, the management regime closely mimics a natural analogue (***it is very unusual for a purely artificial wetland to be rated in this category***)	Moderate alteration to the natural patterns associated with inundation, drawdown, saturation, and seepage discharge due to stressors such as ditches/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. Outlet may be moderately restricted by human activity but flow is still possible. *If wetland hydrology is artificially controlled*, the management regime approaches a natural analogue. Site may be passively managed, meaning that the hydroperiod is still connected to and influenced by natural high flows timed with seasonal water levels.	Significant alteration to the natural patterns associated with inundation, drawdown, saturation, and seepage discharge due to stressors such as a 4-lane highway; large dikes impounding water; 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 hydrology is artificially controlled*, the site is actively managed and has limited (if any) resemblance to natural seasonal fluctuations.

Riverine	M19b HGM:	Hydrological Connectivity	Completely connected to floodplain (backwater sloughs and channels). No geomorphic modifications made to contemporary floodplain. Channel not entrenched.	Minimally disconnected from floodplain due to levees, road grades, tide gates, elevated culverts, or other human structures which limit the lateral movement of floodwaters, relative to what is expected for the setting. Up to 25% of stream banks are affected.	Moderately disconnected from floodplain due to levees, road grades, tide gates, elevated culverts, or other human structures which limit the lateral movement of floodwaters, relative to what is expected for the setting. Between 25-75% of stream banks are affected.	Extensively disconnected from floodplain due to levees, road grades, tide gates, elevated culverts, or other human structures which limit the lateral movement of floodwaters, relative to what is expected for the setting. >75% of stream banks are affected.
Flats (Greasewood)	M19c HGM:	Hydrological Connectivity	No or very little direct connectivity to groundwater. Precipitation is the dominant or only source.	Minor increase in lateral hydrological connectivity non-precipitation water source due to ditches, diversions or other human activity.	Moderate increase in lateral hydrological connectivity with non-precipitation water source due to ditches, diversions or other human activity.	Substantial increase or full connectivity with non-precipitation water source due to ditches, diversions or other human activity.
Nonriverine (freshwater	M19d HGM:)	Hydrological Connectivity	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.	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 then impermeable soil layer partly disturbed (e.g., from drilling or blasting). Restrictions may be intermittent along the site. Flood flows may exceed the obstructions, but drainage back to the wetland is incomplete due to impoundment.	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 then 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.	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 then impermeable soil layer strongly disturbed.

All	M20a	Soil Surface Condition	Bare soil areas are limited to naturally caused disturbances such as flood deposition or game trails.	Small amounts of bare soil areas due to human causes are present but the extent and impact is minimal. The depth of disturbance is limited to only several centimeters (a few inches) and does not show evidence of ponding, channeling water, or effects of boat traffic. Wheel tracks or depressions evident, but faint and shallow. Any disturbance is likely to recover within a few years after the disturbance is removed.	Moderate amounts of bare soil areas due to human causes. Soil trampling by livestock can cause 5-10 centimeters (several inches) of soil disturbance. Off-road-vehicles or other machinery may have left some shallow ruts or erosion. Damage is not excessive and the site will recover to potential with the removal of degrading human influences and moderate recovery times.	Bare soil areas substantial and contribute to altered hydrology or other long-lasting impacts. Deep ruts from Off-road-vehicles or machinery may be present, or livestock soil trampling and/or trails are widespread. Water will be channeled or ponded. The site will not recover without restoration and/or long recovery times.
All	M39	Relative Cover of Native Bunchgrass	Perennial bunchgrass **relative cover** >80% or cover or near site potential.	Perennial bunchgrasses 50-80% **relative** cover or reduced from site potential.	Perennial bunchgrasses 30-50% **relative** cover or reduced from site potential.	Perennial bunchgrass <30% **relative** cover and much reduced from site potential.
M39a = record absolute cover of native bunchgrass cover class mid-pt (see M10 for values) **M39b = M39a/ 10d +10e** M39 Comments: **Native Deep-rooted Bunchgrass -**Idaho & rough fescue, Bluebunch wheatgrass, junegrass, needlegrasses on sandy/coarse texture sites						
not PALOUSE	M33b	Absolute Cover of Ground Mosses and Lichens (Biological Soil Crust)	Largely intact biological soil crust that nearly matches the site capability where natural site characteristics are **not** limiting, i.e. steep unstable, south aspect, dense native grass.	Biological soil crust is evident throughout the site but its continuity is broken.	Biological soil crust is present in protected areas and with a minor component elsewhere.	Biological soil crust, if present , is found only in protected areas.
Palouse Foothill Grassland	M34a	Shrub Cover	None or minimal cover (<5%) of shrubs taller than grass layer.	5-10% cover of shrubs taller than grass layer.	10-25% cover of shrubs taller than grass layer	>25% cover of shrubs taller than grass layer
M34a Comments: **tall shrub increasers:** hawthorn, snowberry cherry, rose, etc						
Palouse Foothill Grassland	M41b	Tree Encroachment	Tree species, if present, consists of widely scattered large, old trees.	Trees at densities of <4 individuals/acre regardless of size.	Trees numerous as seedlings/saplings/small trees.	Trees numerous as seedlings/saplings/small trees and >25% cover.

Shrubsteppe	M36a	Fire-sensitive Shrubs	Fire-sensitive shrubs mature and recovered from past fires; shrubs generally 3-10% cover	Fire-sensitive shrubs not recovered from past fires; represented mostly as seedlings less than height of bunchgrasses. shrubs generally <20% cover	Shrub >20% cover beginning to affect bunchgrass layer	Shrubs well >20% cover reducing bunchgrass layer or sagebrush or bitterbrush only scattered individuals or seedlings
M36a Comments: **fire sensitive shrubs**: sagebrush, bitterbrush *After stressors on mapper*						