# Ecological Condition and Functions of Enhanced, Restored, and Reference Wetlands in the Willamette Valley, Oregon

Report to the
Oregon Watershed Enhancement Board
Salem, Oregon

by
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## Electronic Appendices

(available from OWEB or the author, see text for description)

PlantSpPlots.xlsx
BirdSpSites.xlsx
AllMetrics.xlsx
CorrAll.xlsx
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PlotPhotos.zip

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Cover: Jackson-Frazier restored wet prairie, Corvallis, Oregon

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# 1.0 Introduction

Since 1997, the Oregon Watershed Enhancement Board (OWEB) has funded many projects throughout Oregon whose objective is to restore former wetlands or enhance the ecological condition and functions of existing ones. This has been done under the Oregon Plan for Salmon and Watersheds. The Oregon Department of State Lands (DSL) is charged with ensuring that wetlands impacted by permitted activities are successfully replaced by required mitigation and that applicants adhere to permit conditions. However, with the exception of data collected from 93 reference and mitigation wetlands in the Portland area by the USEPA in 1993 (Magee et al. 1999), and data scattered in reports from a few wetland mitigation banks that are monitored currently, there is relatively little systematic data on biological performance and functions of a suite of restored and enhanced wetlands in the Willamette Valley. Effectiveness monitoring and evaluation must be a consistent part of wetland restoration and mitigation projects in order to realize the full benefit possible under the State's programs.

This report and accompanying electronic data are the products of a project funded through an EPA Region 10 Wetland Program Development Grant. It was a coordinated effort between OWEB, DSL, The Xerces Society for Invertebrate Conservation (Xerces), and Adamus Resource Assessment, Inc.(ARA). The project has had two components, one focused on wetland invertebrates as indicators of wetland condition and conducted by Xerces, and the other focused on vegetation composition and wetland functions (and secondarily on birds, amphibians, and soil chemistry) conducted by ARA, and the latter is the subject of this report. Results of the invertebrate component are being published separately, so the invertebrate data from Xerces are discussed in this report only when comparing with data collected by this component of the project. Together, these two components have established a more realistic picture of the level of the biological quality and ecological function of restored, enhanced, and reference wetlands throughout the Willamette Valley. Guidance that may result from this work should enhance the likelihood of achieving state and federal objectives associated with "no net loss" and wetland gain policies.

# 2.0 Methods

## 2.1 Methods Synopsis

In a series of Willamette Valley wetlands, standardized protocols were used in 2009 and 2010 to primarily assess (a) vegetation species composition and (b) relative levels of ecosystem services in a series of Willamette Valley wetlands. Of the 50 wetlands visited, 34 were classified as riverine and 26 as flats (see Table 1 for definitions). Of the 34 riverine wetlands, 21 are believed to be restored or enhanced. Of the 26 flats wetlands, the same number are believed to be restored or enhanced. Also, 13 riverine and 6 flats wetlands that to our knowledge have not been recently restored or enhanced were visited to provide reference data. Those sites were not selected to represent "least altered" conditions, that being a rather subjective determination in a region as impacted as the Willamette Valley. No opportunities were identified to make before-and-after comparisons of restoration or enhancement practices during the two-year span of this project. To meet the sampling needs of Xerces, all the surveyed wetlands were ones that had a significant area of surface water that persisted at least through early June. No sites that were entirely wet prairies or vernal pools were surveyed. Aquatic plants located in places where water was deeper than about 2 feet were not surveyed.

The protocols were applied by the same person (Paul Adamus) during a single visit each year. Additionally and in 2009 only, selected compounds in the soil from each site were analyzed. During both years, incidental detections of birds and amphibians were also recorded. Between one and three wetlands were assessed per sampling day, depending on their size and proximity.

Table 1. Definitions of some technical terms used in this report

| Term | Definition as Used in This Report |
|---|---|
| Ecological Condition | The quality or integrity of a site as reflected partly by the similarity of its biological communities to those in areas not significantly impacted by human activities |
| Co-dominants | Species that comprise 10% or more of a sampling unit |
| Dominants | Species that comprise more than 50% of a sampling unit |
| Ecosystem Services | The functions of an ecosystem and the values placed on them partly due to their context in the landscape |
| Enhancement | Management actions undertaken to change wetland condition and/or functions to a state more preferred by a landowner, agencies, or others. |
| Facultatives | Plant species almost equally associated with wetlands and uplands as indicated in 1996 list from USFWS |

| Term | Definition as Used in This Report |
|---|---|
| Flats | Wetlands in flat terrain that receive a significant portion of their water from direct precipitation, and secondarily from groundwater and runoff. They usually lack natural outlets. |
| Forbs | Leafy herbaceous plants, including wildflowers, ferns, and others |
| Functions | The things that wetlands do, such as store and purify water, provide habitat |
| Graminoids | Grasslike plants such as sedges, rushes, and grasses |
| Indicators | Measured variables that are useful for informing about particular conditions or functions. |
| Invasives | For this study, plant species listed as invasive in this region in Adamus et al. (2009a) |
| Metrics | Indices calculated from indicator data that summarize condition or functions |
| Non-Native Birds | For this study, includes the following species that were encountered: European starling, house sparrow, California quail, and ring-necked pheasant |
| Nonnatives | For this study, plant species listed as non-native in this region in Adamus et al. (2009a) |
| Obligates | Plant species strongly associated with wetlands as indicated in 1996 list from USFWS |
| Restoration | Management actions undertaken to change wetland condition and/or functions to something closer to its original state |
| Richness | The number of species or other taxa per unit area |
| Riverine | Wetlands with unidirectional flow that occurs at least once every two years. Includes most impounded and excavated channels and ditches, as well as stream riparian areas and river floodplains. |
| Stressors | Factors that are likely to cause wetland conditions to exceed natural levels of variation; usually applied in the context of human actions |
| Wetland Birds | Species which in this region are believed to occur disproportionately in wetlands and were found during this study. Includes all waterfowl, shorebirds, 2 raptors (osprey, northern harrier), and the following passerines: belted kingfisher, willow flycatcher, tree swallow, marsh wren, warbling vireo, common yellowthroat, yellow warbler, red-winged blackbird. |

## 2.2 Site Selection

Wetlands for this study were chosen by Xerces in collaboration with OWEB and DSL. They were chosen selectively rather than randomly and thus cannot be construed to be a probabilistic or representative sample of Willamette wetlands or mitigation projects. This selection approach was necessary in order to easily find enough accessible wetlands of two types (riverine and flats) that fit three management action categories: (restored, enhanced, reference). See Brinson (1993) and Adamus & Field (2001) for definitions of riverine and flats classes (HGM classes). Candidate sites were pre-assigned to categories for management action and HGM class. In a few cases an assigned category was revised as a result of conditions observed during subsequent field work. Table 2 lists the sites with their geographic coordinates and sampling dates.

During both years, all the wetlands that Xerces had selected for their analysis of aquatic macroinvertebrate communities and water quality during 2007-2010 were surveyed. (For selection criteria and partial results, see Mazzacano et al. 2009). An additional five wetlands selected by the DSL were also visited, and were assessed only to estimate the relative levels of their ecosystem services and not their vegetation composition or soil chemistry. Three wetlands visited in 2009 were not revisited in 2010; they were replaced by three new ones in which macroinvertebrates were also sampled by Xerces.

Table 2. Survey dates and coordinates for wetlands surveyed for this study

| Site | Date Yr1 | Date Yr2 | Coordinates Yr1 | Coordinates Yr2 |
|---|---|---|---|---|
| Alton Baker | 6/11/2009 | 6/3/2010 | N44 03.423 W123 04.430 | N44 03.423 W123 04.454 |
| Ankeny | | 8/31/2010 | | N44 47.978 W123 05.192 |
| Arbor Stn | 6/16/2009 | 5/25/2010 | N45 30.500 W122 51.375 | N45 30.500 W122 51.380 |
| Arleda-Willow | 5/21/2009 | 8/30/2010 | N45 30.807 W122 52.671 | N45 30.808 W122 52.669 |
| Aumsville | 8/7/2009 | | N44 49.911 W122 51.365 | |
| Beggars Tick | 6/30/2009 | 8/17/2010 | N45 28.842 W122 33.058 | N45 28.842 W122 32.978 |
| Bergey | 6/26/2009 | 7/20/2010 | N44 10.952 W123 15.510 | N44 10.964 W123 15.404 |
| Bristow | 7/7/2009 | 8/25/2010 | N43 56.380 W122 50.284 | N43 56.375 W122 50.288 |
| Budeau N | 7/16/2009 | 7/19/2010 | N44 49.240 W122 57.067 | N44 49.238 W122 57.069 |
| Budeau S | | 7/19/2010 | | N44 49.153 W122 56.989 |
| Buford E | 6/9/2009 | 6/3/2010 | N43 59.595 W122 56.622 | N43 59.595 W122 56.623 |
| Cedar Mills TWC | 9/2/2009 | 5/25/2010 | N45 31.092 W122 48.061 | N45 31.090 W122 48.087 |
| Corvallis Airport | 5/28/2009 | 6/11/2010 | N44 30.200 W123 16.743 | N44 30.200 W123 16.742 |
| Coyote WMA | 6/10/2009 | 8/24/2010 | N44 02.537 W123 15.684 | N44 02.535 W123 15.687 |
| Deer Creek Park | 5/27/2009 | | N45 09.945 W123 23.338 | |
| Delta Pond | 8/27/2009 | 7/12/2010 | N44 04.673 W123 06.485 | N44 04.671 W123 06.431 |
| EE Wilson Northwest | 8/31/2009 | 9/5/2010 | N44 43.104 W123 12.895 | N44 43.100 W123 12.924 |
| Endicott | 7/10/2009 | 7/23/2010 | N44 31.895 W123 14.848 | N44 31.897 W123 14.844 |
| Finley Brown Swamp | 9/3/2009 | 8/27/2010 | N44 25.739 W123 19.273 | N44 25.737 W123 19.274 |
| Finley McFadden | 9/4/2009 | 8/27/2010 | N44 23.367 W123 17.975 | N44 23.367 W123 17.975 |
| Finley Prairie N | | 5/24/2010 | | N44 25.583 W123 18.461 |
| Fisher Butte | 6/26/2009 | 8/24/2010 | N44 03.300 W123 15.470 | N44 03.299 W123 15.384 |
| Garden Lakes | 7/8/2009 | 6/1/2010 | N43 55.252 W123 00.641 | N43 55.256 W123 00.642 |
| Greenberry (Tyee) | 8/11/2009 | | N44 27.795 W123 19.125 | |
| Harrisburg | 6/23/2009 | 7/20/2010 | N44 16.567 W123 10.447 | N44 16.592 W123 10.457 |
| Hatch | 7/16/2009 | 7/19/2010 | N44 46.381 W122 50.935 | N44 46.379 W122 50.951 |
| Hedges Park | 7/3/2009 | 5/27/2010 | N45 23.111 W122 45.800 | N45 23.109 W122 45.801 |
| Hedges TWC | 7/15/2009 | 5/27/2010 | N45 23.062 W122 46.028 | N45 23.054 W122 46.043 |
| Jackson-Frazier | 8/20/2009 | 9/3/2010 | N44 36.360 W123 14.369 | N44 36.361 W123 14.367 |
| Jampolsky | 6/25/2009 | 7/23/2010 | N44 10.386 W123 14.888 | N44 10.386 W123 14.886 |
| Knez TWC | 6/15/2009 | 8/17/2010 | N45 25.794 W122 45.577 | N45 25.803 W122 45.571 |
| LaFolett | 7/13/2009 | 8/30/2010 | N45 30.387 W123 03.801 | N45 30.385 W123 03.810 |
| McDonald Forest | 8/21/2009 | 7/16/2010 | N44 38.420 W123 18.734 | N44 38.422 W123 18.750 |

| Site | Date Yr1 | Date Yr2 | Coordinates Yr1 | Coordinates Yr2 |
|---|---|---|---|---|
| Mt. Pisgah Arboretum | 6/11/2009 | 8/26/2010 | N44 00.140 W122 58.787 | N44 00.144 W122 58.774 |
| PCC Rock Cr. | 7/1/2009 | 5/26/2010 | N45 34.106 W122 52.011 | N45 34.105 W122 52.014 |
| PDX Vanport | 9/1/2009 | 8/31/2010 | N45 36.203 W122 41.433 | N45 36.202 W122 41.432 |
| Pascuzzi TWC | 7/15/2009 | 5/27/2010 | N45 22.878 W122 47.263 | N45 22.879 W122 47.265 |
| Pearmine | 7/12/2009 | 7/22/2010 | N45 05.905 W122 59.833 | N45 05.894 W122 59.839 |
| Philomath Newton Cr. | 6/1/2009 | 7/13/2010 | N44 32.984 W123 21.538 | N44 32.987 W123 21.543 |
| Randall E | 7/2/2009 | 8/30/2010 | N45 31.617 W123 01.081 | N45 31.617 W123 01.082 |
| SamReynolds (Shippey) | 6/24/2009 | 8/25/2010 | N44 01.273 W123 15.182 | N44 01.274 W123 15.183 |
| Seavy | 5/26/2009 | 5/20/2010 | N44 35.647 W123 14.412 | N44 35.624 W123 14.438 |
| Spongs RFT | 8/10/2009 | 7/9/2010 | N45 00.991 W123 04.428 | N45 00.956 W123 04.442 |
| Spongs RI | 8/10/2009 | 7/9/2010 | N45 00.864 W123 04.192 | N45 00.864 W123 04.196 |
| Springville | 7/13/2009 | 5/26/2010 | N45 33.610 W122 51.188 | N45 33.609 W122 51.187 |
| Stewart Pd N | 6/12/2009 | 8/24/2010 | N44 03.221 W123 09.444 | N44 03.223 W123 09.439 |
| Stewart Pd S | 6/12/2009 | 8/24/2010 | N44 03.038 W123 09.357 | N44 03.038 W123 09.357 |
| Summer Cr | 6/17/2009 | 8/16/2010 | N45 26.372 W122 49.085 | N45 26.375 W122 49.084 |
| Town Ctr (Woodburn) | 5/22/2009 | 7/15/2010 | N45 08.620 W122 47.923 | N45 08.621 W122 47.945 |
| Tualatin Hills | 7/14/2009 | 8/16/2010 | N45 30.174 W122 50.417 | N45 30.175 W122 50.420 |
| Willamette Mission | 8/25/2009 | 7/22/2010 | N45 04.534 W123 03.426 | N45 04.617 W123 03.245 |
| Willamette Park | 7/9/2009 | | N44 32.922 W123 14.830 | N44 32.922 W123 14.830 |
| Willow Creek | 7/6/2009 | 7/23/2010 | N44 02.208 W123 10.375 | N44 02.207 W123 10.375 |
| Wyman | 5/27/2009 | 7/22/2010 | N45 14.013 W123 06.061 | N45 14.014 W123 06.076 |

## 2.3 Assessing Ecosystem Services

The relative levels of 16 potential wetland functions and values (i.e., ecosystem services) were assessed by applying the Oregon Wetland Rapid Assessment Protocol (ORWAP, Adamus et al. 2009a) at each site. Responses to 140 questions about characteristics of a wetland and its surroundings are processed automatically using standardized criteria, resulting in scores on a 0 (lower effectiveness) to 10 (higher effectiveness) scale for each of the functions. In addition, ORWAP provides scores for a wetland's ecological condition, human stressors, relative sensitivity, and contextual value of each of its functions. It is the wetland assessment method recommended for most applications by the Oregon Department of State Lands, US Army Corps of Engineers, NRCS, and several other agencies and groups in Oregon. The replicability of ORWAP as applied to this project specifically was not tested. Previous analyses had indicated that as a consequence of user variation, the resulting scores of independent users are generally within 0.5 of each other for a given function, on the 0 to 10 scale.

For this study, ORWAP questions were answered in the context of the entire wetland, rather than just the immediate area in which vegetation and soils were sampled. The "entire wetland" was delimited visually based on topographic and hydrologic similarity as describe in the procedures of the ORWAP manual (Adamus et al. 2009b).

When an entire wetland could not be accessed for inspection, interpretation of aerial imagery was used to augment ground-level observations from the accessible parts. No attempt was made to delineate exactly the wetland-upland boundary, but a review of the collected vegetation data suggests that nearly all samples were collected in areas likely to qualify as jurisdictional wetland.

Much of the information needed for the "office" component of each assessment had first been compiled by trained OWEB staff using internet data sources. Landowners and managers also were questioned (by phone, email, or in person) about wintertime hydrologic conditions and the type, date, and location of enhancement activities at many of the sites. To answer the one ORWAP indicator question pertaining to wetland soils (F58), surplus material remaining in the composited soil sample collected at each site was examined. Physical processing of this soil by the laboratory had broken up larger aggregates but no chemicals had been added. All such samples were examined on a single day using the ORWAP soils protocol, ensuring optimal consistency in applying the procedures for texturing the soils (e.g., similar moisture among all samples).

## 2.4 Soil Sampling and Analysis

From five locations in each wetland, hand-sized samples of soil were taken from the upper 3 inches of a soil pit after removing large organic matter (duff). The five locations included four at approximately opposite corners of the wetland plus one near the center, after determining that each location contained indicators of wetland conditions. No samples were collected from areas inundated at the time of sampling. The five samples from each wetland were composited into a single sample of about 150 g and then transported to the Central Analytical Laboratory at Oregon State University for analysis within one week of collection. The Laboratory uses standard protocols and quality assurance procedures which are described in their operations manual. The following parameters were measured: pH, extractable bases (Ca, Mg, Na, K), organic matter (LOI), total Kjeldahl phosphorus, nitrate nitrogen, and heavy metals (Cu, Zn, Mn, Fe). Soils were not analyzed from the three wetlands that were substituted in during 2010.

## 2.5 Vegetation

The vegetation protocol was designed so that an average of one wetland per day could be surveyed by one person. In each wetland, all plants were identified to species where possible in the field, and their absolute percent cover was estimated to the nearest 5% within 20 (during 2009) or 10 (during 2010) square quadrats of dimension 1 meter x 1 meter, and 1 meter vertically. The number of quadrats per site was halved in 2010 after

preliminary statistical analysis of the 2009 data on mean percent cover of non-native plants indicated that, for the particular wetlands that were sampled, stable estimates of this variable could be obtained from an average of just 10 evenly-spaced quadrats per wetland. In general, sampling during the earlier parts of each field season focused on wetlands without seasonally persistent water levels (e.g., flats) because their flora often matures earlier. Sampling of persistently flooded wetlands later in the season enabled better access as their deeper waters receded.

Quadrats were spaced as evenly as possible to cover the entire accessible wetland, rather than randomly or in a manner intended to represent all major cover types apparently present, or sections of a wetland suspected of having undergone management actions. Cover of trees and shrubs was estimated only where all or parts of those woody plants were present in the 1-meter high vertical zone above a quadrat. In every wetland at least one quadrat was placed at or near the location where the Xerces Society had sampled invertebrates and water quality, and was so labeled in the database. However, no quadrats were placed in water deeper than about 2 feet at the time of vegetation sampling. Where wetlands consisted entirely of a ponded area surrounded by a fringe of wetland vegetation, quadrats were positioned evenly around the "shoreline." The quadrats also were positioned to span the range of elevations within the the shore zone. Due to access difficulty, vegetation was not sampled in portions of wetlands dominated by extensive areas of dense brush (e.g., snowberry, *Rubus* spp.).

Geographic coordinates were recorded for every quadrat location using instantaneous readings from a handheld Garmin etrex Vista HCx. The datum was WGS84 and precision averaged about 20 feet. Time-averaged readings and a high-precision GPS device were not used because of the additional time and cost it would have involved, and the fact that even a device such as that would not allow quadrats to be relocated exactly between years. Consideration was given to using rebar or flagging to mark quadrat locations so they could be relocated in subsequent years, but this was not done because of the additional time required and because of the high potential for marker loss as a consequence of many of the wetlands being used extensively by the public. Nonetheless, when resampling the same wetlands in the second year, attempts were made to place the quadrats at *approximately* the same locations, by referring to their coordinates from the prior year. Because the number of quadrats was halved in year 2, only the odd-numbered quadrat locations from year 1 were revisited.

In addition to recording each plant species, in each quadrat the percent cover of "Water" and "Bare/Litter" was estimated as it existed *beneath* any overhanging vegetation. For example, if surface water covered an entire quadrat, Water was

recorded as 100% despite it containing both emergent and submergent plants. Similarly, if the ground was almost entirely bare beneath a canopy of (for example) reed canary grass that filled the entire quadrat, then Bare/Litter was recorded as 90% as well as reed canary grass being recorded as 100%. When areas with less than about 20 percent cover of emergent plants were encountered, quadrat locations were shifted to locations with more vegetation. Every quadrat was photographed from both vertical and horizontal aspects during 2009, and these photos have been labeled and archived for possible future reference.

Plants that could not be identified in the field to species were collected, pressed, and examined later under a dissecting scope if any potentially diagnostic parts were present. Use of the XID taxonomic keys in *Flora ID Northwest* (2009) software allowed many immature and partial specimens to be identified with confidence. Besides consulting many standard regional references for wetland plant identification (Hitchcock & Cronquist 1973, Guard 1995, Cooke 1997, Wilson et al. 2008), the investigator frequently consulted the extensive collection of photos at the Oregon Flora web site (oregonflora.org). Taxonomic nomenclature from the USDA Plants web site (plants.usda.gov) was used.

A "confidence rating" was assigned to every identification in the database (PlantSpPlots.xlsx), with "1" indicating high certainty that identification to species was correct, "2" that identification to genus was probably correct but species (if reported) was less certain, "3" that only the identification to taxonomic family was likely to be correct and/or that genus-level identification was uncertain, and "4" indicating plants that could only be identified as "forb" or "graminoid," which in most cases was due to the poor physical condition of available specimens, e.g., not yet flowering or fruiting, or too long past that time. Of the 9238 plants individually examined for this project, 82% had the highest certainty rating, 15% had a rating of "2", 1% had a rating of "3", and 2% had the lowest rating. In only 9% of all quadrats did plants with a certainty level less than "1" comprise more than half the absolute cover within the quadrat. The most frequent of these were *Polygonum persicaria* (diagnostic leaf spot and flower are often absent, some are likely *Persicaria hydropiper* or *P. hydropiperoides*), *Agrostis* spp. (most were either *A. exarata* or *A. capillaris*), *Alopecurus geniculatus*, *Callitriche* spp., *Plagiobothrys* (mostly either *P. figuratus* or *P. scouleri*), *Poa* spp. (mostly *P. trivialis*, *P. palustris*, *P. pratensis*), *Gnaphalium* (either *palustre* or *uliginosum*), *Salix* spp., *Trifolium* spp., *Carex* spp., *Festuca* spp. (either *F. arundinacea* or *F. rubra*), *Epilobium*/ *Veronica*, and unknown submerged aquatics (mostly *Potamogeton* spp., but probably some *Stuckenia*, *Myriophyllum, Ceratophyllum*, and *Elodea*). The identity of many collected and pressed specimens was resolved under a 10X dissecting scope. Voucher specimens were preserved for most species.

## 2.6 Birds and Other Wildlife

As noted earlier, wildlife species were not surveyed systematically or using standardized protocols and equipment. This was primarily because of seasonal and diurnal constraints (the optimal times for surveying amphibians and birds do not match well the best times for plants) and the inability to make repeated visits during a relatively short period of time as needed for effective surveys. Nonetheless, the investigator is skilled in auditory recognition of all breeding bird and frog species of the Willamette Valley so the number of detections was fairly large, especially when wetlands were visited early in the season and early in the day. Nearly all detections were auditory. From these alone it is not possible to determine with certainty which records were from individuals located within a visited wetland as opposed to being from upland habitats immediately surrounding a wetland.

## 2.7 Data Compilation and Analysis

Metrics and indicators pertaining to vegetation, invertebrates, birds, and all chemical and physical characteristics were merged into a single database for each of the two sampling years (AllMetrics.xlsx). Because of the statistical non-normality of most of the data, Spearman (rather than Pearson) rank correlation coefficients were computed for each of the approximately 66,290 pairs of numeric indicators or metrics, separately by year. Of those pairs, a total of 16,538 (~25%) were determined to be statistically significant ($p<0.05$) during one or both years. Unless otherwise explained, all mention in this document of metrics or indicators being related or correlated, or correlated significantly, refers to correlation at the $p<0.05$ level of statistical significance or less. Inference about potential ecological relationships may be considered to be stronger when the same metrics correlate during sucessive years across all sites. Even then, ecological causality should not be inferred only from the statistical correlations reported herein. Had there been sufficient time, far more useful statistical procedures (e.g., Non-metric Dimensional Scaling, Principal Components Analysis, ordination techniques, or or classification-tree variance partitioning) could have been applied to more clearly elucidate the correlation structure and thus truer relationships among intercorrelated variables. Two files, one containing all the correlations (CorrAll.xlsx) and the other containing just the significant ones (CorrSign.xlsx), are available with this report and can be sorted by metric, correlation coefficient, p-level, or theme.

The other statistical analysis involved performing Mann-Whitney U tests, which are similar to two-sample T-tests but are used with statistically non-normal data. For each year's data, a statistical determination was made whether differences in the medians for riverine vs. flats wetlands were significant for every metric and indicator. Separately, a statistical determination was made whether differences in the medians of each of the

following site management categories were significant for every metric and indicator: Enhanced vs. Reference, Restored vs. Reference, Enhanced vs. Restored (see Discussion section for limitations of this categorization).

Before running the Spearman rank correlations and Mann-Whitney tests, raw field data were compiled mathematically into metrics. For example, from a file containing a list of all plants identified by quadrat and wetland (PlantSpPlots.xlsx), metrics such as the following were computed and reported (in file AllMetrics.xlsx): number of species per plot and per site (richness); proportion (frequency) of a site's plots that contained invasive plants; cumulative dominance per quadrat of species that were less-common among all sites (constancy)[1]; wetland bird species as a percentage of all bird species detected per site; average and maximum percent-cover of graminoids among all of a site's quadrats; number of species considered dominant by virtue of having >50% cover per quadrat; cumulative dominance per quadrat of species that were less-common among all sites; and many others described in the Data Dictionary (Appendix A-1). Dozens more could have been computed from the raw data and examined for correlation with invertebrates, birds, soil chemistry, and other variables. These particular ones were chosen both for conceptual reasons and because they have shown promise as descriptors or definers of wetland condition in studies of wetland restoration elsewhere in the world.

# 3.0 Results

## 3.1 Ecosystem Services (Wetland Functions and Values)

Based on ORWAP results (Appendix A-2), these wetlands as a whole are probably most effective for Sediment Retention. Almost equally, they are effective for Organic Matter Export, Resident Fish Habitat, Waterbird Feeding Habitat, and Habitat for Songbirds, Raptors, and Mammals. They are least effective for Anadromous Fish Support, Thermoregulation, and Waterbird Nesting. The potential *values* of the functions, based mainly on the location of these particular wetlands relative to upslope and downslope

[1] This metric was computed as follows: 1) Calculate each species' frequency of occurrence among all sites, both years together; include only native wetland indicator species that had been identified fully to species. 2) Divide each species' frequency by 289 (the maximum frequency among all species across all quadrats), then subtract from 1. This is the U coefficient. Species that occurred less frequently among all plots have higher values for U. 3) For every occurrence of a species, multiply its U coefficient by its percent cover. Then divide by the sum of all percent cover for native wetland species in the plot, to give the average U within each plot, weighted by percent cover. 4) For each site, calculate average of the plot averages (UbiqWetNtvAvg), and maximum for whole site (UbiqWetNtvMx).

potential beneficiaries, are likely greatest for Pollinator Support, Wetland Invertebrate Support, Water Storage & Delay, Songbird Habitat, Plant Diversity, and Public Use.

Comparing these wetlands to a nonrandom set of 221 wetlands assessed statewide (Adamus et al. 2009b), these wetlands on the average scored lower with the exception of only one function (Resident Fish Habitat). The potential *values* of their functions was greater than wetlands statewide for Water Storage, all the water quality functions, Resident Fish Habitat, and Pollinator Habitat.

Using ORWAP, no between-year differences could be detected in functions at any of the sites. ORWAP did not detect the briefly wetter conditions in 2010 because, in order to maintain consistency among users, many ORWAP questions are intentionally phrased in terms of what conditions would be like during a normal year rather than conditions at the moment a wetland is visited. ORWAP may nonetheless be capable of detecting changes over longer periods (e.g., 5 years) in many functionally-relevant wetland features that are susceptible to management, such as the category and general pattern of vegetation.

## 3.2 Vegetation Characteristics

A total of 367 plant species was identified from 1546 quadrats and 55 wetland sites (Appendix A-4). At least 16 (4%) of these species occurred in more than half of the sites, and 138 (38%) were found in more than 10%. Of all the plant species, 40% were non-native and 60% were native or indeterminable; 13% were invasive. Also, 60% were forbs and 58% were species listed officially as wetland indicators. On a per-quadrat basis, the number of species averaged 5.08 (1.84-13.50) of which 2.41 (1.10-7.35) were non-native. *Non-native* species were found as dominants or co-dominants in an average of 75% (30-100%) of the quadrats per wetland, and invasive species in 57% (5-100%). Overall, *invasive* species were found in 75% of the quadrats, were co-dominant or dominant in 55% of the quadrats, and were dominant in 27%. As expected, the invasive plant encountered most frequently was reed canary-grass, *Phalaris arundinacea* (84% of sites, 37% of quadrats), followed by *Holcus lanatus* (60%, 11%), *Alopecurus pratensis* (49%, 11%), *Solanum dulcamara* (47%, 7%), *Rubus armeniacus* (49%, 6%), *Mentha pulegium* (42%, 15%), and *Lotus corniculatus* (42%, 8%). Where reed canary-grass was present, its percent-cover averaged 42% per quadrat. Native plants comprised more than 80% of the cover in 9% of the wetlands[2] and more than 50% of cover in 56% of the wetlands. Graminoids comprised more than 80% of the cover in 13% of the wetlands and more than 50% of the cover in 58% of the wetlands.

[2] Jackson-Frazier enhanced, Budeau restored, Tualatin Hills, Willow Creek riverine, and Finley Brown Swamp enhanced.

These statistics (from metrics in Appendix A-3) are but a few of dozens that were calculated or could be calculated from the collected data, in order to describe these wetlands more fully. They are important because along with statistics calculated from other similar accessible databases (e.g., McCain & Christy 2005, Adamus 2001), they help establish normative conditions and thus what may be reasonable to expect as performance standards among Willamette Valley riverine and flats wetlands, both "unmanaged" and ones in various stages of restoration or enhancement.

## 3.3 Birds and Other Wildlife

A total of 114 bird species, averaging about 27 per wetland, were identified from 55 wetland sites over the two summertime field seasons (Appendix A-5). Four of these were detected in >90% of the sites (American Goldfinch, Barn Swallow, Song Sparrow, Cedar Waxwing), 22 in more than half of the sites, and 58 in more than 10% of the sites. Of all the birds detected, 34 (30%) were species that are clearly wetland obligates, the most frequent being Common Yellowthroat (47 wetlands), Red-winged Blackbird (35), Killdeer (33), and Mallard (27). On a per-site basis, in 2009 the number of bird species averaged 23 (10-39) of which 19% (0-49%) were wetland obligates. In 2010 the total averaged 14 (6-33) per site of which 22% (5-53%) were wetland obligates. As noted earlier, all the bird detections were incidental to other survey activities and no data were collected using standard protocols for bird surveys. Similarly, no standard protocols were used to survey amphibians, but adults of four amphibian species were noted incidentally: American Bullfrog (58% of the wetlands), Pacific Treefrog (27%), Rough-skinned Newt (2 sites), and Northern Red-legged Frog (1 site). Nutria were noted at 11 sites. All the animal data are available in the accompanying electronic file, BirdSpSites.xlsx.

## 3.3 Stressors and Management Features

On a scale of 0 to 10, the median value for ORWAP's Stress metric was 5.34 (range 1.41-7.41), compared with a median of 5.70 from 221 nonrandomly selected wetlands statewide. Sites identified by this metric as having the highest relative levels of potential stress from water level alterations, soil disturbance, polluted runoff, and/or other factors were Knez and Arbor Station. The metric averaged higher for Riverine sites (5.19, range 1.41-7.41) than for Flats (4.86, range= 1.41-6.78). A somewhat analogous metric, the Human Disturbance Assessment index (HDA) which was developed originally by a wetland monitoring project in Minnesota and applied by Xerces, also averaged higher in Riverine wetlands. The sites it identified as having the most actual or potential human disturbance were Hedges Park, Endicott, Corvallis Airport, and Knez.

Data from the chemical analyses of soils, which were not used in calculating either of the stress metrics, are shown in Appendix A-3. In soils collected from 53 wetlands, the median concentration was 3.05 ppm for zinc, 4.00 ppm for copper, and 295 ppm for iron. For the western United States in general, mean concentrations in soil in relatively undisturbed settings are 55 ppm for zinc, 21 ppm for copper, 210 ppm for iron, and 380 ppm for manganese (Shacklette & Boerngen 1984). Among the 53 Willamette wetlands, 9% exceeded this regional mean for zinc, 42% for copper, 72% for iron, and none for manganese. Soil zinc concentrations were significantly higher in Riverine wetlands than in Flats (Mann-Whitney test, $p<0.05$), but no other soil parameter differed significantly by HGM class.

No definitive ecological standards exist for metal concentrations in wetland soils, but a limited review of literature suggests that the levels of zinc, copper, and manganese we measured are unlikely to be toxic to plants in any of the surveyed wetlands. In contrast, in at least half the wetlands, the levels of soil iron might have been toxic to some plant species that otherwise would have been present. Wetlands with the most soil iron were Town Center (Woodburn), Hedges TWC, Summer Creek, and Arbor Station. Highest levels of zinc were at Delta Pond, Garden Lakes, Knez, Summer Creek, Hedges TWC, and Stewart Pond North. Wetlands with the most copper were Portland Vanport and surprisingly, Buford East and McDonald Forest. And those with the most manganese were Willow Creek, Seavy, and Fisher Butte.

Nutrients (mainly phosphorus, nitrate, and potassium) can also influence plants, but their actual effect is difficult to discern without repeated sampling and simultaneous measurement of levels in plant tissues. In soils of these 53 wetlands, the median level of total Kjeldahl phosphorus was 697 ppm (range= 242-2042), nitrate was 3.51 ppm (0.1 – 47.03), and potassium was 143 ppm (63-1041).

Soil organic matter is important to plant growth, soil invertebrates, and the cycling of several elements in wetlands. The median level of soil organic matter was 7.08%, with a range of 1.03 to 18.98%. Sites with the most soil organic matter were Jackson-Frazier, Hedges TWC, and Delta Pond, while those with the least were Spongs Riverine Flow-through, Randall, and Wyman. In previous sampling of 95 wetlands in the Portland area, Shaffer & Ernst (1999) found the mean level of soil organic matter to be 9.75% in Reference wetlands and 5.83% in mitigation wetlands.

## 3.4 Statistical Associations

### 3.4.1 Statistical Associations Between Stressor/Management Features and Condition

The following were significantly **greater at Enhanced wetlands than at Reference** wetlands (but see Discussion for cautionary note):
2009: Number of graminoid species, % of species that are graminoids, maximum percent-cover of graminoids among quads, number of dominant species, number of wetland-obligate species, % of species that are wetland obligates, ORWAP Water Storage function score.
2010: Number and % of quads that contained surface water on date of vegetation survey, maximum number of species among quads, number of graminoid species, number of dominant species, number of co-dominant species, number of wetland-obligate species, number of wetland bird species, ORWAP Water Storage function score.

The following were significantly **greater at Reference wetlands than at Enhanced** wetlands:
2009: Average and maximum % of plant cover that is uncommon species, % of all species that are invasive, % of species that are forbs, % of species that are wetland-facultative, Wetland Prevalence Index (i.e., drier conditions), ORWAP scores for Pollinator Habitat and Plant Diversity.
2010: Percent of species that are shrubs (seedlings only), % of species that are wetland-facultative species, ORWAP scores for Pollinator Habitat and Plant Diversity.

The following were significantly **greater at Restored wetlands than at Reference** wetlands:
2009: Number of graminoid species, number of wetland-obligate species, % of species that are graminoids, average and maximum number of non-native species among quads.
2010: Number of dominant species, average percent-cover of graminoids among quads, number of graminoid species, % of species that are graminoids, % of species that are wetland species, number of wetland-obligate species, % of species that are wetland obligate species.

The following were significantly **greater at Reference wetlands than at Restored** wetlands:

2009: Number of shrub species (seedlings only), % of species that are shrubs, % of species that are facultative, average and maximum percent-cover of shrub seedlings, maximum percent-cover of tree seedlings among quads.
2010: Surface water pH, number and % of quads per site that may be non-wetland according to plant WIS index, number of shrub species, % of species that are shrubs, average and maximum percent-cover of shrub seedlings among quads.

The following were significantly **greater at Restored than at Enhanced** wetlands:
2009: Surface water phosphorus, soil potassium, % of all species that are invasive, % of species that are forbs.
2010: (no differences)

The following were significantly **greater at Enhanced than at Restored** wetlands:
2009: Number of shrub species, % of species that are shrubs, average and maximum percent-cover of shrub seedlings among quads, average and maximum percent-cover of tree seedlings among quads.
2010: Soil organic matter, soil zinc, number and % of quads that contained surface water on date of vegetation survey, average percent cover of surface water among quads, number of shrub species, % of species that are shrubs, average and maximum percent-cover of seedling shrubs among quads, number of quads containing invasive plant species as co-dominants, % of quads where invasive plant species were co-dominants, maximum percent-cover of invasive plants among quads.

As expected, ORWAP's rapid metric for estimating Ecological Condition correlated negatively with its metric for Stress, although not significantly.

Where **ORWAP's Stress metric** was higher, the per-quadrat number of co-dominant species was significantly lower and the per-quadrat graminoid cover was greater, as were several invertebrate metrics.

Where the score for the **Human Disturbance Assessment index (HDI)** was higher there were more non-native bird species during 2010. Also, where the HDI was higher there was significantly more per-quadrat cover of non-native and invasive plant cover, and site conditions were wetter, with more shrub species. Where disturbance was less, there were significantly fewer species of co-dominant plants (both cumulatively and per-quadrat), proportionately more cover and diversity of wetland plants, and fewer graminoids.

Total macroinvertebrate abundance was greater where there was more soil organic matter, as was also true of several vegetation metrics:

% of plant richness that is non-native, % of plant richness that is invasive, number of quads containing invasive plant species, number of co-dominant species, % of quads where invasive plant species were co-dominants, number of shrub species, average % of plant cover that is uncommon species, number of facultative-wetland plant species, % of plant richness that is facultative-wetland plant species.

Two vegetation metrics were less where there was more organic matter:
number of graminoid species, % of plant richness that is obligate wetland species.

Several invertebrate metrics were greater where there was more soil organic matter:
% of richness that is snails, % of richness that is Crustacea, number of Crustacea & Mollusca genera, % of richness that is Crustacea+Mollusca, % of abundance that is Sphaeriidae, number of non-insect taxa, % of total abundance that is Amphipod+Isopoda.

But two invertebrate metrics were less where there was more soil organic matter:
% of total abundance that is beetles,
number of Ephemeroptera, Coleoptera, Odonata, Trichoptera

Higher levels of **soil nitrate** supported significantly greater total macroinvertebrate abundance and greater % of invertebrate richness that is Crustacea. More soil nitrate also supported more:
average % of plant cover that is uncommon species, number of co-dominant species, forb cover per-quadrat, % of plant species that are co-dominant, % of all species that are facultative-wetland, maximum WIS Prevalence Index among quads (drier conditions).

Where soil nitrate was low, there were greater levels of the following:
extent of permanent surface water, number and % of quads per site that contained surface water on date of vegetation survey, average and maximum percent cover of surface water among quads, number of graminoid species, % of species that are invasive, % of species that are non-native, total number of invertebrate taxa, number of beetle & snail taxa, number of uncommon invertebrate taxa, number of highly tolerant taxa, number of sensitive taxa, % of total abundance that is sensitive taxa, number of Chironomidae genera, number of Orthocladiinae taxa, % of total abundance that is predators, % of total abundance that is mites, score for Macroinvertebrate Habitat Biotic Index.

**Surface water nitrate** concentrations did not correlate with soil nitrate concentrations, which is not unusual because they were sampled at different times and analyzed differently. The following vegetation metrics were greater where surface water nitrate concentrations were high:

> % of species that are non-native at Xerces sample point, % of species that are graminoids at Xerces sample point, % of species that are graminoids, % of all species that are co-dominants, % of all species that are dominants, number and % of species that are wetland-obligates, number of wetland birds, number of non-native birds.

but these metrics were less where the concentration of surface water nitrate was high:

> % of all species that are non-native, number and % of quads containing any invasive plant species, % of all species that are invasive, maximum percent-cover of invasive plants among quads, average and maximum % of plant cover that is uncommon species, average and maximum percent-cover of shrub seedlings among quads, % of all species that are shrubs, average and maximum percent-cover of tree seedlings among quads, number of all species that are trees, number of facultative species, % of all species that are facultative species, shrub cover and number of shrub species at the Xerces sampling point, % water at the Xerces sampling point at time of vegetation sampling.

Greater levels of **soil phosphorus** were associated with more organic matter and iron in the soil, as well as supporting higher levels of the following vegetation metrics:

> % of plant richness that is invasive, % of plant richness that is non-native, % of plant richness that is co-dominant or dominant species, % of plant richness and cover that is shrub seedlings, number of shrub species, % of plant richness that is facultative-wetland species, average % of plant cover that is uncommon species.

Greater levels of soil phosphorus also were associated with greater levels of the following invertebrate metrics:

> % of total invertebrate abundance that is highly tolerant taxa, % of abundance that is Sphaeriidae, % of richness that is Crustacea, number of Crustacea & Mollusca genera, % of richness that is Crustacea+Mollusca, number of snail genera, % of richness that is snails, % of total abundance that is beetles & snails, number of non-insect taxa, Macroinvertebrate Habitat Biotic Index.

Higher levels of the following vegetation metrics were associated with lower levels of soil phosphorus:

Richness of wetland-obligate species, % of plant richness that is wetland-obligates, number of graminoid species, % of plant richness that is graminoids, and number of species (maximum of quads).

And higher levels of several invertebrate metrics were associated with lower levels of soil phosphorus:

number of beetle taxa, % of richness that is beetle taxa, % of total abundance that is beetles, number of predator taxa, % of richness that is predators, % of total abundance that is predators, number of Ephemeroptera-Coleoptera-Odonata-Trichoptera, % of total abundance that is mayflies and caddisflies.

**Surface water phosphorus** concentrations did not correlate with soil phosphorus concentrations, which is not unusual because they were sampled at different times and analyzed differently. The following vegetation metrics were greater where surface water phosphorus concentrations were high:

% of species that are dominants, % of species that are co-dominants, % of species that are wetland obligates, % of species that are trees.

But most vegetation metrics were less where surface water phosphorus concentrations were high, as follows:

percent-cover of water at Xerces sampling point at time of vegetation survey, number of invasive species, % of all species that are invasive, number and % of quads containing invasive plant species, % of all species that are non-native, % of quads in which invasive plant species were co-dominants, summed percent-cover of co-dominant species, number of graminoid species, number of facultative-wet species, % of all species that are facultative-wet species, number of shrub species, % of species that are shrubs, average and maximum percent-cover of shrub seedlings among quads, maximum % of plant cover that is uncommon species.

Several vegetation metrics were associated with higher levels of **iron in the soil**:

% of plant richness that is dominants, % of plant richness that is co-dominants or dominants, number and % of quads co-dominant non-native plant species.

These invertebrate metrics also were associated with higher levels of iron in the soil:

Total macroinvertebrate abundance, number of non-insect taxa, number of Crustacea & Mollusca genera, % of richness that is Crustacea+Mollusca, % of total abundance that is Crustacea, % of richness that is Crustacea, % of richness that is snails, % of total abundance that is beetles & snails, % of total invertebrate abundance that is highly tolerant taxa, Macroinvertebrate Habitat Biotic Index.

Higher levels of the following were associated with lower levels of soil iron:

maximum number of species among quads, number of non-native plant species, average and maximum number of non-native species among quads, number of graminoid species, % of plant richness that is graminoids, number of predator taxa, % of total abundance that is predators, number of beetle taxa, % of richness that is beetle taxa, % of total abundance that is beetles, number of beetle & snail taxa, number of Ephemeroptera-Coleoptera-Odonata-Trichoptera, number of mayfly and caddisfly taxa, % of total abundance that is mayflies and caddisflies, % of diversity that is mayflies and caddisflies, number of sensitive taxa.

Only two metrics were greater where levels of soil manganese were high:

graminoid cover per-quadrat,
% of total invertebrate abundance that is in the most common taxon.

High levels of soil manganese were associated with lower levels of:

average number of plant species among quadrats, number of mayfly and caddisfly taxa,
% of diversity that is mayfly and caddisfly taxa, % of total abundance that is mayflies and caddisflies, % of total abundance that is Caecidotea, % of total abundance that is in most common taxon.

### 3.4.2 Statistical Associations Between Functions and Condition

For these sites, ORWAP's **Ecological Condition** score tracked the ORWAP scores for only 5 of 16 functions, those being Phosphorus Retention, Amphibian Habitat, Songbird-Mammal Habitat, Pollinator Habitat, and Plant Diversity.

Neither the ORWAP function score for Waterbird Nesting Habitat nor the one for Songbird Habitat correlated significantly with the number of wetland bird species (or all bird species) detected during either year. This may have been because the bird data were only incidental and methods were not intended to detect most nesting waterbirds.

ORWAP's score for Plant Diversity correlated positively with the per-quadrat forb cover. The Plant Diversity score correlated negatively with mean cover of invasive plants among quadrats, the proportion of a site's quadrats that had co-dominant or dominant invasive species, and the proportion of a site's species that were shrubs. Sites with invasive plants in a larger proportion of their quadrats had lower ORWAP scores for Resident Fish Habitat and Invertebrate Habitat. Wetlands with a greater variety of

plants happened to rate higher for the Nitrogen Removal function but lower for Songbird Habitat according to ORWAP.

The ORWAP function scores for Phosphorus Retention and Nitrogen Removal did not have a significant correlation (positive or negative) with concentrations of phosphorus or nitrate, respectively, in the uppermost horizon of the soils in these wetlands. That is perhaps because one-time grab samples, such as those collected for this study, are not likely to represent annual fluxes of these nutrients in wetlands.

Among the functions that ORWAP estimates, only a few significant score differences based on management status (Enhanced, Restored, Reference) were found. Wetlands categorized as Enhanced had significantly higher scores than Reference wetlands for Water Storage, and Reference wetlands had significantly higher scores than Enhanced wetlands for Pollinator Habitat and Plant Diversity functions.

### 3.4.3 Statistical Associations Among Function Metrics

Correlations among functions for these sites can be found in file CorrAll.xlsx. For comparison, a similar analysis done statewide and based on fourfold more wetland sites is reported in Adamus et al. (2009b).

### 3.4.4 Statistical Associations Among Condition Metrics

**ORWAP's Ecological Condition** metric scored higher (indicating better ecological condition) with greater values for the following metrics:

> maximum % of plant cover (among quads) that is uncommon species, number of shrub species, % of plant species that are shrubs, % of total abundance that is mayflies and caddisflies, % of total abundance that is mayflies and caddisflies, % of total abundance that is beetles & snails, % of richness that is Ephemeroptera + Trichoptera + Sphaeraidae+ dragonflies,

and with smaller values for:

> % of plant richness that is graminoids, % of plant richness that is wetland species, % of total invertebrate abundance that is the most dominant species, % of total invertebrate abundance that is the three most-dominant taxa, % of richness that is predators, % of total abundance that is beetles.

<u>Vegetation Metrics vs. Invertebrate Metrics</u>

A large number of vegetation metrics correlated significantly with invertebrate metrics. These are listed in Appendices A-7 and A-8. Highlights include the following, based on data just from the point at each site where both types of sampling coincided:

1) Where percent-cover of **invasive plants** was great, there was greater:

> % of total abundance that was Amphipoa+Isopoda, % of total abundance that was Crustacea, % of diversity that was Crustacea, % of total abundance that was microcrustacea, and less % of species that were midges or snails.

2) Where percent-cover of all **non-native plants** combined was great, there were more Chironomini genera and smaller % of richness that were predators.

3) Where **percent-cover of shrub or tree seedlings** was great, there was more non-insect taxa and Crustacea & Mollusca genera, larger average MHBI, and greater % of total abundance and richness that is mayflies and caddisflies, % of diversity that is highly tolerant taxa, and more highly tolerant taxa, while there was less % of richness that was beetle taxa and lower % of total abundance that was Crustacea+Mollusca.

<u>Vegetation Metrics vs. Birds and Other Wildlife</u>

**Total number of bird species** was greater where the following plant metrics were greater:

> Number of facultative wetland plant species, number of invasive plant species, number of dominant plant species, number of co-dominant plant species, number of invasive plant species, prevalence of uncommon native wetland plant species per quadrat, prevalence of wetland plant species per quadrat, and these invertebrate metrics: % of total abundance that is Caecidotea, % of total abundance that is mites, % of total abundance that is Orthocladiinae.

Where number of bird species was lower, the following plant metrics were higher:

> Average and maximum forb cover among quadrats, number of graminoid species, % of plant richness that is graminoids, % of plant richness that is co-dominant or dominant species, % of plant richness that is dominant species, % of plant richness that is wetland species.

The number of **nonnative bird species** was greater where bullfrogs were present as well as where levels were greater of:

> % of total abundance that is Orthocladiinae midges, % of total invertebrate abundance that is highly tolerant taxa, graminoid cover per-quadrat, invasive plant cover per quadrat, maximum nonnative cover per quadrat, proportion of the quadrats in which nonnative plants were dominant, and prevalence of wetland plant species per quadrat.

Where the number of nonnative bird species was fewer, levels of the following invertebrate metrics were higher:

> Number of mayfly and caddisflly taxa, % of total abundance and richness that is mayflies and caddisflies, % of richness that is sensitive taxa, % of Chironomidae richness that is Tanytarsini, Number of sensitive taxa. These vegetation metrics also were higher: Forb cover per-quadrat, cover of shrubs per quadrat, maximum forb cover among quadrats, richness of co-dominant species, richness of obligate wetland species, % of plant richness that is obigate wetland species, % of plant richness that is wetland species.

The number of **wetland bird species** was greater where bullfrogs were present as well as where levels of the following were higher:

> total macroinvertebrate abundance,% of richness that is Crustacea, % of total abundance that is Crustacea, % of total abundance that is microcrustacea, number of tolerant invertebrate taxa, % of total invertebrate abundance that is highly tolerant taxa, number of Crustacea & Mollusca genera, number of tolerant taxa, % of total invertebrate abundance that is highly tolerant taxa, modified Hilsenhoff Biotic Index.

The number of wetland bird species was fewer where levels of the following were higher:

> % of richness that is sensitive invertebrate taxa, % of total abundance that is sensitive invertebrate taxa, number of plant species among all quadrats, number of plant species per quadrat, number of co-dominant plant species, % of quadrats having nonnative plant species, number of non-native plant species, % of plant richness that is non-native species, prevalence of wetland plant species per quadrat, number of facultative wetland plant species,% of plant richness that is facultative wetland species, prevalence of uncommon native wetland plant species per quadrat, % of plant richness that is shrub species, average and maximum cover of shrubs among quadrats, average and maximum cover of tree cover among quadrats, number of tree species, % of plant richness that is tree species.

The **total number of plant species per site** was greater at sites where a smaller proportion of the quadrats were dominated by non-native plants, the average percent-cover of invasives and non-natives among the quads was low, the average percent-cover of graminoids was low, and where a smaller percentage of the plant species were dominants or co-dominants. The **average number of plant species per quadrat** was greater in quadrats in which there was less cover of non-native and invasive plants, no quadrat had a large percent cover of invasive species, forb cover was greater, and a

smaller percent of the species were graminoids or trees. The **number of forb species** was greater where there was less cover of non-native species per quad. The **number of graminoid species** was greater where a larger percent of the species were wetland obligates.

**HGM Class**

**Riverine** wetlands had significantly more of the following than Flats:
2009: Proportion of quadrats with dominant invasive species, proportion of quadrats with dominant non-native species, proportion of quadrats with dominant or co-dominant non-native species % of plant cover that is uncommon native wetland species (maximum among quads), number of shrub species, % of richness that is shrub species, average and maximum percent-cover of shrubs among quads, average and maximum percent-cover of invasive species among quads.
2010: Number of invasive species, % of species that are invasive, proportion of quadrats with invasive species, proportion of quadrats in which invasive species are dominant or co-dominant, average and maximum percent-cover of invasive species among quads, number of non-native species, proportion of quadrats in which non-native species are dominant or co-dominant, average and maximum percent-cover of non-native species among quads, number of shrub species, % of richness that is shrub species, average and maximum percent-cover of shrubs among quads, number of facultative species, % of species that are facultative species.
both years: Persistent water, large water level range, coarser soils, fish more likely to be present, higher conductivity, pH, soil zinc, and soil pH.

**Flats** had significantly more of the following than Riverine wetlands:
2009: Average percent cover of forbs per quadrat
2010: Number of obligate wetland species, % of species that are wetland obligates, % of species that are wetland species, % of species that are graminoids, % of species that are dominants or co-dominants.
both: Water level control structures, more nitrogen & phosphorus in surface water, more soil manganese.

### 3.4.5 Statistical Associations Among Stressors

Among the soil chemistry variables, soil **nitrate** was greater where there was more soil **phosphorus**. These both are often associated with the same nonpoint sources. **Iron** was greater where there was more zinc, phosphorus, nitrate, and soil organic matter. **Soil organic matter** was greater where soil pH was more acidic. Levels of calcium, phosphorus, nitrate, iron, copper, zinc in the soil were greater where there was more soil organic matter.

The **ORWAP Stress metric** was significantly higher where levels of soil manganese were higher and soils were more acidic. The conceptually similar **HDA metric** was higher where levels of soil zinc, iron, and phosphorus were relatively high and soil magnesium and sodium were lower.

## 3.5 Sampling Effects

### 3.5.1 Year Differences

During the second year the conditions overall were wetter due to greater springtime rainfall. Differences in values of some metrics between years could be due to differences in those moisture conditions, or to the fact that at most sites only half the number of quadrats was sampled in 2010. In the case of birds, less time was spent per wetland during the second year so number of detections would be expected to be fewer.

### 3.5.2 Sample Date Differences

The wetter conditions in 2010 delayed the sampling of vegetation in many wetlands. Nonetheless the median sampling date was not too dissimilar between years (July 13 in 2009, July 22 in 2010). The range in 2009 was May 20 to September 5, and in 2010 was May 21 to September 4. During both years, sites whose vegetation was sampled later in the growing season tended to be the wetter sites (e.g., significant correlations for prevalence of wetland plant species per quadrat, richness of obligate wetland species, number of facultative wetland plant species, % of plant richness that is wetland species). They also happened to have greater maximum cover of forbs among the quadrats (maximum forb cover among quadrats) and a larger number of native species per quadrat.

### 3.5.3 Plant Identification Differences

Overall, 81% of the plant identifications per site had high certainty at the species level, 15% had high certainty only to genus only, 2% were high certainty only to Family, and 2% were unknown. During both years, sites with higher proportions of unidentifiable plant taxa were more likely to be those with persistent water. They tended to average more taxa per quadrat and had proportionately fewer quadrats in which nonnative species were dominant or co-dominant. They also averaged lower percent-cover of graminoids per quad. Identification uncertainties did not appear to significantly affect the Wetland Prevalence Index.

### 3.5.4 Representativeness of Vegetation at the Invertebrate Plot

To what degree were the vegetation metrics calculated from the one quadrat where invertebrates were sampled, representative of those vegetation metrics calculated for

the entire wetland? Data analysis indicated that during both years more than half the vegetation metrics from just the one invertebrate quadrat correlated signficantly with the same metrics compiled from 10-20 vegetation quadrats. This is remarkable, considering that the vegetation quadrats were scattered throughout the entire wetland. It suggests that among-site variation in most of the vegetation metrics was more significant than within-site spatial variation.

# 4.0 Discussion

## 4.1 Key Findings

Drawing conclusions about the condition of wetlands based only on mitigation category (Restorated, Enhanced, Reference) is fraught with a high level of uncertainty because of the influence of many other factors as well as variation among practices within each of those categories. To determine in which category to place a wetland, the history of past conditions and management actions must be known well. On virtually all sites selected for this study it was impossible to determine this in regard to all the essential information -- such as whether the site was originally a wetland, the types of subsequent alterations, their durations and timings, and especially the exact locations of restorative or enhancing actions implemented within the site. In most cases little if any such information was found by reading applications for grants or alteration permits. Current site managers who were interviewed sometimes had only limited knowledge of original conditions. Such issues are common to nearly all published studies that have attempted to examine compensatory wetland mitigation in terms of simple categories, and yet simple categories are what are used to compute mitigation ratios.

Despite these uncertainties, results from this study confirmed and geographically extended the conclusions of previous researchers in parts of the Willamette Valley region. Key findings are summarized as follows:

1) Previously, several researchers (e.g., Gwin et al. 1999, Morlan et al. 2010) have observed that Enhanced wetlands in this region tend to contain more open water with longer seasonal duration than Reference wetlands. This was confirmed by our data. Wetlands categorized as Enhanced had significantly higher scores for Water Storage, a lower Wetland Prevalence Index (indicating greater cover of aquatic plant species), greater number and percentage of wetland obligate species, fewer shrub species (shrubs tend to grow in drier areas), and more sample units that contained surface water on the summer date of the vegetation survey. Wetlands classified as Restored were also wetter than Reference, as indicated by greater number of wetland-obligate species and percent

of all species that are wetland obligates. The wetter condition of Enhanced and Restored wetlands could be due to management goals. Wetter sites are usually easier to keep free of invasive plants, have more wetland bird species (confirmed by this study), and to some people are perceived as more aesthetically attractive.

2) If a prevalence of non-native (especially, invasive non-native) cover is considered to constitute evidence of degraded wetland condition, then no statistically significant evidence was found that wetlands categorized as Enhanced were in worse or better condition than Reference wetlands overall. However, they did have less cover dominance by regionally uncommon plant species, and a relatively few dominant species comprised most of the vegetative cover. Restored wetlands had a greater average and maximum number of non-native (but not necessarily invasive) species among quadrats. This could be due to recentness of some of the restorations, and might improve naturally with time if abiotic conditions trend towards stabililty.

3) If functional equivalency is used as a basis for judging mitigation success, then no statistically significant evidence was found that wetlands categorized as Restored functioned at a relatively higher or lower level than Reference wetlands (as estimated using ORWAP). Comparing Enhanced and Reference wetlands, only three functions differed significantly. Pollinator Habitat and Plant Diversity functions were less in Enhanced wetlands, but the Water Storage function (as noted above) was greater. It is not possible to tell if the lack of many significant differences in functions is due to insensitivity of ORWAP to real differences, or if the differences were simply not significant, or statistical power was insufficient (not enough wetlands sampled in each category).

4) If chemical parameters of a soil sample collected during a single visit are used as a basis for judging mitigation success, then no statistically significant evidence was found that wetlands categorized as Enhanced or Restored were in better or worse condition than Reference wetlands. Although previous studies (e.g., Shaffer & Ernst 1999) found Enhanced wetlands to have generally lower concentrations of soil organic carbon than Reference, no statistically significant difference in this parameter was found between these mitigation categories in our study population.

5) Relatively few statistically significant differences were found between Enhanced and Restored sites. Enhanced wetlands did tend to have more surface water, a higher proportion of quadrats with significant cover of invasive plant species, more soil organic matter, and less soil phosphorus.

6) If the two stress metrics that were examined (ORWAP's stress metric and the HDA metric) truly represent key factors that may degrade wetland condition, then the relatively simple vegetation metrics used here, which correlated significantly and negatively in many cases with one or both stress metrics, appeared to be sensitive enough to react to those stress factors overall.

7) An ongoing debate among wetland scientists is whether wetlands in good ecological condition (e.g., as assessed by vegetation metrics and soil chemistry parameters such as those used here) are necessarily high functioning (e.g., as assessed by ORWAP metrics such as those used here). Our data analysis found only a few significant correlations. Sites with invasive plants in a larger proportion of their quadrats had lower ORWAP scores for Resident Fish Habitat and Invertebrate Habitat. Wetlands with a greater variety of plants happened to rate higher for the Nitrogen Removal but lower for Songbird Habitat functions according to ORWAP. Wetlands with a relatively high soil zinc concentration tended to have a lower score for Invertebrate Habitat function according to ORWAP.

8) As regards the relative ecological condition of the studied wetlands, there was frequent agreement between particular pairs of vegetation, invertebrate, and bird indicators. This could be due as much to similar direction of responses to conditions at a landscape scale (e.g., proportion of forested area within a given radius) as to conditions at the site scale (e.g., management actions).

9) Data from this study have provided some potentially useful benchmarks for future performance standards in the Willamette Valley. If the same vegetation metrics and protocols used here are used to evaluate performance of other mitigation sites or mitigation banks in the region, percentiles calculated from the numbers in Appendix A-3 could be used. For example, Table 3 shows levels that might be considered for use on a case-by-case basis as realistic performance standards for Willamette Valley wetlands sampled in the same way as this study. In this case, Poor, Fair, Good, and Excellent are defined, respectively, by the $10^{th}$, $25^{th}$, $75^{th}$, and $90^{th}$ percentiles of the extensive data collected by this study.

Table 3. Examples of possible performance standards for Willamette Valley wetlands as derived from plant metrics in Appendix A-3

| | FLATS | | | | RIVERINE | | | |
|---|---|---|---|---|---|---|---|---|
| Metric | Poor | Fair | Good | Excellent | Poor | Fair | Good | Excellent |
| Number of plant species per quadrat (RichAllQdAvg) | <3.85 | 3.85-5.45 | 8.00-9.95 | >9.95 | <4.14 | 4.14-5.00 | 7.85-9.46 | >9.46 |
| % of quadrats with >9% cover of invasive plants (xFqInvGT9) | >75 | 51-75 | 8-20 | <8 | 100 | 100 | 55-70 | <55 |
| Average percent cover of invasive plants (PCinvQdAv) | >46 | 28-46 | 7-12 | <7 | >74 | 57-74 | 16-24 | <16 |

## 4.2 Lessons Learned and Future Directions

Because both restoration and enhancement can involve some of the same types of management actions, a more meaningful way of classifying sites is by their specific component management actions, e.g., mowing, burning, flooding, planting, weed control. Had there been sufficient time and quality information, the study sites might have been classified with higher certainty with regard to the extent, recentness, and location of each of those component actions. Statistical tests could then be run on the data to indicate how each metric and indicator was associated with each of these component management categories, rather than with just the broad category of Restoration or Enhancement. Such information would better inform decisions about which management actions are most and least beneficial to preserving native vegetation in various types of mitigation wetlands in the Willamette Valley. As a condition of wetland restoration project grant funding, OWEB should require applicants to provide detailed maps showing which areas of project sites will be (and were) subjected to planting, weed control, flooding, and other specific actions, and when those actions were completed (and/or their anticipated future frequency).

Inferences about the success of restoration or enhancement of these sites was also constrained by lack of comparable baseline (pre-restoration or pre-enhancement) data. To deal with this limitation, attempts were made in the project design to address the mitigation "success" question by doing a space-for-time exchange; that is, sites that were known to have been enhanced were be compared with some that have not been (i.e., the Reference wetlands). However, as noted above, the lack of sufficient background information on past management actions at all sites confounded attempts at comparisons.

Although the two metrics intended to summarize stress or threat to wetlands were in general agreement and performed as expected with regard to predicting biological responses, they should be validated in the future by comparing their scores with detailed measurements of land cover using GIS and topographic information based on LiDAR imagery.

In summary, as OWEB continues to monitor wetland projects in this and other regions in order to assess their overall success, it should:

1. As a criterion for selecting study sites, use the amount and specificity (spatial and temporal) of information on the types of past and ongoing management actions.

2. Place increased emphasis on selecting sites where a before-and-after comparison can be made of ecological conditions, and then make such comparisons.

3. Employ the protocols for vegetation monitoring and functional assessment used in this study, or similar protocols shown to be equally or more informative and cost-effective. Ideally, the protocols should be do-able by only a single field person visiting a site for one day. For vegetation, soils, and ORWAP assessments, collecting data from the same sites for two successive years may not be essential.

4. Allocate more resources and time for analyzing data at the conclusion of the field season.

5. Also allocate more resources and time for at least two visits to individual sites during the field seasons, so that amphibians (e.g., egg masses) and water regimes can also be assessed as indicators.

6. Support the long term development of more sensitive indicators of wetland condition, such as the floristic quality assessment indices that many eastern states have developed.

# 5.0 References

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# Appendices

A-1. Data dictionary for appendices and accompanying electronic spreadsheets.
A-2. ORWAP function scores for Willamette Valley wetlands from OWEB 2010 assessment.
A-3. Means and percentiles for vegetation metrics and ORWAP scores from Willamette Valley flats and riverine study wetlands, summer 2009-2010.
A-4. Frequencies of vascular plants identified from the Willamette Valley study wetlands, 2009 and 2010.
A-5. Frequencies of birds and other animals identified incidental to vegetation surveys of the Willamette Valley study wetlands, May-September 2009 and 2010.
A-6. Vegetation metrics that correlated significantly with soil and surface water quality parameters in 2009 survey of Willamette wetlands.
A-7. Paired metrics for vegetation and macroinvertebrates that were significantly correlated both years: positive correlations.
A-8. Paired metrics for vegetation and macroinvertebrates that were significantly correlated both years: negative correlations.

# Electronic Appendices

(available from OWEB or the author)

PlantSpPlots.xlsx
BirdSpSites.xlsx
AllMetrics.xlsx
CorrAll.xlsx
CorrSign.xlsx
SitePhotos.zip

A-1. Data dictionary for appendices and accompanying electronic spreadsheets

| **A-1. Data Dictionary Variable** | **Category** | **Definition/ Codes** |
|---|---|---|
| Site | | location of veg survey and/or invertebrate sampling |
| HGM | | hydrogeomorphic class: F= Flat, R= Riverine, S= Slope, D= Depressional |
| Alt | | whether site is a significantly altered version of the named geomorphic class (Y= yes, N- no) |
| CATsub | | E= enhanced, R= restored, C= created, N= naturally occurring wetland and not enhanced |
| CAT | | A= altered, N= natural |
| Outlet | SITE | 0= no outlet, 1= temporary outflow, 2= seasonal outflow, 3= perennial outflow |
| Perm | SITE | site contains water year-round (2), seasonal only (1) |
| Flux | SITE | annual water level range (fluctuation) in most of the site (ORWAP categories, 1= least to 4= most) |
| Soil | SITE | texture of A-horizon soil: 1= coarse, 2= loam, 3= clay, 4= organic |
| Fish | SITE | fish probably present: 1= yes, 0= no |
| Mgt | SITE | management score |
| Grade | ALT | soils graded, plowed, or excavated, probably in past 10 years (1= yes, 0= no) |
| Mow | ALT | vegetation mowed in past year (1= yes, 0= no) |
| SprayPull | ALT | invasive plants sprayed or pulled in past year (1= yes, 0= no) |
| Seed | ALT | native plants seeded or planted in last year (1= yes, 0= no) |
| Burn | ALT | part of site burned in last 5 years (1= yes, 0= no) |
| Pump/ Control | ALT | water level control device is present or water is pumped to the site (1= yes, 0= no) |
| Berm | ALT | a berm or dike surrounds part of the site (1= yes, 0= no) |
| Yr | SAMP | sampling year |
| DateVeg | SAMP | veg & bird sampling date converted to Excel format |
| DateXer | SAMP | Xerces sampling date converted to Excel format |
| NumPlots | SAMP | number of 1 x 1 m veg quadrats (plots) surveyed at the site |
| QA_qdAv | SAMP | number indicating average certainty rating per quadrat (1= all ID'd to species, 3= many unknowns) |
| QA_Xer | SAMP | ditto, but average just for the veg quad coinciding with Xerces sample point |
| WaterFq | SITE | # of quads (i.e., quadrats, plots) per site that contained surface water on date of veg survey |
| xWaterFq | SITE | WaterFq as percent of NumPlots |
| WaterPCav | SITE | average percent cover of surface water among quads on veg survey date |
| WaterPCmx | SITE | maximum percent cover of surface water among quads on veg survey date |
| QdNonWet | SITE | # of quads per site that may be non-wetland according to plant WIS index |
| FqNonWet | SITE | QdNonWet as percent of NumPlots |
| UbiqWetNtvAv | VEG | constancy score for native wetland plant cover (see explanation in report), |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| | | average of quads |
| UbiqWetNtvMx | VEG | constancy score for native wetland plant cover (see explanation in report), maximum of quads |
| Rich1Cumu | VEG | # of plant taxa among all quads at this site, counting only those identified to species (i.e., certainty level = 1) |
| Rich1GT50 | VEG | # of plant taxa with >50% cover among all quads at this site, counting only those identified to species |
| Rich1GT20 | VEG | # of plant taxa with >20% cover among all quads at this site, counting only those identified to species |
| Rich1GT9 | VEG | # of plant taxa with >9% cover among all quads at this site, counting only those identified to species |
| Rich1NN | VEG | # of non-native plant taxa among all quads at this site, counting only those identified to species |
| Rich1Invas | VEG | # of invasive plant taxa among all quads at this site, counting only those identified to species (invasive according to DSL-ORWAP list) |
| Rich1Forb | VEG | # of forb taxa among all quads at this site, counting only those identified to species (invasive according to DSL-ORWAP list) |
| Rich1Gram | VEG | # of graminoid taxa among all quads at this site, counting only those identified to species (invasive according to DSL-ORWAP list) |
| Rich1Shrub | VEG | # of shrub taxa among all quads at this site, counting only those identified to species and <3 ft tall (seedlings) |
| Rich1Tree | VEG | # of tree taxa among all quads at this site, counting only those identified to species and <3 ft tall (seedlings) |
| Rich1Wet | VEG | # of wetland plant taxa among all quads at this site, counting only those identified to species (FAC, FACW, or OBL) |
| Rich1FAC | VEG | # of wetland-facultative plant taxa among all quads at this site, counting only those identified to species |
| Rich1FACW | VEG | # of fac-wet plant taxa among all quads at this site, counting only those identified to species |
| Rich1OBL | VEG | # of wetland obligate plant taxa among all quads at this site, counting only those identified to species |
| xRich1GT50 | VEG | Rich1GT50 as percent of Rich1Cumu |
| xRich1GT20 | VEG | Rich1GT20 as percent of Rich1Cumu |
| xRich1GT9 | VEG | Rich1GT9 as percent of Rich1Cumu |
| xRich1NN | VEG | Rich1NN as percent of Rich1Cumu |
| xRich1Invas | VEG | Rich1Invas as percent of Rich1Cumu |
| xRich1Forb | VEG | Rich1Forb as percent of Rich1Cumu |
| xRich1Gram | VEG | Rich1Gram as percent of Rich1Cumu |
| xRich1Shrub | VEG | Rich1Shrub as percent of Rich1Cumu |
| xRich1Tree | VEG | Rich1Tree as percent of Rich1Cumu |
| xRich1Wet | VEG | Rich1Wet as percent of Rich1Cumu |
| xRich1FAC | VEG | Rich1FAC as percent of Rich1Cumu |
| xRich1FACW | VEG | Rich1FACW as percent of Rich1Cumu |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| xRich1OBL | VEG | Rich1OBL as percent of Rich1Cumu |
| Rich12Cumu | VEG | # of plant taxa among all quads at this site, counting those identified to species or genus (i.e., certainty levels = 1 or 2) |
| Rich12GT50 | VEG | # of plant taxa with >50% cover among all quads at this site, counting only those identified to species or genus |
| Rich12GT19 | VEG | # of plant taxa with >19% cover among all quads at this site, counting only those identified to species or genus |
| Rich12GT9 | VEG | # of plant taxa with >9% cover among all quads at this site, counting only those identified to species or genus |
| Rich12NN | VEG | # of non-native plant taxa among all quads at this site, counting only those identified to species or genus |
| Rich12invas | VEG | # of invasive plant taxa among all quads at this site, counting only those identified to species or genus (invasive according to DSL-ORWAP list) |
| Rich12forb | VEG | # of forb taxa among all quads at this site, counting only those identified to species or genus (invasive according to DSL-ORWAP list) |
| Rich12gram | VEG | # of graminoid taxa among all quads at this site, counting only those identified to species or genus (invasive according to DSL-ORWAP list) |
| Rich12tree | VEG | # of tree taxa among all quads at this site, counting only those identified to species or genus and <3 ft tall (seedlings) |
| Rich12shrub | VEG | # of shrub taxa among all quads at this site, counting only those identified to species or genus and <3 ft tall (seedlings) |
| Rich12Wet | VEG | # of wetland plant taxa among all quads at this site, counting only those identified to species or genus (FAC, FACW, or OBL) |
| Rich12FAC | VEG | # of wetland-facultative plant taxa among all quads at this site, counting only those identified to species or genus |
| Rich12FACW | VEG | # of fac-wet plant taxa among all quads at this site, counting only those identified to species or genus |
| Rich12OBL | VEG | # of wetland obligate plant taxa among all quads at this site, counting only those identified to species or genus |
| xRich12GT50 | VEG | Rich12GT50 as percent of Rich12Cumu |
| xRich12GT19 | VEG | Rich12GT20 as percent of Rich12Cumu |
| xRich12GT9 | VEG | Rich12GT9 as percent of Rich12Cumu |
| xRich12NN | VEG | Rich12NN as percent of Rich12Cumu |
| xRich12invas | VEG | Rich12Invas as percent of Rich12Cumu |
| xRich12forb | VEG | Rich12Forb as percent of Rich12Cumu |
| xRich12gram | VEG | Rich12Gram as percent of Rich12Cumu |
| xRich12tree | VEG | Rich12Tree as percent of Rich12Cumu |
| xRich12shrub | VEG | Rich12Shrub as percent of Rich12Cumu |
| xRich12Wet | VEG | Rich12Wet as percent of Rich12Cumu |
| xRich12FAC | VEG | Rich12FAC as percent of Rich12Cumu |
| xRich12FACW | VEG | Rich12FACW as percent of Rich12Cumu |
| xRich12OBL | VEG | Rich12OBL as percent of Rich12Cumu |
| RichAllQdAvg | VEG | Average # of plant taxa per quad (all levels of identification certainty) |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| RichAllQdMax | VEG | Maximum # of plant taxa per quad (all levels of identification certainty) |
| Rich1QdAvg | VEG | Average # of plant taxa per quad, counting only those identified to species (certainty level 1) |
| Rich1QdMax | VEG | Maximum # of plant taxa per quad, counting only those identified to species |
| Rich1QdAvGT9 | VEG | Average # of plant taxa per quad with percent-cover >9, counting only those identified to species |
| Rich1QdMxGT9 | VEG | Maximum # of plant taxa per quad with percent-cover >9, counting only those identified to species |
| Rich1QdAvNN | VEG | Average # of non-native plant taxa per quad, counting only those identified to species |
| Rich1QdMxNN | VEG | Maximum # of plant taxa per quad, counting only those identified to species |
| Rich12QdAvGT9 | VEG | Average # of plant taxa per quad, counting only those identified to species (certainty level 1) |
| Rich12QdMxGT9 | VEG | Maximum # of plant taxa per quad, counting only those identified to species |
| Rich12QdAvNN | VEG | Average # of non-native plant taxa per quad, counting only those identified to species |
| Rich12QdMxNN | VEG | Maximum # of plant taxa per quad, counting only those identified to species |
| Fq1NNgt9 | VEG | # of quads in which summed percent-cover of non-native plant species was >9% |
| Fq1NnGT50 | VEG | # of quads in which summed percent-cover of non-native plant species was >50% |
| Fq12nnGT9 | VEG | # of quads in which summed percent-cover of non-native plant species and genera was >9% |
| Fq12nnGT50 | VEG | # of quads in which summed percent-cover of non-native plant species and genera was >50% |
| FqInvAll | VEG | # of quads containing any invasive plant species |
| FqInvGT9 | VEG | # of quads containing invasive plant species summed percent-cover >9% |
| FqInvGT50 | VEG | # of quads containing invasive plant species summed percent-cover >50% |
| xFq1NNgt9 | VEG | Fq1NNgt9 as a percent of NumPlots |
| xFq1NnGT50 | VEG | Fq1NNgt50 as a percent of NumPlots |
| xFq12nnGT9 | VEG | Fq12NNgt9 as a percent of NumPlots |
| xFq12nnGT50 | VEG | Fq12NNgt50 as a percent of NumPlots |
| xFqInvAll | VEG | FqInvAll as a percent of NumPlots |
| xFqInvGT9 | VEG | FqInvgt9 as a percent of NumPlots |
| xFqInvGT50 | VEG | FqInvgt50 as a percent of NumPlots |
| PCavForbQd | VEG | average percent-cover of forbs per quad (any identification certainty level) |
| PCavGramQd | VEG | average percent-cover of graminoids per quad (any identification certainty level) |
| PCavShrQd | VEG | average percent-cover of shrubs per quad (any identification certainty |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| | | level); only those <3 ft tall |
| PCavTreeQd | VEG | average percent-cover of graminoids per quad (any identification certainty level); only those <3 ft tall |
| PCmxForb | VEG | maximum percent-cover of forbs per quad (any identification certainty level) |
| PCmxGram | VEG | maximum percent-cover of graminoids per quad (any identification certainty level) |
| PCmxShr | VEG | maximum percent-cover of shrubs per quad (any identification certainty level); only those <3 ft tall |
| PCmxTree | VEG | maximum percent-cover of graminoids per quad (any identification certainty level); only those <3 ft tall |
| PCnnQdav | VEG | average percent-cover of non-native plants per quad (any identification certainty level) |
| PCnnQdMx | VEG | maximum percent-cover of non-native plants per quad (any identification certainty level) |
| PCinvQdAv | VEG | average percent-cover of invasive plants per quad (any identification certainty level) |
| PCinvQdMx | VEG | maximum percent-cover of invasive plants per quad (any identification certainty level) |
| WISavg | VEG | WIS Prevalence Index, average per quad (average wetland indicator status of plant species weighted by percent-cover; 1= OBL, 2= FACW, 3= FAC) |
| WISmin | VEG | WIS Prevalence Index, minimum per quad |
| WISmax | VEG | WIS Prevalence Index, maximum per quad |
| XerRichAll | VEG | # of plant taxa (all levels of identification certainty) at Xerces sampling plot (quad) |
| XerRich12 | VEG | # of plant taxa (identification certainty level 1 or 2) at Xerces sampling plot |
| XerRich1 | VEG | # of plant taxa (identification certainty level 1) at Xerces sampling plot |
| XerRichNN | VEG | # of non-native plant taxa at Xerces sampling plot |
| XerRichInv | VEG | # of invasive plant taxa at Xerces sampling plot |
| XerRichForb | VEG | # of forb taxa at Xerces sampling plot |
| XerRichGram | VEG | # of graminoid taxa at Xerces sampling plot |
| XerRichTree | VEG | # of tree species (<3 ft height) at Xerces sampling plot |
| XerRichShr | VEG | # of shrub species (<3 ft height) at Xerces sampling plot |
| XerWet | VEG | # of wetland plant species (FAC, FACW, OBL) at Xerces sampling plot |
| XerRichFAC | VEG | # of facultative wetland plant species at Xerces sampling plot |
| XerRichFACW | VEG | # of FACW plant species at Xerces sampling plot |
| XerRichOBL | VEG | # of obligate plant species at Xerces sampling plot |
| xXerRichAll | VEG | # of plant taxa (all levels of identification certainty) at Xerces sampling plot as a percent of all plant taxa at the entire site |
| xXerRichNN | VEG | # of non-native plant taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichInv | VEG | # of invasive plant taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| xXerRichForb | VEG | # of forb taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichGram | VEG | # of graminoid taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichTree | VEG | # of tree species (<3 ft high) at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichShr | VEG | # of shrub species (<3 ft high) at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerWet | VEG | # of wetland plant taxa (FAC, FACW, or OBL) at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichFAC | VEG | # of facultative plant taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichFACW | VEG | # of FACW plant taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| xXerRichOBL | VEG | # of obligate plant taxa at Xerces sampling plot as a percent of all plant taxa at the Xerces sampling plot |
| XerPCgt9 | VEG | summed percent-cover of all plant species with >9 percent cover at the Xerces sampling plot |
| XerPCnn | VEG | summed percent-cover of all non-native plant species at the Xerces sampling plot |
| XerPCinv | VEG | summed percent-cover of all invasive plant species at the Xerces sampling plot |
| XerForbPC | VEG | summed percent-cover of all forbs at the Xerces sampling plot |
| XerGramPC | VEG | summed percent-cover of all graminoids at the Xerces sampling plot |
| XerTreePC | VEG | summed percent-cover of all trees (<3 ft high) at the Xerces sampling plot |
| XerShrPC | VEG | summed percent-cover of all shrubs (<3 ft high) at the Xerces sampling plot |
| XerWIS | VEG | WIS Prevalence Index at the Xerces sampling plot |
| XerWaterPC | VEG | percent-cover of water at the Xerces sampling plot during the vegetation survey visit |
| AllBird | BIRD | # of bird species noted incidentally during vegetation survey visit |
| WetBird | BIRD | # of wetland or water-dependent bird species noted incidentally during vegetation survey visit |
| NNbird | BIRD | # of non-native bird species noted incidentally during vegetation survey visit |
| Amph | AMPH | amphibian and reptile species noted incidentally during vegetation survey visit (1= yes) |
| Bullf | AMPH | bullfrog heard or seen incidentally (1=yes) |
| HDA | ALT | Human Disturbance Assessment index (see Xerces report) |
| HDA class | ALT | Human Disturbance Assessment index (see Xerces report) |
| MIVnum | MIV | total # of invertebrates (abundance) |
| MIVspp | MIV | total # of taxa (richness) |
| TolSpp1 | MIV | # of highly tolerant taxa (HBI8-10) |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| TolSpp2 | MIV | |
| PredSp | MIV | # of predator taxa |
| GenChiri | MIV | # of Chironomini genera |
| PctDivCG | MIV | % of richness that is midges or snails |
| NonInsects | MIV | # of non-insect taxa |
| Shannon | MIV | Shannon diversity index (number of taxa and evenness of their abundance) |
| GenChirdae | MIV | # of Chironomidae genera |
| PctNDom | MIV | % of total abundance that is the top 3 dominant taxa |
| PctSpPred | MIV | % of richness that is predators |
| GasGen | MIV | # snail genera |
| PctSpGas | MIV | % of richness that is snails |
| PctNGas | MIV | % of total abundance that is snails |
| GenCM | MIV | # of Crustacea & Mollusca genera |
| PctSpChiri | MIV | % of richness that is Chironomini |
| PctNChiri | MIV | % of total abundance that is Chironomini |
| GenECOT | MIV | # of ECOT genera (Ephemeroptera, Coleoptera, Odonata, Trichoptera) |
| PctSpTol | MIV | % of diversity that is highly tolerant taxa |
| PctNTol | MIV | % of total abundance highly tolerant |
| PctNpred | MIV | % of total abundance predator |
| PctNcg | MIV | % of total abundance that is beetles & snails |
| PctNChiro | MIV | % of total abundance of Chironomus |
| PctNCM | MIV | % of total abundance that is Crustacea+Mollusca |
| TanySpp | MIV | # of Tanytarsini taxa |
| PctSpTany | MIV | % of Chironomidae diversity that is Tanytarsini |
| PctNTany | MIV | % of Chironomidae abundance that is Tanytarsini |
| ETSDspp | MIV | # of taxa of Ephemeroptera + Trichoptera + Sphaeraidae+ Diptera |
| PctSpETSD | MIV | % of richness that is Ephemeroptera + Trichoptera + Sphaeraidae+ Diptera |
| PctN_ETSD | MIV | % of abundance that is Ephemeroptera + Trichoptera + Sphaeraidae+ Diptera |
| PctMostDom | MIV | % of total abundance tha is in the top 1 taxon |
| PctNCaecid | MIV | % of total abundance that is Caecidotea |
| PctNAmpIso | MIV | % of total abundance that is Amphipoa+Isopoda |
| PctNCrusAI | MIV | % of total Crustacea abundance that is Amphipoa+Isopoda |
| PctSpCrus | MIV | % of diversity that is Crustacea |
| PctNCrus | MIV | % of total abundance that is Crustacea |
| PctNmites | MIV | % of total abundance that is mites |
| CGspp | MIV | # of beetle & snail taxa |
| OrthoSpp | MIV | # of Orthocladiinae taxa |
| PctSpOrtho | MIV | % of richness that is Orthocladiinae |
| PctNortho | MIV | % of total abundance that is Orthocladiinae |
| MHBIav | MIV | Macroinvertebrate Habitat Biotic Index (unweighted mean) |
| MHBIavWtd | MIV | Macroinvertebrate Habitat Biotic Index (weighted mean) |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| PctNmicroc | MIV | % of total abundance that is microcrustacea |
| PctSpET | MIV | % of diversity that is Ephemeroptera + Trichoptera |
| ETspp | MIV | # of mayfly and caddisflly taxa |
| PctN_ET | MIV | % of total abundance that is mayflues and caddisflies |
| PctSpCM | MIV | % of richness that is Crustacea+Mollusca |
| ChiroPctMidge | MIV | % of Chironomidae that are Chironomus |
| ColeoSpp | MIV | # of beetle taxa |
| PctSpColeo | MIV | % of richness that is beetle taxa |
| PctN_Coleo | MIV | % of total abundance that is beetles |
| SensSp | MIV | # of sensitive taxa (HBI1-4) |
| PctSpSens | MIV | % of richness that is sensitive taxa (HBI1-4) |
| PctNsens | MIV | % of total abundance that is sensitive taxa |
| RareSpp | MIV | # of rare taxa (<1% abund.) |
| PctSpRare | MIV | % of diversity that is rare taxa |
| PctNSphaer | MIV | % of abundance that is Sphaeriidae |
| pH | CHEM_W | pH of surface water sample collected at time of invertebrate sampling |
| Cl | CHEM_W | chloride concentration of surface water sample collected at time of invertebrate sampling |
| NO3_w | CHEM_W | total nitrogen of surface water sample collected at time of invertebrate sampling |
| TP_w | CHEM_W | total phosphorus of surface water sample collected at time of invertebrate sampling |
| Conduc | CHEM_W | conductivity (specific conductance) surface water sample collected at time of invertebrate sampling |
| pH_s | CHEM_S | pH of surface soil sample (composite from 4 pits per site) as analyzed in lab |
| K_s | CHEM_S | potassium concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Mg_s | CHEM_S | magnesium concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Na_s | CHEM_S | sodium concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Ca_s | CHEM_S | calcium concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Cu_s | CHEM_S | copper concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Zn_s | CHEM_S | zinc concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Mn_s | CHEM_S | manganese concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| Fe_s | CHEM_S | iron concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |

| A-1. Data Dictionary Variable | Category | Definition/ Codes |
|---|---|---|
| TP_s | CHEM_S | total phosphorus concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| NO3_s | CHEM_S | nitrate concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| OM_s | CHEM_S | organic matter concentration in surface soil sample (composite from 4 pits per site) as analyzed in lab |
| WSf | ORWAP | ORWAP score for Water Storage function |
| SRf | ORWAP | ORWAP score for Sediment Retention function |
| PRf | ORWAP | ORWAP score for Phosphorus Retention function |
| NRf | ORWAP | ORWAP score for Nitrate Removal function |
| TRf | ORWAP | ORWAP score for Thermoregulation function |
| CSf | ORWAP | ORWAP score for Carbon Sequestration function |
| OEf | ORWAP | ORWAP score for Organic Export function |
| INVf | ORWAP | ORWAP score for Invertebrate Support function |
| FAf | ORWAP | ORWAP score for Anadromous Fish Support function |
| FRf | ORWAP | ORWAP score for Resident Fish Support function |
| AMf | ORWAP | ORWAP score for Amphibian Supportfunction |
| WBFf | ORWAP | ORWAP score for Feeding Waterbird Support function |
| WBNf | ORWAP | ORWAP score for Breeding Waterbird Support function |
| SBMf | ORWAP | ORWAP score for Songbird, Raptor, and Mammal Support function |
| POLf | ORWAP | ORWAP score for Pollinator Support function |
| PDf | ORWAP | ORWAP score for Plant Diversity function |
| WSv | ORWAP | ORWAP score for Water Storage value |
| SRv | ORWAP | ORWAP score for Sediment Retention value |
| PRv | ORWAP | ORWAP score for Phosphorus Retention value |
| NRv | ORWAP | ORWAP score for Nitrate Removal value |
| TRv | ORWAP | ORWAP score for Thermoregulation value |
| INVv | ORWAP | ORWAP score for Invertebrate Support value |
| FAv | ORWAP | ORWAP score for Anadromous Fish Support value |
| FRv | ORWAP | ORWAP score for Resident Fish Support value |
| AMv | ORWAP | ORWAP score for Amphibian Supportvalue |
| WBFv | ORWAP | ORWAP score for Feeding Waterbird Support value |
| WBNv | ORWAP | ORWAP score for Breeding Waterbird Support value |
| SBMv | ORWAP | ORWAP score for Songbird, Raptor, and Mammal Support value |
| POLv | ORWAP | ORWAP score for Pollinator Support value |
| PDv | ORWAP | ORWAP score for Plant Diversity value |
| PUv | ORWAP | ORWAP score for Public Use and Access value |
| PSv | ORWAP | ORWAP score for Provisioning Services value |
| Cond | ORWAP | ORWAP score for Ecological Condition value |
| Stress | ORWAP | ORWAP score for Stressor Index |
| Sens | ORWAP | ORWAP score for Site Sensitivity |

A-2. ORWAP function scores for Willamette Valley wetlands from OWEB 2010 assessment.

HGM: R= riverine, F= flats, S= slope, D= depressional
Category: E= enhanced, R= restored, N= reference
See Adamus et al. (2009a) for definitions of functions and how they were calculated.

| Site | HGM | Category | Wetland Function Effectiveness | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Storage | Sediment Retention | Phosphorus Retention | Nitrate Removal | Thermo regulation | Carbon Seques | Organic Export | Invertebrate Habitat | Andromous Fish Habitat | Resident Fish Habitat | Amphibian Habitat | Waterbird Feeding Habitat | Waterbird Nesting Habitat | Songbird Raptor & Mammal Habitat | Pollinator Habitat | Plant Diversity Support |
| Alton Baker | R | E | 5.53 | 5.13 | 7.56 | 4.80 | 2.22 | 1.88 | 7.17 | 3.30 | 0.00 | 2.96 | 2.77 | 3.92 | 0.00 | 3.24 | 4.88 | 2.36 |
| Ankeny | F | E | 5.82 | 6.80 | 5.58 | 6.14 | 2.22 | 1.83 | 4.78 | 5.09 | 0.00 | 1.68 | 4.63 | 6.64 | 5.27 | 5.19 | 7.59 | 4.63 |
| Arbor Stn | R | E | 0.87 | 3.42 | 7.71 | 3.24 | 3.33 | 2.75 | 6.59 | 3.02 | 0.00 | 2.27 | 2.24 | 3.23 | 0.00 | 2.76 | 4.57 | 5.20 |
| Arleda-Willow | R | N | 5.53 | 5.13 | 7.56 | 4.80 | 2.22 | 1.88 | 7.17 | 3.30 | 0.00 | 2.96 | 2.77 | 3.92 | 0.00 | 3.24 | 4.88 | 2.36 |
| Athey Slope | S | E | 0.00 | 3.21 | 4.28 | 4.44 | 0.00 | 3.08 | 0.00 | 5.81 | 0.00 | 1.25 | 3.73 | 4.21 | 0.00 | 2.54 | 2.54 | 1.48 |
| Aumsville | D | E | 2.58 | 6.63 | 3.38 | 4.14 | 1.11 | 2.70 | 4.24 | 4.29 | 0.00 | 5.53 | 2.52 | 3.90 | 4.70 | 4.93 | 4.42 | 1.64 |
| Beggars Tick | F | N | 4.86 | 6.53 | 6.01 | 5.36 | 0.56 | 2.75 | 5.81 | 3.17 | 0.00 | 4.17 | 5.11 | 2.99 | 0.00 | 2.16 | 4.69 | 3.51 |
| Bergey | F | R | 4.31 | 6.59 | 8.11 | 5.42 | 0.28 | 3.02 | 5.65 | 5.30 | 0.00 | 6.79 | 3.89 | 7.58 | 6.61 | 4.74 | 5.30 | 4.26 |
| Bristow | R | N | 3.13 | 6.76 | 3.32 | 4.61 | 1.11 | 2.51 | 5.60 | 4.52 | 0.00 | 5.68 | 4.11 | 4.67 | 5.08 | 6.85 | 5.33 | 2.49 |
| Budeau N | F | E | 2.95 | 6.97 | 5.37 | 4.34 | 1.11 | 2.93 | 4.44 | 5.49 | 0.00 | 5.78 | 4.39 | 5.26 | 5.97 | 6.96 | 5.10 | 3.14 |
| Budeau S | F | R | 4.33 | 7.30 | 5.69 | 5.61 | 1.11 | 2.00 | 4.47 | 6.20 | 0.00 | 3.59 | 4.28 | 6.59 | 5.86 | 5.09 | 5.76 | 4.09 |
| Buford E | F | E | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 2.15 | 0.00 | 7.41 | 0.00 | 0.72 | 7.59 | 4.02 | 0.00 | 5.12 | 8.76 | 7.77 |
| Cedar Mills | R | E | 2.89 | 6.33 | 8.38 | 3.80 | 1.11 | 2.78 | 4.79 | 3.31 | 0.00 | 4.83 | 2.71 | 4.40 | 6.52 | 4.89 | 4.41 | 3.86 |
| Corvallis Airport | F | N | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 1.62 | 0.00 | 4.70 | 0.00 | 0.38 | 5.86 | 5.21 | 0.00 | 3.06 | 3.19 | 4.55 |
| Coyote WMA | F | E | 5.60 | 7.97 | 8.25 | 5.12 | 1.11 | 1.72 | 4.72 | 5.07 | 0.00 | 6.65 | 3.95 | 8.58 | 6.88 | 4.53 | 5.00 | 2.79 |
| Crossland | F | E | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 1.62 | 0.00 | 4.67 | 0.00 | 0.46 | 5.81 | 6.32 | 5.11 | 2.70 | 3.19 | 6.25 |

| Site | HGM | Category | Wetland Function Effectiveness | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Storage | Sediment Retention | Phosphorus Retention | Nitrate Removal | Thermo regulation | Carbon Seques | Organic Export | Invertebrate Habitat | Andromous Fish Habitat | Resident Fish Habitat | Amphibian Habitat | Waterbird Feeding Habitat | Waterbird Nesting Habitat | Songbird Raptor & Mammal Habitat | Pollinator Habitat | Plant Diversity Support |
| Deer Creek Park | F | R | 3.34 | 5.22 | 7.88 | 4.21 | 2.50 | 2.47 | 7.54 | 6.20 | 0.00 | 1.46 | 3.70 | 4.64 | 0.00 | 4.79 | 7.95 | 8.47 |
| Delta Pond | R | E | 3.56 | 6.76 | 3.34 | 4.77 | 1.11 | 2.93 | 4.22 | 3.12 | 0.00 | 5.33 | 2.11 | 4.53 | 6.13 | 4.15 | 3.01 | 2.01 |
| EE Wilson Northwest | R | E | 4.68 | 6.42 | 5.61 | 5.65 | 0.00 | 2.46 | 6.23 | 5.29 | 0.00 | 2.46 | 3.35 | 5.56 | 0.00 | 4.52 | 6.03 | 2.70 |
| Endicott | R | E | 5.62 | 5.93 | 4.67 | 5.94 | 1.39 | 1.75 | 5.58 | 5.09 | 0.00 | 3.14 | 3.35 | 6.46 | 5.94 | 4.53 | 5.66 | 4.96 |
| Entek | F | R | 1.25 | 10.00 | 10.00 | 10.00 | 0.00 | 2.03 | 0.00 | 5.28 | 0.00 | 0.57 | 5.97 | 4.98 | 0.00 | 2.65 | 4.13 | 2.72 |
| Finley Brown Swamp | F | E | 5.00 | 6.23 | 7.70 | 5.74 | 1.39 | 1.91 | 5.92 | 5.38 | 0.00 | 3.44 | 4.17 | 7.19 | 6.84 | 6.02 | 6.96 | 4.96 |
| Finley McFadden | R | E | 5.20 | 6.65 | 8.39 | 5.84 | 0.56 | 2.31 | 5.92 | 5.33 | 0.00 | 3.42 | 4.35 | 6.05 | 5.20 | 6.17 | 6.71 | 3.57 |
| Finley Prairie N | F | N | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 1.77 | 0.00 | 7.21 | 0.00 | 0.86 | 8.21 | 6.25 | 4.89 | 5.36 | 6.50 | 6.41 |
| Fisher Butte | F | E | 4.31 | 6.55 | 8.64 | 5.08 | 0.56 | 2.64 | 5.42 | 5.50 | 0.00 | 3.96 | 4.28 | 8.40 | 7.95 | 4.84 | 5.90 | 4.61 |
| Garden Lakes | R | E | 2.98 | 3.52 | 2.50 | 4.16 | 3.06 | 2.43 | 5.99 | 3.66 | 0.00 | 1.08 | 1.51 | 4.32 | 0.00 | 2.06 | 3.61 | 4.30 |
| Greenberry (Tyee) | F | N | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 2.13 | 0.00 | 5.13 | 0.00 | 5.53 | 3.17 | 5.60 | 0.00 | 4.51 | 7.79 | 5.91 |
| Harrisburg | R | N | 3.30 | 4.10 | 2.09 | 4.71 | 3.61 | 1.94 | 7.33 | 4.30 | 0.00 | 3.77 | 2.73 | 5.49 | 5.08 | 4.01 | 4.20 | 2.56 |
| Hatch | R | R | 3.17 | 4.28 | 2.46 | 4.71 | 3.06 | 1.89 | 5.72 | 4.88 | 0.00 | 3.15 | 3.38 | 4.60 | 3.84 | 4.62 | 6.14 | 3.84 |
| Hedges Park | R | E | 3.46 | 4.37 | 7.70 | 4.55 | 1.94 | 2.65 | 5.52 | 2.61 | 0.00 | 2.27 | 1.52 | 4.50 | 0.00 | 1.73 | 2.82 | 3.00 |
| Hedges TWC | R | E | 2.81 | 5.18 | 7.86 | 5.15 | 2.50 | 2.63 | 6.59 | 5.05 | 0.00 | 3.72 | 2.76 | 6.52 | 5.86 | 3.74 | 5.42 | 4.78 |
| Jackson-Frazier | F | E | 4.81 | 6.51 | 8.36 | 4.58 | 0.83 | 2.54 | 5.95 | 5.44 | 0.00 | 6.49 | 4.02 | 5.08 | 0.00 | 5.20 | 7.40 | 7.70 |
| Jampolsky | F | E | 3.25 | 10.00 | 10.00 | 10.00 | 0.00 | 1.65 | 0.00 | 6.22 | 0.00 | 8.06 | 3.27 | 6.60 | 5.95 | 3.85 | 5.52 | 3.42 |
| Knez | R | E | 1.77 | 4.93 | 4.85 | 4.23 | 2.78 | 3.17 | 6.54 | 3.37 | 0.00 | 3.74 | 1.54 | 4.67 | 5.49 | 2.00 | 3.01 | 4.44 |
| LaFolett | R | E | 3.67 | 4.23 | 7.10 | 4.27 | 1.11 | 1.53 | 6.48 | 3.66 | 0.00 | 2.97 | 2.44 | 5.36 | 4.23 | 3.07 | 2.89 | 2.09 |
| Lebanon AP | F | N | 2.92 | 4.08 | 7.49 | 3.47 | 0.00 | 2.47 | 5.83 | 4.99 | 0.00 | 0.87 | 5.25 | 4.03 | 0.00 | 1.66 | 2.91 | 4.57 |
| Lomatium Prairie | F | E | 1.25 | 10.00 | 10.00 | 10.00 | 0.00 | 2.59 | 0.00 | 7.32 | 0.00 | 0.82 | 7.88 | 4.09 | 0.00 | 5.93 | 8.68 | 7.81 |

| Site | HGM | Category | Wetland Function Effectiveness | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Storage | Sediment Retention | Phosphorus Retention | Nitrate Removal | Thermo regulation | Carbon Seques | Organic Export | Invertebrate Habitat | Andromous Fish Habitat | Resident Fish Habitat | Amphibian Habitat | Waterbird Feeding Habitat | Waterbird Nesting Habitat | Songbird Raptor & Mammal Habitat | Pollinator Habitat | Plant Diversity Support |
| McDonald Forest | R | N | 2.05 | 4.53 | 5.00 | 5.00 | 5.00 | 3.00 | 6.41 | 6.52 | 0.00 | 4.72 | 4.56 | 3.60 | 0.00 | 6.09 | 7.95 | 5.35 |
| Mt. Pisgah Arboretum | R | N | 4.29 | 6.80 | 8.44 | 5.63 | 4.44 | 2.83 | 4.63 | 5.62 | 0.00 | 4.82 | 4.42 | 3.83 | 4.03 | 5.05 | 6.74 | 5.55 |
| Munger | F | E | 4.75 | 10.00 | 10.00 | 10.00 | 0.00 | 2.62 | 0.00 | 5.08 | 0.00 | 3.11 | 4.09 | 5.18 | 5.19 | 5.09 | 5.08 | 3.41 |
| Pascuzzi | R | E | 4.01 | 8.10 | 8.96 | 5.35 | 1.11 | 2.76 | 4.12 | 3.75 | 0.00 | 4.76 | 2.62 | 5.20 | 5.83 | 3.50 | 4.46 | 1.84 |
| PCC | R | E | 0.00 | 4.28 | 3.69 | 3.90 | 2.78 | 1.95 | 6.54 | 4.93 | 0.00 | 3.19 | 2.60 | 4.37 | 0.00 | 3.02 | 4.92 | 2.08 |
| PDX Vanport | R | R | 5.59 | 7.37 | 8.34 | 5.92 | 0.56 | 2.48 | 5.59 | 5.00 | 0.00 | 3.26 | 2.57 | 7.08 | 5.34 | 3.96 | 4.21 | 3.38 |
| Pearmine | R | R | 4.86 | 6.09 | 7.58 | 4.99 | 1.67 | 2.05 | 6.22 | 3.64 | 0.00 | 1.47 | 2.97 | 6.13 | 0.00 | 3.84 | 5.71 | 4.48 |
| Philomath Newton Cr. | R | N | 3.04 | 5.33 | 8.56 | 4.40 | 1.67 | 2.77 | 5.12 | 5.00 | 0.00 | 1.33 | 2.75 | 3.22 | 0.00 | 3.61 | 6.66 | 4.15 |
| Randall Enhanced | F | E | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 1.57 | 0.00 | 5.09 | 0.00 | 4.04 | 2.30 | 4.86 | 0.00 | 2.21 | 5.62 | 5.47 |
| Randall NE | F | E | 4.18 | 5.38 | 7.87 | 4.55 | 0.00 | 2.04 | 7.35 | 5.34 | 0.00 | 4.13 | 2.59 | 4.87 | 0.00 | 3.07 | 6.80 | 6.43 |
| SamReynolds (Shippey) | R | R | 4.99 | 7.03 | 8.40 | 5.68 | 0.28 | 2.80 | 6.10 | 5.75 | 0.00 | 2.84 | 4.25 | 5.44 | 0.00 | 5.60 | 8.01 | 5.93 |
| Seavy | F | N | 5.00 | 10.00 | 10.00 | 10.00 | 0.00 | 2.34 | 0.00 | 5.97 | 0.00 | 0.44 | 6.83 | 5.37 | 0.00 | 3.17 | 3.74 | 3.91 |
| South Meadow | R | E | 4.54 | 4.62 | 2.77 | 5.05 | 1.72 | 1.85 | 6.97 | 5.57 | 0.00 | 3.22 | 4.21 | 5.04 | 4.94 | 5.48 | 6.64 | 3.80 |
| Spongs combined | R | N | 3.60 | 4.42 | 2.32 | 4.78 | 2.22 | 1.79 | 7.24 | 5.56 | 0.00 | 3.84 | 3.19 | 6.11 | 4.81 | 5.00 | 6.14 | 3.82 |
| Springville | R | N | 3.43 | 3.81 | 7.68 | 4.33 | 5.00 | 2.22 | 7.68 | 3.43 | 0.00 | 2.45 | 1.82 | 4.23 | 0.00 | 2.97 | 3.76 | 3.87 |
| Stewart Pd N | F | E | 4.39 | 7.56 | 8.14 | 4.91 | 1.11 | 1.98 | 4.38 | 3.77 | 0.00 | 4.85 | 2.95 | 6.46 | 6.06 | 3.55 | 4.26 | 3.86 |
| Stewart Pd S | F | R | 7.00 | 10.00 | 10.00 | 10.00 | 0.00 | 1.72 | 0.00 | 3.15 | 0.00 | 4.21 | 2.13 | 6.19 | 5.00 | 2.22 | 3.84 | 6.53 |
| Summer Cr | R | N | 3.58 | 4.38 | 7.46 | 4.92 | 1.61 | 2.32 | 6.22 | 3.95 | 0.00 | 2.86 | 1.62 | 5.15 | 4.35 | 2.59 | 3.66 | 2.66 |
| Town Ctr (Woodburn) | R | R | 4.69 | 5.12 | 7.15 | 4.64 | 3.33 | 1.74 | 5.92 | 3.64 | 0.00 | 2.83 | 2.43 | 6.27 | 0.00 | 3.53 | 5.26 | 3.89 |

| Site | HGM | Category | Wetland Function Effectiveness | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Water Storage | Sediment Retention | Phosphorus Retention | Nitrate Removal | Thermo regulation | Carbon Seques | Organic Export | Invertebrate Habitat | Andromous Fish Habitat | Resident Fish Habitat | Amphibian Habitat | Waterbird Feeding Habitat | Waterbird Nesting Habitat | Songbird Raptor & Mammal Habitat | Pollinator Habitat | Plant Diversity Support |
| Tualatin Hills | R | N | 3.54 | 6.43 | 8.60 | 5.15 | 3.61 | 2.45 | 5.79 | 5.13 | 0.00 | 8.28 | 6.52 | 5.40 | 5.88 | 4.99 | 7.55 | 6.09 |
| Willamette Mission | R | E | 5.09 | 6.77 | 3.22 | 5.98 | 0.56 | 2.33 | 5.63 | 5.95 | 0.00 | 3.83 | 4.37 | 6.17 | 5.80 | 6.01 | 7.26 | 3.82 |
| Willamette Park | R | N | 6.21 | 5.12 | 4.72 | 6.37 | 3.06 | 1.85 | 7.26 | 4.85 | 0.00 | 3.19 | 3.41 | 6.24 | 5.97 | 5.28 | 5.87 | 3.49 |
| Willow Creek | R | N | 4.45 | 6.76 | 8.17 | 5.00 | 1.94 | 2.58 | 5.73 | 6.28 | 0.00 | 7.30 | 4.07 | 5.67 | 0.00 | 5.49 | 7.71 | 5.56 |
| Wyman | F | R | 4.10 | 4.47 | 7.17 | 4.49 | 0.83 | 2.24 | 7.68 | 4.46 | 0.00 | 1.44 | 2.83 | 4.34 | 0.00 | 3.17 | 5.48 | 4.27 |

Table A-3. Means and percentiles for vegetation metrics and ORWAP scores from Willamette Valley flats and riverine wetlands, summer 2009-2010

For metric abbreviations, see Data Dictionary in Table A-1. These statistics are from all sites, both years combined.

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| WaterFq | 2.42 | 3.98 | 0.00 | 0.00 | 4.00 | 8.00 | 2.78 | 3.87 | 0.00 | 0.00 | 4.00 | 7.60 |
| xWaterFq | 18% | 28% | 0% | 0% | 20% | 73% | 20% | 26% | 0% | 0% | 30% | 70% |
| WaterPCav | 13.19 | 22.94 | 0.00 | 0.00 | 14.06 | 57.38 | 11.19 | 17.26 | 0.00 | 0.00 | 12.25 | 35.70 |
| WaterPCmx | 35.97 | 46.92 | 0.00 | 0.00 | 100.00 | 100.00 | 49.54 | 44.95 | 0.00 | 0.00 | 100.00 | 100.00 |
| QdNonWet | 1.44 | 2.99 | 0.00 | 0.00 | 2.00 | 5.00 | 0.78 | 1.58 | 0.00 | 0.00 | 1.00 | 2.60 |
| FqNonWet | 0.09 | 0.19 | 0.00 | 0.00 | 0.10 | 0.30 | 0.05 | 0.09 | 0.00 | 0.00 | 0.05 | 0.13 |
| UbiqWetNtvAv | 0.57 | 0.15 | 0.39 | 0.44 | 0.69 | 0.74 | 0.68 | 0.10 | 0.55 | 0.65 | 0.75 | 0.78 |
| UbiqWetNtvMx | 0.83 | 0.12 | 0.67 | 0.75 | 0.93 | 0.96 | 0.89 | 0.08 | 0.77 | 0.86 | 0.96 | 0.98 |
| Rich1Cumu | 27.14 | 14.05 | 11.00 | 19.75 | 33.75 | 43.50 | 28.32 | 14.64 | 14.00 | 17.00 | 36.00 | 46.20 |
| Rich1GT50 | 3.42 | 1.81 | 1.50 | 2.00 | 5.00 | 5.00 | 3.40 | 1.80 | 2.00 | 2.00 | 4.00 | 6.00 |
| Rich1GT20 | 7.39 | 2.84 | 4.00 | 5.75 | 10.00 | 10.50 | 7.35 | 3.55 | 3.40 | 5.00 | 9.00 | 11.60 |
| Rich1GT9 | 12.81 | 5.10 | 7.00 | 9.00 | 15.00 | 18.50 | 12.83 | 5.61 | 6.00 | 9.00 | 16.00 | 21.60 |
| Rich1NN | 10.42 | 6.70 | 4.00 | 5.00 | 14.00 | 19.00 | 11.32 | 7.81 | 4.00 | 6.00 | 15.00 | 21.20 |
| Rich1Invas | 4.97 | 3.32 | 2.00 | 2.00 | 7.25 | 9.50 | 6.72 | 3.71 | 3.00 | 4.00 | 9.00 | 12.00 |
| Rich1Forb | 14.75 | 9.04 | 5.00 | 8.75 | 19.25 | 27.50 | 15.28 | 9.87 | 6.00 | 8.00 | 20.00 | 28.20 |
| Rich1Gram | 10.92 | 5.28 | 5.50 | 7.00 | 14.00 | 16.00 | 8.97 | 5.03 | 3.00 | 6.00 | 12.00 | 15.00 |
| Rich1Shrub | 0.97 | 1.13 | 0.00 | 0.00 | 1.00 | 2.00 | 3.26 | 2.37 | 0.40 | 2.00 | 4.00 | 6.00 |
| Rich1Tree | 0.50 | 0.65 | 0.00 | 0.00 | 1.00 | 1.00 | 0.75 | 0.85 | 0.00 | 0.00 | 1.00 | 2.00 |
| Rich1Wet | 20.58 | 8.95 | 10.50 | 16.50 | 25.00 | 30.00 | 19.97 | 8.02 | 10.00 | 14.00 | 26.00 | 29.60 |
| Rich1FAC | 3.42 | 3.43 | 0.00 | 1.00 | 5.00 | 7.50 | 4.85 | 3.61 | 1.00 | 2.00 | 7.00 | 10.00 |
| Rich1FACW | 7.81 | 4.33 | 3.00 | 5.00 | 10.00 | 13.00 | 7.62 | 3.65 | 3.00 | 5.00 | 10.00 | 12.00 |
| Rich1OBL | 9.36 | 3.45 | 5.00 | 7.00 | 12.00 | 14.00 | 7.51 | 3.78 | 3.00 | 5.00 | 10.00 | 12.00 |
| xRich1GT50 | 32% | 17% | 16% | 20% | 40% | 49% | 28% | 10% | 18% | 20% | 33% | 43% |
| xRich1GT20 | 51% | 13% | 37% | 39% | 58% | 68% | 48% | 13% | 33% | 38% | 57% | 66% |
| xRich1GT9 | 38% | 12% | 23% | 30% | 46% | 50% | 39% | 12% | 21% | 31% | 47% | 55% |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A-3. Metric | Mean | Std Dev | 10th %ile | 25th %ile | 75th %ile | 90th %ile | Mean | Std Dev | 10th %ile | 25th %ile | 75th %ile | 90th %ile |
| xRich1NN | 18% | 6% | 9% | 14% | 21% | 25% | 25% | 10% | 12% | 18% | 29% | 36% |
| xRich1Invas | 53% | 12% | 38% | 45% | 59% | 69% | 52% | 12% | 36% | 47% | 61% | 65% |
| xRich1Forb | 53% | 12% | 38% | 45% | 59% | 69% | 52% | 12% | 36% | 47% | 61% | 65% |
| xRich1Gram | 42% | 13% | 29% | 34% | 50% | 53% | 32% | 12% | 16% | 22% | 39% | 46% |
| xRich1Shrub | 3% | 4% | 0% | 0% | 5% | 9% | 13% | 10% | 1% | 6% | 17% | 23% |
| xRich1Tree | 2% | 3% | 0% | 0% | 3% | 7% | 3% | 4% | 0% | 0% | 5% | 8% |
| xRich1Wet | 79% | 12% | 66% | 68% | 88% | 93% | 74% | 11% | 60% | 67% | 81% | 86% |
| xRich1FAC | 15% | 11% | 0% | 5% | 21% | 28% | 23% | 12% | 7% | 13% | 32% | 39% |
| xRich1FACW | 37% | 12% | 20% | 30% | 45% | 47% | 39% | 12% | 25% | 30% | 46% | 53% |
| xRich1OBL | 49% | 15% | 30% | 39% | 60% | 70% | 38% | 17% | 19% | 28% | 50% | 61% |
| Rich12Cumu | 32.06 | 16.06 | 13.50 | 22.50 | 40.75 | 51.50 | 33.52 | 16.89 | 16.20 | 20.00 | 42.00 | 54.60 |
| Rich12GT50 | 4.22 | 2.11 | 2.00 | 3.00 | 6.00 | 6.50 | 3.88 | 2.19 | 2.00 | 2.00 | 5.00 | 6.00 |
| Rich12GT19 | 10.44 | 4.46 | 5.50 | 7.00 | 13.00 | 15.00 | 10.38 | 4.74 | 5.00 | 7.00 | 13.00 | 15.00 |
| Rich12GT9 | 15.17 | 5.80 | 8.00 | 10.75 | 17.50 | 21.50 | 15.23 | 6.42 | 7.00 | 11.00 | 20.00 | 23.60 |
| Rich12NN | 11.61 | 7.74 | 4.00 | 5.75 | 16.50 | 21.50 | 12.97 | 8.95 | 5.00 | 7.00 | 17.00 | 24.00 |
| Rich12invas | 5.19 | 3.37 | 2.00 | 2.00 | 7.25 | 10.00 | 6.86 | 3.75 | 3.00 | 4.00 | 9.00 | 12.60 |
| Rich12forb | 19.69 | 12.85 | 6.00 | 9.00 | 28.25 | 34.50 | 16.34 | 8.80 | 7.40 | 10.00 | 22.00 | 28.00 |
| Rich12gram | 12.92 | 6.72 | 5.00 | 8.00 | 17.00 | 18.00 | 11.42 | 6.31 | 3.00 | 7.00 | 16.00 | 18.20 |
| Rich12tree | 2.86 | 2.70 | 0.00 | 1.00 | 4.00 | 7.50 | 2.58 | 2.22 | 0.00 | 1.00 | 4.00 | 5.00 |
| Rich12shrub | 0.81 | 0.89 | 0.00 | 0.00 | 1.00 | 2.00 | 0.89 | 1.00 | 0.00 | 0.00 | 2.00 | 2.00 |
| Rich12Wet | 23.83 | 9.72 | 12.50 | 18.50 | 29.00 | 34.50 | 23.23 | 9.26 | 11.80 | 16.00 | 30.00 | 35.00 |
| Rich12FAC | 4.28 | 3.65 | 0.50 | 2.00 | 6.25 | 8.50 | 5.82 | 4.28 | 2.00 | 3.00 | 9.00 | 11.60 |
| Rich12FACW | 8.94 | 4.89 | 3.00 | 6.00 | 11.00 | 14.50 | 8.60 | 4.28 | 3.00 | 5.00 | 11.00 | 14.60 |
| Rich12OBL | 10.61 | 4.02 | 5.50 | 7.00 | 14.00 | 15.00 | 8.82 | 4.34 | 3.40 | 5.00 | 11.00 | 14.00 |
| xRich12GT50 | 16% | 10% | 7% | 9% | 18% | 27% | 13% | 6% | 7% | 9% | 17% | 21% |
| xRich12GT19 | 37% | 16% | 19% | 27% | 44% | 54% | 33% | 10% | 20% | 26% | 38% | 46% |
| xRich12GT9 | 52% | 13% | 37% | 39% | 60% | 67% | 48% | 12% | 37% | 40% | 54% | 64% |
| xRich12NN | 35% | 11% | 21% | 28% | 42% | 48% | 37% | 11% | 23% | 29% | 47% | 51% |
| xRich12invas | 16% | 5% | 9% | 12% | 19% | 21% | 21% | 8% | 10% | 16% | 25% | 30% |
| xRich12forb | 82% | 81% | 18% | 35% | 98% | 153% | 67% | 61% | 16% | 27% | 79% | 164% |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| xRich12gram | 56% | 51% | 14% | 20% | 71% | 113% | 45% | 38% | 8% | 16% | 63% | 94% |
| xRich12tree | 12% | 14% | 0% | 2% | 21% | 30% | 10% | 11% | 0% | 3% | 15% | 21% |
| xRich12shrub | 4% | 5% | 0% | 0% | 6% | 11% | 4% | 6% | 0% | 0% | 5% | 11% |
| xRich12Wet | 78% | 12% | 63% | 67% | 87% | 93% | 72% | 10% | 61% | 67% | 78% | 84% |
| xRich12FAC | 17% | 11% | 2% | 9% | 21% | 31% | 24% | 12% | 10% | 14% | 32% | 38% |
| xRich12FACW | 36% | 12% | 20% | 29% | 43% | 49% | 37% | 12% | 24% | 29% | 45% | 53% |
| xRich12OBL | 47% | 15% | 28% | 36% | 58% | 67% | 39% | 17% | 15% | 26% | 52% | 66% |
| RichAllQdAvg | 6.66 | 2.36 | 3.85 | 5.45 | 8.00 | 9.95 | 6.58 | 2.44 | 4.14 | 5.00 | 7.85 | 9.46 |
| RichAllQdMax | 11.97 | 4.12 | 7.00 | 9.00 | 15.00 | 18.00 | 11.82 | 3.81 | 7.00 | 9.00 | 15.00 | 16.60 |
| Rich1QdAvg | 4.82 | 1.94 | 2.61 | 3.86 | 5.23 | 7.55 | 4.88 | 2.03 | 2.84 | 3.55 | 5.80 | 6.72 |
| Rich1QdMax | 9.36 | 3.42 | 5.00 | 7.00 | 11.00 | 14.00 | 9.42 | 3.42 | 5.00 | 7.00 | 12.00 | 14.00 |
| Rich1QdAvGT9 | 2.09 | 0.54 | 1.45 | 1.69 | 2.37 | 2.75 | 2.14 | 0.47 | 1.52 | 1.82 | 2.40 | 2.80 |
| Rich1QdMxGT9 | 3.69 | 0.95 | 3.00 | 3.00 | 4.00 | 5.00 | 4.02 | 1.08 | 3.00 | 3.00 | 5.00 | 5.00 |
| Rich1QdAvNN | 2.14 | 0.90 | 1.44 | 1.55 | 2.36 | 3.20 | 2.38 | 1.07 | 1.51 | 1.75 | 2.80 | 3.48 |
| Rich1QdMxNN | 4.89 | 2.46 | 2.50 | 3.00 | 6.25 | 8.00 | 5.00 | 2.46 | 3.00 | 3.00 | 6.00 | 8.00 |
| Rich12QdAvGT9 | 2.40 | 0.58 | 1.69 | 2.09 | 2.69 | 3.15 | 2.41 | 0.56 | 1.63 | 2.10 | 2.70 | 3.09 |
| Rich12QdMxGT9 | 4.19 | 1.01 | 3.00 | 3.75 | 5.00 | 5.00 | 4.31 | 1.16 | 3.00 | 4.00 | 5.00 | 6.00 |
| Rich12QdAvNN | 2.34 | 1.00 | 1.47 | 1.66 | 2.61 | 3.78 | 2.60 | 1.20 | 1.60 | 1.80 | 3.00 | 3.85 |
| Rich12QdMxNN | 5.36 | 2.70 | 2.50 | 3.00 | 7.25 | 9.00 | 5.40 | 2.57 | 3.00 | 3.00 | 7.00 | 9.00 |
| Fq1NNgt9 | 9.03 | 4.79 | 3.50 | 4.00 | 13.25 | 15.50 | 10.85 | 5.11 | 5.00 | 7.00 | 16.00 | 18.00 |
| Fq1NnGT50 | 3.17 | 3.41 | 0.00 | 1.00 | 5.00 | 8.00 | 4.72 | 4.32 | 1.00 | 2.00 | 6.00 | 12.60 |
| Fq12nnGT9 | 9.72 | 4.90 | 4.00 | 5.00 | 14.00 | 16.00 | 11.65 | 5.27 | 5.00 | 8.00 | 16.00 | 19.00 |
| Fq12nnGT50 | 3.64 | 3.59 | 0.00 | 1.00 | 5.00 | 9.00 | 5.15 | 4.50 | 1.00 | 2.00 | 8.00 | 13.00 |
| FqInvAll | 9.50 | 5.63 | 3.00 | 5.00 | 13.25 | 18.50 | 12.46 | 5.16 | 6.40 | 9.00 | 18.00 | 20.00 |
| FqInvGT9 | 5.78 | 4.52 | 1.00 | 2.00 | 9.00 | 12.50 | 9.45 | 5.41 | 3.40 | 5.00 | 14.00 | 17.60 |
| FqInvGT50 | 1.69 | 2.30 | 0.00 | 0.00 | 2.00 | 5.00 | 4.35 | 4.41 | 0.00 | 1.00 | 6.00 | 12.00 |
| xFq1NNgt9 | 58% | 24% | 30% | 40% | 80% | 90% | 72% | 22% | 40% | 60% | 90% | 100% |
| xFq1NnGT50 | 19% | 20% | 0% | 5% | 30% | 48% | 31% | 23% | 5% | 10% | 50% | 68% |
| xFq12nnGT9 | 63% | 23% | 33% | 40% | 80% | 92% | 76% | 20% | 50% | 65% | 90% | 100% |
| xFq12nnGT50 | 23% | 21% | 0% | 10% | 31% | 50% | 33% | 24% | 5% | 10% | 50% | 70% |

| A-3. Metric | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std Dev | 10th %ile | 25th %ile | 75th %ile | 90th %ile | Mean | Std Dev | 10th %ile | 25th %ile | 75th %ile | 90th %ile |
| xFqInvAll | 61% | 27% | 30% | 38% | 80% | 100% | 83% | 20% | 55% | 70% | 100% | 100% |
| xFqInvGT9 | 37% | 27% | 8% | 20% | 51% | 75% | 62% | 27% | 22% | 40% | 80% | 100% |
| xFqInvGT50 | 10% | 13% | 0% | 0% | 11% | 30% | 28% | 24% | 0% | 10% | 40% | 68% |
| PCavForbQd | 42.54 | 20.51 | 16.67 | 27.82 | 58.38 | 67.54 | 35.19 | 18.27 | 11.33 | 19.47 | 48.59 | 58.53 |
| PCavGramQd | 52.79 | 18.87 | 32.41 | 38.93 | 64.58 | 75.41 | 56.58 | 20.80 | 31.89 | 39.20 | 72.05 | 83.91 |
| PCavShrQd | 6.16 | 8.71 | 0.00 | 0.00 | 9.14 | 14.50 | 11.00 | 9.95 | 1.00 | 5.00 | 14.22 | 22.78 |
| PCavTreeQd | 3.91 | 7.00 | 0.00 | 0.00 | 5.81 | 11.00 | 6.49 | 8.09 | 0.00 | 0.00 | 10.50 | 16.63 |
| PCmxForb | 98.19 | 35.91 | 45.00 | 86.50 | 119.25 | 135.00 | 88.08 | 39.11 | 27.80 | 61.00 | 111.00 | 128.40 |
| PCmxGram | 97.44 | 20.85 | 86.50 | 95.00 | 105.00 | 114.00 | 102.18 | 25.41 | 76.20 | 95.00 | 106.00 | 120.00 |
| PCmxShr | 10.28 | 18.87 | 0.00 | 0.00 | 10.00 | 20.50 | 29.94 | 28.57 | 1.00 | 10.00 | 50.00 | 78.00 |
| PCmxTree | 6.08 | 9.56 | 0.00 | 0.00 | 10.00 | 22.50 | 11.68 | 15.66 | 0.00 | 0.00 | 20.00 | 30.00 |
| PCnnQdav | 38.06 | 19.97 | 14.38 | 27.16 | 49.35 | 61.66 | 49.75 | 20.84 | 24.33 | 33.30 | 65.55 | 78.33 |
| PCnnQdMx | 90.42 | 34.39 | 45.50 | 80.75 | 101.00 | 108.50 | 104.15 | 26.88 | 72.00 | 97.00 | 115.00 | 129.20 |
| PCinvQdAv | 22.70 | 14.21 | 7.07 | 12.81 | 28.54 | 46.80 | 42.89 | 22.02 | 16.84 | 24.75 | 57.88 | 74.14 |
| PCinvQdMx | 65.28 | 39.90 | 15.00 | 30.00 | 92.00 | 100.00 | 93.52 | 31.59 | 47.60 | 90.00 | 105.00 | 115.00 |
| WISavg | 1.79 | 0.62 | 1.19 | 1.34 | 2.12 | 2.50 | 1.87 | 0.38 | 1.34 | 1.62 | 2.08 | 2.25 |
| WISmin | 1.16 | 0.31 | 1.00 | 1.00 | 1.12 | 1.58 | 1.19 | 0.32 | 1.00 | 1.00 | 1.22 | 1.68 |
| WISmax | 2.75 | 0.82 | 1.87 | 2.11 | 3.38 | 3.89 | 2.82 | 0.67 | 2.03 | 2.33 | 3.31 | 3.72 |
| AllBird | 15.03 | 6.64 | 8.40 | 10.00 | 19.00 | 23.20 | 16.17 | 6.04 | 9.00 | 12.75 | 20.00 | 23.70 |
| WetBird | 3.97 | 2.63 | 1.00 | 2.00 | 6.00 | 8.00 | 4.16 | 3.16 | 1.00 | 2.00 | 5.25 | 7.70 |
| CGspp | 12.91 | 3.73 | 8.00 | 10.25 | 16.00 | 17.70 | 14.68 | 4.22 | 9.40 | 12.00 | 17.00 | 19.00 |
| ChiroPctMidge | 33.50 | 29.50 | 0.95 | 9.76 | 54.92 | 76.03 | 23.65 | 28.24 | 0.00 | 2.20 | 44.13 | 68.68 |
| ColeoSpp | 4.37 | 2.06 | 2.00 | 3.00 | 6.00 | 7.00 | 2.58 | 2.06 | 1.00 | 1.00 | 3.00 | 5.00 |
| ETSDspp | 1.60 | 1.73 | 0.00 | 0.00 | 2.00 | 4.00 | 3.07 | 2.08 | 1.00 | 2.00 | 4.00 | 5.00 |
| ETspp | 0.82 | 1.00 | 0.00 | 0.00 | 1.00 | 2.00 | 1.38 | 1.51 | 0.00 | 0.00 | 2.00 | 4.00 |
| GasGen | 2.29 | 1.29 | 1.00 | 1.25 | 3.00 | 3.70 | 2.63 | 1.01 | 1.00 | 2.00 | 3.00 | 4.00 |
| GenChirdae | 8.07 | 3.34 | 4.00 | 5.25 | 10.75 | 12.70 | 10.59 | 5.58 | 3.80 | 7.00 | 14.00 | 18.00 |
| GenChiri | 2.09 | 1.48 | 1.00 | 1.00 | 3.00 | 4.70 | 2.68 | 1.75 | 1.00 | 1.00 | 4.00 | 5.00 |
| GenCM | 7.12 | 2.57 | 3.30 | 6.00 | 9.00 | 10.00 | 8.58 | 2.28 | 5.40 | 7.00 | 10.00 | 11.00 |
| GenECOT | 6.34 | 2.96 | 2.30 | 4.00 | 8.88 | 10.00 | 4.86 | 2.65 | 2.00 | 3.00 | 6.00 | 8.00 |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| HDA | 30.08 | 11.64 | 17.20 | 20.00 | 37.50 | 47.20 | 35.45 | 13.48 | 16.60 | 26.00 | 45.00 | 50.00 |
| HDA class | 1.94 | 0.74 | 1.00 | 1.00 | 2.00 | 3.00 | 2.15 | 0.67 | 1.00 | 2.00 | 3.00 | 3.00 |
| MHBIav | 7.37 | 0.42 | 7.00 | 7.20 | 7.70 | 7.90 | 7.36 | 0.83 | 6.60 | 6.90 | 7.80 | 8.50 |
| MHBIavWtd | 7.79 | 0.39 | 7.43 | 7.70 | 8.00 | 8.17 | 7.59 | 0.59 | 6.90 | 7.40 | 7.90 | 8.00 |
| MIVnum | 21858 | 20349 | 2636 | 5861 | 32037 | 58901 | 20361 | 19455 | 2455 | 6950 | 25488 | 47190 |
| MIVspp | 26.68 | 8.29 | 15.60 | 21.25 | 31.75 | 38.10 | 29.62 | 7.60 | 19.40 | 26.00 | 34.00 | 37.60 |
| NonInsects | 9.62 | 3.03 | 5.00 | 7.00 | 11.75 | 13.70 | 12.06 | 2.82 | 8.00 | 10.00 | 14.00 | 16.00 |
| OrthoSpp | 3.24 | 1.48 | 1.00 | 2.00 | 4.75 | 5.00 | 3.85 | 2.15 | 1.00 | 2.00 | 5.00 | 6.00 |
| PctDivCG | 51.25 | 10.00 | 40.27 | 43.48 | 57.10 | 64.74 | 50.90 | 8.67 | 41.26 | 46.43 | 55.20 | 60.91 |
| PctMostDom | 46.06 | 18.37 | 26.90 | 31.20 | 54.18 | 76.32 | 41.50 | 17.60 | 23.02 | 28.86 | 48.40 | 67.46 |
| PctN_Coleo | 1.68 | 1.75 | 0.45 | 0.61 | 2.25 | 3.87 | 0.74 | 1.04 | 0.06 | 0.20 | 0.76 | 1.81 |
| PctN_ET | 0.15 | 0.22 | 0.00 | 0.00 | 0.19 | 0.46 | 2.11 | 6.30 | 0.00 | 0.00 | 0.42 | 4.14 |
| PctN_ETSD | 0.74 | 1.88 | 0.00 | 0.00 | 0.52 | 1.51 | 4.04 | 7.15 | 0.08 | 0.34 | 4.04 | 8.14 |
| PctNAmpIso | 7.52 | 9.61 | 0.00 | 0.74 | 12.05 | 17.76 | 5.27 | 6.80 | 0.03 | 0.33 | 7.22 | 16.03 |
| PctNCaecid | 2.28 | 4.47 | 0.00 | 0.00 | 1.56 | 9.43 | 2.08 | 4.14 | 0.00 | 0.00 | 1.87 | 6.69 |
| PctNcg | 39.36 | 19.38 | 21.21 | 25.48 | 45.15 | 66.64 | 62.91 | 20.92 | 35.75 | 50.00 | 80.18 | 88.53 |
| PctNChiri | 5.62 | 7.55 | 0.36 | 0.80 | 5.91 | 13.40 | 6.70 | 7.89 | 0.22 | 1.54 | 9.22 | 16.01 |
| PctNChiro | 4.52 | 5.80 | 0.23 | 0.53 | 5.57 | 10.80 | 4.61 | 6.94 | 0.00 | 0.31 | 4.53 | 14.94 |
| PctNCM | 68.97 | 23.18 | 42.75 | 59.65 | 83.95 | 90.83 | 50.24 | 28.03 | 13.67 | 26.26 | 78.01 | 87.01 |
| PctNCrus | 51.75 | 29.63 | 9.65 | 24.52 | 80.10 | 85.42 | 40.79 | 27.66 | 7.69 | 17.05 | 63.50 | 79.19 |
| PctNCrusAI | 20.34 | 25.89 | 0.00 | 1.43 | 30.61 | 53.80 | 16.05 | 19.72 | 0.07 | 0.93 | 21.83 | 50.43 |
| PctNDom | 73.67 | 14.20 | 55.79 | 65.80 | 85.43 | 91.75 | 69.40 | 13.97 | 50.82 | 60.50 | 79.20 | 87.90 |
| PctNGas | 16.67 | 21.58 | 0.10 | 1.08 | 26.94 | 53.79 | 7.59 | 13.47 | 0.40 | 0.89 | 6.63 | 20.04 |
| PctNmicroc | 44.22 | 30.91 | 3.29 | 15.95 | 70.73 | 84.97 | 35.51 | 26.91 | 6.14 | 13.61 | 60.67 | 76.77 |
| PctNmites | 0.20 | 0.58 | 0.00 | 0.00 | 0.17 | 0.41 | 1.26 | 3.51 | 0.00 | 0.00 | 1.20 | 2.48 |
| PctNortho | 4.08 | 5.16 | 0.27 | 0.75 | 5.90 | 11.75 | 3.76 | 3.99 | 0.22 | 0.62 | 5.52 | 9.44 |
| PctNpred | 4.21 | 5.98 | 0.54 | 1.34 | 4.80 | 7.39 | 3.97 | 4.66 | 0.56 | 1.07 | 5.15 | 9.56 |
| PctNsens | 0.26 | 0.58 | 0.00 | 0.00 | 0.20 | 0.72 | 2.53 | 6.88 | 0.00 | 0.00 | 0.91 | 6.53 |
| PctNSphaer | 0.55 | 1.70 | 0.00 | 0.00 | 0.10 | 1.24 | 1.86 | 3.55 | 0.00 | 0.00 | 2.13 | 5.00 |
| PctNTany | 19.07 | 23.52 | 0.00 | 1.53 | 26.20 | 59.00 | 25.88 | 25.39 | 0.86 | 3.40 | 41.25 | 65.16 |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| PctNTol | 79.99 | 20.47 | 49.99 | 75.62 | 94.57 | 97.97 | 75.06 | 23.37 | 39.70 | 56.03 | 93.13 | 96.68 |
| PctSpChiri | 7.64 | 4.41 | 3.00 | 4.09 | 11.22 | 12.50 | 8.45 | 4.56 | 3.45 | 5.00 | 11.43 | 14.97 |
| PctSpCM | 27.28 | 8.71 | 17.05 | 22.29 | 31.62 | 36.25 | 30.81 | 10.38 | 16.27 | 25.00 | 37.50 | 43.51 |
| PctSpColeo | 16.49 | 6.64 | 8.74 | 11.60 | 20.00 | 26.92 | 8.91 | 7.31 | 2.76 | 5.00 | 11.43 | 17.48 |
| PctSpCrus | 18.26 | 6.76 | 10.83 | 13.52 | 20.52 | 25.00 | 18.76 | 6.50 | 12.83 | 14.29 | 21.43 | 26.45 |
| PctSpET | 2.58 | 2.96 | 0.00 | 0.00 | 3.96 | 6.95 | 4.32 | 4.20 | 0.00 | 0.00 | 7.69 | 10.59 |
| PctSpETSD | 5.18 | 5.05 | 0.00 | 0.00 | 9.02 | 11.93 | 10.02 | 5.65 | 2.89 | 6.67 | 13.16 | 17.01 |
| PctSpGas | 8.22 | 3.76 | 3.94 | 6.72 | 10.00 | 11.86 | 9.61 | 4.68 | 3.13 | 5.88 | 11.76 | 14.93 |
| PctSpOrtho | 12.39 | 5.26 | 6.67 | 8.94 | 15.47 | 20.35 | 12.51 | 5.59 | 5.35 | 9.09 | 16.13 | 19.05 |
| PctSpPred | 28.05 | 8.48 | 16.20 | 23.89 | 32.95 | 38.33 | 21.30 | 7.52 | 11.91 | 15.79 | 25.71 | 30.86 |
| PctSpRare | 69.60 | 11.57 | 57.47 | 62.50 | 76.50 | 85.59 | 67.75 | 9.22 | 55.84 | 62.50 | 72.20 | 78.76 |
| PctSpSens | 2.18 | 3.39 | 0.00 | 0.00 | 3.19 | 6.36 | 6.54 | 7.00 | 0.00 | 0.00 | 9.50 | 18.32 |
| PctSpTany | 14.96 | 11.46 | 0.00 | 2.69 | 21.67 | 29.58 | 16.85 | 8.31 | 2.45 | 13.13 | 22.20 | 26.59 |
| PctSpTol | 57.13 | 9.78 | 46.24 | 50.66 | 61.71 | 67.42 | 57.58 | 13.97 | 39.68 | 48.21 | 66.67 | 77.25 |
| PredSp | 7.49 | 2.97 | 2.60 | 6.25 | 9.38 | 11.00 | 6.35 | 2.66 | 3.00 | 4.00 | 9.00 | 9.60 |
| RareSpp | 18.78 | 6.61 | 11.00 | 14.00 | 23.00 | 26.70 | 20.13 | 5.76 | 12.00 | 16.00 | 24.00 | 26.00 |
| SensSp | 0.60 | 0.92 | 0.00 | 0.00 | 1.00 | 1.00 | 2.21 | 2.78 | 0.00 | 0.00 | 3.00 | 6.60 |
| Shannon | 1.72 | 0.60 | 0.88 | 1.22 | 2.09 | 2.29 | 1.78 | 0.57 | 0.91 | 1.43 | 2.09 | 2.53 |
| TanySpp | 1.51 | 0.93 | 0.00 | 1.00 | 2.00 | 3.00 | 1.92 | 1.09 | 1.00 | 1.00 | 2.50 | 3.00 |
| TolSpp1 | 15.38 | 4.70 | 10.00 | 12.25 | 18.00 | 21.70 | 16.43 | 4.03 | 11.40 | 13.00 | 19.00 | 22.00 |
| TolSpp2 | 2.88 | 2.03 | 1.00 | 1.75 | 3.25 | 6.00 | 2.42 | 1.27 | 1.00 | 2.00 | 3.00 | 4.00 |
| pH | 7.06 | 0.71 | 6.23 | 6.43 | 7.68 | 8.04 | 6.99 | 0.89 | 5.97 | 6.50 | 7.50 | 8.16 |
| Cl | 5.50 | 6.27 | 2.00 | 2.25 | 5.00 | 9.70 | 4.46 | 2.45 | 2.00 | 3.00 | 6.00 | 7.00 |
| NO3_w | 3.06 | 4.75 | 0.93 | 1.20 | 2.08 | 3.44 | 1.14 | 0.93 | 0.50 | 0.70 | 1.35 | 2.04 |
| TP_w | 0.38 | 0.37 | 0.11 | 0.17 | 0.41 | 0.79 | 4.72 | 34.15 | 0.07 | 0.10 | 0.27 | 0.67 |
| Conduc | 108.10 | 68.68 | 47.10 | 62.58 | 138.38 | 183.91 | 157.80 | 77.92 | 55.06 | 105.90 | 183.10 | 264.32 |
| pH_s | 5.46 | 0.39 | 5.16 | 5.26 | 5.57 | 6.15 | 5.79 | 0.48 | 5.21 | 5.44 | 6.02 | 6.40 |
| K_s | 158.94 | 53.79 | 90.00 | 115.00 | 200.75 | 228.00 | 181.22 | 169.66 | 80.00 | 96.00 | 203.00 | 301.00 |
| Mg_s | 540 | 258 | 202 | 395 | 723 | 867 | 526 | 318 | 275 | 317 | 583 | 923 |
| Na_s | 51.71 | 12.13 | 39.00 | 42.00 | 64.25 | 69.00 | 58.49 | 27.29 | 37.00 | 41.00 | 66.00 | 90.00 |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| Ca_s | 2171 | 871 | 1220 | 1527 | 2483 | 3356 | 2257 | 1175 | 1032 | 1460 | 2691 | 3820 |
| Cu_s | 4.31 | 2.57 | 1.65 | 2.93 | 5.85 | 8.56 | 4.74 | 2.38 | 2.00 | 3.00 | 6.00 | 8.90 |
| Zn_s | 5.79 | 11.76 | 0.16 | 1.00 | 3.90 | 13.40 | 18.81 | 29.06 | 2.00 | 2.40 | 20.90 | 60.20 |
| Mn_s | 80.09 | 56.45 | 25.00 | 30.70 | 116.40 | 168.80 | 51.24 | 44.80 | 16.60 | 24.00 | 55.00 | 101.00 |
| Fe_s | 264 | 94 | 153 | 185 | 335 | 385 | 281 | 115 | 112 | 196 | 366 | 432 |
| TP_s | 636 | 220 | 335 | 442 | 779 | 960 | 814 | 345 | 497 | 626 | 929 | 1114 |
| NO3_s | 11.55 | 14.13 | 0.53 | 1.70 | 19.35 | 35.30 | 6.89 | 7.94 | 1.00 | 2.10 | 7.60 | 20.93 |
| OM_s | 6.85 | 4.85 | 2.02 | 3.22 | 9.23 | 14.47 | 7.05 | 3.91 | 3.36 | 4.52 | 8.91 | 11.63 |
| WSf | 1.36 | 0.17 | 1.21 | 1.25 | 1.36 | 1.71 | 1.51 | 0.31 | 1.25 | 1.29 | 1.67 | 2.08 |
| SRf | 5.36 | 0.26 | 5.13 | 5.13 | 5.46 | 5.79 | 5.30 | 0.25 | 5.13 | 5.13 | 5.46 | 5.79 |
| PRf | 3.12 | 0.10 | 2.99 | 3.09 | 3.21 | 3.21 | 3.13 | 0.08 | 2.99 | 3.10 | 3.19 | 3.21 |
| NRf | 3.90 | 0.13 | 3.68 | 3.85 | 3.97 | 4.02 | 3.92 | 0.13 | 3.68 | 3.85 | 4.02 | 4.02 |
| TRf | 1.11 | 0.00 | 1.11 | 1.11 | 1.11 | 1.11 | 1.11 | 0.00 | 1.11 | 1.11 | 1.11 | 1.11 |
| CSf | 2.43 | 0.04 | 2.40 | 2.40 | 2.47 | 2.47 | 2.45 | 0.04 | 2.40 | 2.41 | 2.47 | 2.52 |
| OEf | 4.86 | 0.04 | 4.83 | 4.83 | 4.88 | 4.92 | 4.86 | 0.06 | 4.83 | 4.83 | 4.88 | 4.92 |
| INVf | 3.86 | 0.35 | 3.42 | 3.64 | 4.06 | 4.39 | 3.71 | 0.35 | 3.26 | 3.48 | 3.95 | 4.23 |
| FAf | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| FRf | 4.99 | 0.10 | 4.86 | 4.92 | 5.03 | 5.15 | 4.99 | 0.10 | 4.92 | 4.92 | 5.03 | 5.16 |
| AMf | 2.69 | 0.72 | 1.74 | 2.08 | 3.33 | 3.47 | 2.58 | 0.57 | 1.80 | 2.19 | 2.93 | 3.39 |
| WBFf | 4.76 | 0.76 | 3.97 | 4.33 | 5.31 | 5.91 | 4.72 | 0.48 | 4.07 | 4.41 | 5.02 | 5.36 |
| WBNf | 1.30 | 2.70 | 0.00 | 0.00 | 0.00 | 6.64 | 0.94 | 2.29 | 0.00 | 0.00 | 0.00 | 6.19 |
| SBMf | 4.58 | 0.91 | 3.41 | 3.79 | 5.38 | 5.60 | 4.43 | 0.68 | 3.58 | 3.93 | 4.83 | 5.19 |
| POLf | 3.05 | 0.86 | 1.84 | 2.23 | 3.73 | 4.01 | 2.93 | 0.69 | 1.95 | 2.23 | 3.51 | 3.73 |
| PDf | 2.97 | 0.37 | 2.50 | 2.70 | 3.21 | 3.42 | 2.78 | 0.36 | 2.32 | 2.61 | 3.06 | 3.11 |
| WSv | 6.00 | 1.68 | 3.73 | 4.83 | 7.08 | 7.49 | 5.48 | 1.37 | 3.54 | 4.44 | 6.60 | 6.94 |
| SRv | 5.01 | 0.87 | 3.92 | 4.23 | 5.79 | 6.02 | 5.43 | 0.65 | 4.43 | 5.13 | 6.05 | 6.08 |
| PRv | 5.76 | 0.92 | 4.84 | 5.14 | 6.28 | 6.68 | 5.97 | 0.91 | 5.00 | 5.22 | 6.42 | 7.31 |
| NRv | 5.50 | 0.79 | 4.84 | 5.19 | 6.04 | 6.21 | 5.57 | 0.55 | 4.80 | 5.12 | 6.07 | 6.34 |
| TRv | 3.62 | 0.81 | 2.58 | 3.33 | 3.33 | 5.00 | 3.77 | 0.96 | 2.50 | 3.33 | 5.00 | 5.00 |
| INVv | 6.82 | 0.49 | 6.00 | 7.00 | 7.00 | 7.00 | 6.82 | 0.38 | 6.00 | 7.00 | 7.00 | 7.00 |

| | FLATS WETLANDS | | | | | | RIVERINE WETLANDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A-3. Metric** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** | **Mean** | **Std Dev** | **10th %ile** | **25th %ile** | **75th %ile** | **90th %ile** |
| FAv | 4.76 | 0.76 | 3.97 | 4.33 | 5.31 | 5.91 | 4.72 | 0.48 | 4.07 | 4.41 | 5.02 | 5.36 |
| FRv | 2.84 | 0.97 | 1.99 | 2.19 | 3.33 | 3.33 | 3.10 | 1.03 | 2.23 | 2.35 | 3.33 | 3.33 |
| AMv | 5.38 | 1.69 | 3.40 | 4.00 | 7.33 | 7.33 | 5.55 | 1.66 | 4.00 | 4.00 | 7.33 | 7.33 |
| WBFv | 6.07 | 2.39 | 4.00 | 4.00 | 7.33 | 10.00 | 5.69 | 2.29 | 4.00 | 4.00 | 7.33 | 10.00 |
| WBNv | 4.14 | 1.36 | 3.00 | 3.00 | 5.50 | 5.50 | 4.01 | 1.35 | 3.00 | 3.00 | 5.50 | 5.50 |
| SBMv | 5.85 | 0.36 | 5.00 | 6.00 | 6.00 | 6.00 | 5.87 | 0.38 | 5.00 | 6.00 | 6.00 | 6.00 |
| POLv | 5.59 | 3.25 | 0.00 | 5.00 | 6.67 | 10.00 | 7.01 | 2.42 | 5.00 | 5.00 | 10.00 | 10.00 |
| PDv | 5.96 | 0.41 | 5.08 | 6.00 | 6.00 | 6.61 | 5.98 | 0.37 | 5.63 | 6.00 | 6.00 | 6.67 |
| PUv | 5.35 | 2.62 | 2.86 | 4.29 | 4.29 | 10.00 | 7.02 | 3.03 | 4.29 | 4.29 | 10.00 | 10.00 |
| PSv | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Cond | 4.13 | 1.07 | 2.82 | 3.37 | 4.68 | 6.01 | 4.31 | 1.00 | 3.31 | 3.54 | 4.74 | 5.77 |
| Stress | 4.79 | 1.43 | 2.44 | 4.28 | 5.84 | 6.38 | 5.20 | 1.28 | 3.53 | 4.34 | 5.97 | 6.72 |
| Sens | 6.78 | 2.82 | 3.93 | 4.18 | 10.00 | 10.00 | 4.17 | 1.17 | 3.17 | 3.59 | 4.44 | 4.83 |

A-4. Frequencies of vascular plants identified from the Willamette Valley study wetlands, 2009 and 2010

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Acer circinatum | 6 | 11% | 11 | 1% | 0 | 0.00% | 5 | 0.32% | 25 |
| Achillea millefolium | 8 | 15% | 25 | 2% | 2 | 0.13% | 9 | 0.58% | 70 |
| Agrostis spp. | 55 | 100% | 221 | 14% | 17 | 1.10% | 95 | 6.14% | 90 |
| Aira caryophyllea | 9 | 16% | 26 | 2% | 0 | 0.00% | 1 | 0.06% | 50 |
| Alisma gramineum | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Alisma lanceolatum | 1 | 2% | 8 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Alisma triviale | 20 | 36% | 135 | 9% | 8 | 0.52% | 54 | 3.49% | 90 |
| Allium vineale | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Alnus rubra | 4 | 7% | 8 | 1% | 0 | 0.00% | 4 | 0.26% | 20 |
| Alopecurus aequalis | 4 | 7% | 8 | 1% | 1 | 0.06% | 1 | 0.06% | 55 |
| Alopecurus geniculatus | 17 | 31% | 107 | 7% | 8 | 0.52% | 46 | 2.98% | 90 |
| Alopecurus pratensis | 27 | 49% | 164 | 11% | 65 | 4.20% | 109 | 7.05% | 100 |
| Anagallis arvensis | 4 | 7% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Anaphalis margaritacea | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Anthemis cotula | 9 | 16% | 35 | 2% | 1 | 0.06% | 8 | 0.52% | 65 |
| Anthoxanthum aristatum | 2 | 4% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Anthoxanthum odoratum | 5 | 9% | 12 | 1% | 1 | 0.06% | 5 | 0.32% | 70 |
| Apocynum androsaemifolium | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Arrhenatherum elatius | 3 | 5% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Asteraceae | 3 | 5% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 25 |
| Athyrium filix-femina | 6 | 11% | 9 | 1% | 0 | 0.00% | 2 | 0.13% | 30 |
| Azolla mexicana | 2 | 4% | 16 | 1% | 2 | 0.13% | 6 | 0.39% | 65 |
| BARE | 55 | 100% | 867 | 56% | 227 | 14.68% | 742 | 47.99% | 100 |
| Beckmannia syzigachne | 18 | 33% | 71 | 5% | 3 | 0.19% | 22 | 1.42% | 65 |
| Bidens cernua | 19 | 35% | 68 | 4% | 1 | 0.06% | 29 | 1.88% | 60 |
| Bidens frondosa | 33 | 60% | 123 | 8% | 10 | 0.65% | 36 | 2.33% | 100 |
| Brachypodium sylvaticum | 1 | 2% | 4 | 0% | 0 | 0.00% | 3 | 0.19% | 10 |
| Brassica rapa | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Briza minor | 3 | 5% | 6 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Bromus | 3 | 5% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Bromus arenarius | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Bromus carinatus | 2 | 4% | 3 | 0% | 1 | 0.06% | 1 | 0.06% | 55 |
| Bromus cf.diandrus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Bromus commutatus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Bromus hordeaceus | 4 | 7% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Bromus inermis | 5 | 9% | 7 | 0% | 0 | 0.00% | 1 | 0.06% | 45 |
| Bromus racemosus | 4 | 7% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Bromus secalinus | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Bromus sitchensis | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Bromus sterilis | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Callitriche | 28 | 51% | 76 | 5% | 3 | 0.19% | 29 | 1.88% | 90 |
| Camassia leichtlinii | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Camassia quamash | 4 | 7% | 18 | 1% | 0 | 0.00% | 1 | 0.06% | 10 |
| Capsella bursa-pastoris | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Cardamine hirsuta | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Cardamine nuttallii | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Carex | 17 | 31% | 25 | 2% | 2 | 0.13% | 11 | 0.71% | 60 |
| Carex amplifolia | 1 | 2% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 20 |
| Carex aperta | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Carex cf.comosa | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Carex densa | 19 | 35% | 93 | 6% | 2 | 0.13% | 33 | 2.13% | 85 |
| Carex echinata | 3 | 5% | 3 | 0% | 1 | 0.06% | 1 | 0.06% | 55 |
| Carex exsiccata | 1 | 2% | 2 | 0% | 1 | 0.06% | 1 | 0.06% | 80 |
| Carex feta | 5 | 9% | 6 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Carex interrupta | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Carex laeviculmis | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Carex leporina | 6 | 11% | 16 | 1% | 0 | 0.00% | 4 | 0.26% | 35 |
| Carex leptopoda | 15 | 27% | 45 | 3% | 0 | 0.00% | 17 | 1.10% | 50 |
| Carex obnupta | 28 | 51% | 110 | 7% | 30 | 1.94% | 89 | 5.76% | 100 |
| Carex pachystachya | 5 | 9% | 5 | 0% | 0 | 0.00% | 2 | 0.13% | 20 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Carex pellita | 3 | 5% | 13 | 1% | 0 | 0.00% | 4 | 0.26% | 35 |
| Carex scoparia | 5 | 9% | 7 | 0% | 0 | 0.00% | 2 | 0.13% | 25 |
| Carex stipata | 11 | 20% | 19 | 1% | 0 | 0.00% | 4 | 0.26% | 30 |
| Carex subfusca | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Carex unilateralis | 17 | 31% | 58 | 4% | 0 | 0.00% | 16 | 1.03% | 40 |
| Centaurium erythraea | 13 | 24% | 25 | 2% | 0 | 0.00% | 1 | 0.06% | 10 |
| Cerastium arvense | 4 | 7% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Cerastium glomeratum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Ceratophyllum demersum | 6 | 11% | 9 | 1% | 0 | 0.00% | 3 | 0.19% | 10 |
| Chenopodium album | 1 | 2% | 3 | 0% | 0 | 0.00% | 2 | 0.13% | 15 |
| Cichorium intybus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Cicuta douglasii | 1 | 2% | 2 | 0% | 0 | 0.00% | 2 | 0.13% | 25 |
| Cirsium arvense | 18 | 33% | 46 | 3% | 0 | 0.00% | 4 | 0.26% | 25 |
| Cirsium vulgare | 15 | 27% | 29 | 2% | 0 | 0.00% | 5 | 0.32% | 10 |
| Claytonia lanceolata | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Claytonia sibirica | 3 | 5% | 12 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Conium maculatum | 1 | 2% | 1 | 0% | 1 | 0.06% | 1 | 0.06% | 100 |
| Convolvulus arvensis | 11 | 20% | 40 | 3% | 0 | 0.00% | 10 | 0.65% | 45 |
| Conyza canadensis | 7 | 13% | 8 | 1% | 0 | 0.00% | 0 | 0.00% | 1 |
| Cornus sericea | 17 | 31% | 60 | 4% | 3 | 0.19% | 28 | 1.81% | 90 |
| Coronopus squamatus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Crataegus monogyna | 4 | 7% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Crataegus suksdorfii | 8 | 15% | 23 | 1% | 0 | 0.00% | 1 | 0.06% | 15 |
| Crepis capillaris | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Crepis occidentalis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Crypsis alopecuroides | 1 | 2% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 50 |
| Cuscuta californica | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Cynosurus cristatus | 1 | 2% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Cynosurus echinatus | 3 | 5% | 9 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Cyperus erythrorhizos | 6 | 11% | 27 | 2% | 0 | 0.00% | 9 | 0.58% | 40 |
| Cyperus esculentus | 1 | 2% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 40 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Cyperus squarrosus | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Dactylis glomerata | 4 | 7% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Danthonia californica | 3 | 5% | 5 | 0% | 0 | 0.00% | 2 | 0.13% | 30 |
| Danthonia intermedia | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Daucus carota | 9 | 16% | 29 | 2% | 2 | 0.13% | 9 | 0.58% | 70 |
| Deschampsia cespitosa | 25 | 45% | 127 | 8% | 20 | 1.29% | 82 | 5.30% | 100 |
| Deschampsia elongata | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Digitaria ischaemum | 3 | 5% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Dipsacus fullonum | 9 | 16% | 18 | 1% | 1 | 0.06% | 8 | 0.52% | 75 |
| Downingia elegans | 10 | 18% | 35 | 2% | 0 | 0.00% | 14 | 0.91% | 40 |
| Echinochloa crus-galli | 16 | 29% | 36 | 2% | 3 | 0.19% | 10 | 0.65% | 90 |
| Eleocharis acicularis | 16 | 29% | 95 | 6% | 18 | 1.16% | 60 | 3.88% | 100 |
| Eleocharis obtusa | 30 | 55% | 116 | 8% | 8 | 0.52% | 40 | 2.59% | 85 |
| Eleocharis palustris | 34 | 62% | 289 | 19% | 64 | 4.14% | 170 | 11.00% | 100 |
| Elodea canadensis | 12 | 22% | 25 | 2% | 1 | 0.06% | 13 | 0.84% | 100 |
| Elymus caninus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Elymus elymoides | 1 | 2% | 1 | 0% | 0 | 0.00% | 1 | 0.06% | 30 |
| Elymus glaucus | 6 | 11% | 12 | 1% | 1 | 0.06% | 2 | 0.13% | 90 |
| Elymus repens | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Elymus trachycaulus | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Epilobium / Stellaria | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Epilobium / Veronica | 6 | 11% | 29 | 2% | 0 | 0.00% | 11 | 0.71% | 35 |
| Epilobium ciliatum | 33 | 60% | 128 | 8% | 2 | 0.13% | 25 | 1.62% | 95 |
| Epilobium densiflorum | 3 | 5% | 7 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Epilobium minutum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Equisetum arvense | 17 | 31% | 50 | 3% | 3 | 0.19% | 17 | 1.10% | 85 |
| Equisetum fluviatile | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Equisetum telmateia | 8 | 15% | 21 | 1% | 1 | 0.06% | 10 | 0.65% | 65 |
| Eragrostis pilosa | 3 | 5% | 9 | 1% | 0 | 0.00% | 3 | 0.19% | 20 |
| Eriophyllum lanatum | 1 | 2% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Eryngium petiolatum | 9 | 16% | 14 | 1% | 0 | 0.00% | 2 | 0.13% | 15 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Festuca arundinacea | 8 | 15% | 26 | 2% | 2 | 0.13% | 4 | 0.26% | 90 |
| Festuca rubra | 11 | 20% | 61 | 4% | 6 | 0.39% | 21 | 1.36% | 90 |
| Fontinalis antipyretica | 3 | 5% | 4 | 0% | 0 | 0.00% | 2 | 0.13% | 25 |
| Fragaria virginiana | 4 | 7% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Fraxinus latifolia | 34 | 62% | 101 | 7% | 0 | 0.00% | 39 | 2.52% | 40 |
| Galium | 10 | 18% | 18 | 1% | 0 | 0.00% | 2 | 0.13% | 45 |
| Galium aparine | 21 | 38% | 58 | 4% | 1 | 0.06% | 8 | 0.52% | 80 |
| Galium divaricatum | 7 | 13% | 11 | 1% | 0 | 0.00% | 2 | 0.13% | 25 |
| Galium saxatile | 1 | 2% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Galium trifidum | 16 | 29% | 33 | 2% | 0 | 0.00% | 2 | 0.13% | 25 |
| Galium triflorum | 7 | 13% | 8 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Gaultheria shallon | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Geranium | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Geranium carolinianum | 3 | 5% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Geranium dissectum | 10 | 18% | 29 | 2% | 0 | 0.00% | 7 | 0.45% | 30 |
| Geranium lucidum | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Geranium molle | 3 | 5% | 5 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Geranium pusillum | 3 | 5% | 4 | 0% | 2 | 0.13% | 3 | 0.19% | 80 |
| Geranium robertianum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Geum macrophyllum | 6 | 11% | 10 | 1% | 0 | 0.00% | 2 | 0.13% | 20 |
| Geum urbanum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Glyceria | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Glyceria borealis | 1 | 2% | 4 | 0% | 0 | 0.00% | 2 | 0.13% | 45 |
| Glyceria elata | 3 | 5% | 4 | 0% | 0 | 0.00% | 3 | 0.19% | 50 |
| Glyceria grandis | 3 | 5% | 5 | 0% | 1 | 0.06% | 3 | 0.19% | 100 |
| Glyceria striata | 5 | 9% | 13 | 1% | 2 | 0.13% | 4 | 0.26% | 95 |
| Gnaphalium | 19 | 35% | 83 | 5% | 2 | 0.13% | 16 | 1.03% | 70 |
| Grindelia integrifolia | 2 | 4% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 25 |
| Grindelia squarrosa | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Hedera helix | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Heracleum lanatum | 4 | 7% | 10 | 1% | 1 | 0.06% | 9 | 0.58% | 55 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Heuchera micrantha | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Holcus lanatus | 33 | 60% | 175 | 11% | 9 | 0.58% | 71 | 4.59% | 90 |
| Hordeum brachyantherum | 15 | 27% | 67 | 4% | 15 | 0.97% | 37 | 2.39% | 95 |
| Hydrocotyle ranunculoides | 5 | 9% | 14 | 1% | 0 | 0.00% | 5 | 0.32% | 25 |
| Hypericum perforatum | 9 | 16% | 15 | 1% | 0 | 0.00% | 1 | 0.06% | 10 |
| Hypericum scouleri | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Hypochaeris radicata | 22 | 40% | 78 | 5% | 0 | 0.00% | 15 | 0.97% | 50 |
| Ilex aquifolium | 3 | 5% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Impatiens capensis | 14 | 25% | 42 | 3% | 1 | 0.06% | 19 | 1.23% | 70 |
| Iris pseudacorus | 2 | 4% | 10 | 1% | 2 | 0.13% | 8 | 0.52% | 75 |
| Juncus | 2 | 4% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 50 |
| Juncus acuminatus | 5 | 9% | 8 | 1% | 1 | 0.06% | 4 | 0.26% | 55 |
| Juncus arcticus | 5 | 9% | 6 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Juncus articulatus | 11 | 20% | 33 | 2% | 0 | 0.00% | 10 | 0.65% | 50 |
| Juncus bufonius | 19 | 35% | 57 | 4% | 3 | 0.19% | 23 | 1.49% | 70 |
| Juncus effusus | 28 | 51% | 136 | 9% | 19 | 1.23% | 99 | 6.40% | 95 |
| Juncus ensifolius | 5 | 9% | 16 | 1% | 0 | 0.00% | 5 | 0.32% | 45 |
| Juncus marginatus | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 20 |
| Juncus nevadensis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Juncus occidentalis | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 20 |
| Juncus orthophyllus | 1 | 2% | 1 | 0% | 1 | 0.06% | 1 | 0.06% | 65 |
| Juncus oxymeris | 4 | 7% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Juncus patens | 18 | 33% | 51 | 3% | 4 | 0.26% | 36 | 2.33% | 95 |
| Juncus tenuis | 21 | 38% | 48 | 3% | 1 | 0.06% | 13 | 0.84% | 60 |
| Kickxia elatine | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lactuca serriola | 10 | 18% | 18 | 1% | 0 | 0.00% | 2 | 0.13% | 15 |
| Lamium purpureum | 2 | 4% | 6 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Lapsana communis | 8 | 15% | 18 | 1% | 1 | 0.06% | 3 | 0.19% | 70 |
| Lathyrus | 3 | 5% | 8 | 1% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lathyrus angulatus | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Leersia oryzoides | 14 | 25% | 68 | 4% | 2 | 0.13% | 24 | 1.55% | 95 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Lemna minor | 20 | 36% | 85 | 5% | 6 | 0.39% | 41 | 2.65% | 100 |
| Leucanthemum vulgare | 11 | 20% | 22 | 1% | 0 | 0.00% | 5 | 0.32% | 20 |
| Linum bienne | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lolium perenne | 12 | 22% | 43 | 3% | 22 | 1.42% | 25 | 1.62% | 100 |
| Lomatium dissectum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lonicera involucrata | 5 | 9% | 6 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Lotus corniculatus | 23 | 42% | 119 | 8% | 8 | 0.52% | 76 | 4.92% | 90 |
| Lotus unifoliolatus | 4 | 7% | 7 | 0% | 0 | 0.00% | 2 | 0.13% | 35 |
| Ludwigia palustris | 33 | 60% | 195 | 13% | 36 | 2.33% | 96 | 6.21% | 100 |
| Ludwigia peploides | 3 | 5% | 35 | 2% | 4 | 0.26% | 17 | 1.10% | 95 |
| Lupinus bicolor | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lupinus polycarpus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lupinus polyphyllus | 4 | 7% | 12 | 1% | 0 | 0.00% | 6 | 0.39% | 35 |
| Lupinus rivularis | 1 | 2% | 3 | 0% | 2 | 0.13% | 2 | 0.13% | 90 |
| Luzula | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lycopus americanus | 6 | 11% | 22 | 1% | 0 | 0.00% | 7 | 0.45% | 50 |
| Lycopus uniflorus | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Lysichiton americanum | 1 | 2% | 6 | 0% | 1 | 0.06% | 4 | 0.26% | 70 |
| Lysimachia nummularia | 9 | 16% | 31 | 2% | 4 | 0.26% | 22 | 1.42% | 100 |
| Lythrum hyssopifolium | 7 | 13% | 9 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Lythrum portula | 25 | 45% | 123 | 8% | 18 | 1.16% | 72 | 4.66% | 100 |
| Lythrum salicaria | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Madia glomerata | 17 | 31% | 50 | 3% | 2 | 0.13% | 12 | 0.78% | 90 |
| Madia sativa | 4 | 7% | 7 | 0% | 1 | 0.06% | 4 | 0.26% | 95 |
| Malus fusca | 2 | 4% | 5 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Marah oreganus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Medicago lupulina | 1 | 2% | 8 | 1% | 2 | 0.13% | 7 | 0.45% | 70 |
| Melilotus officinalis | 5 | 9% | 8 | 1% | 0 | 0.00% | 3 | 0.19% | 20 |
| Mentha canadensis | 2 | 4% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Mentha piperita | 5 | 9% | 30 | 2% | 0 | 0.00% | 20 | 1.29% | 50 |
| Mentha pulegium | 23 | 42% | 225 | 15% | 24 | 1.55% | 128 | 8.28% | 100 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Mimulus guttatus | 3 | 5% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 40 |
| Mimulus moschatus | 2 | 4% | 19 | 1% | 1 | 0.06% | 4 | 0.26% | 80 |
| Mollugo verticillata | 2 | 4% | 7 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Montia linearis | 1 | 2% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Myosotis arvensis | 2 | 4% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Myosotis discolor | 4 | 7% | 6 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Myosotis laxa | 25 | 45% | 100 | 6% | 1 | 0.06% | 15 | 0.97% | 55 |
| Myosotis scorpioides | 5 | 9% | 6 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Myriophyllum hippuroides | 2 | 4% | 7 | 0% | 1 | 0.06% | 1 | 0.06% | 90 |
| Myriophyllum sibiricum | 2 | 4% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 30 |
| Myriophyllum spicatum | 5 | 9% | 6 | 0% | 2 | 0.13% | 4 | 0.26% | 90 |
| Nasturtium officinale | 1 | 2% | 2 | 0% | 1 | 0.06% | 1 | 0.06% | 60 |
| Navarretia intertexta | 4 | 7% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Nuphar lutea | 2 | 4% | 12 | 1% | 6 | 0.39% | 11 | 0.71% | 90 |
| Oemleria cerasiformis | 3 | 5% | 5 | 0% | 0 | 0.00% | 2 | 0.13% | 20 |
| Oenanthe sarmentosa | 10 | 18% | 56 | 4% | 6 | 0.39% | 30 | 1.94% | 95 |
| Panicum capillare | 8 | 15% | 12 | 1% | 0 | 0.00% | 1 | 0.06% | 30 |
| Parentucellia viscosa | 14 | 25% | 46 | 3% | 0 | 0.00% | 7 | 0.45% | 50 |
| Paspalum distichum | 4 | 7% | 10 | 1% | 1 | 0.06% | 4 | 0.26% | 85 |
| Persicaria spp. | 15 | 27% | 20 | 1% | 0 | 0.00% | 5 | 0.32% | 100 |
| Petasites frigidus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Phalaris aquatica | 10 | 18% | 13 | 1% | 4 | 0.26% | 5 | 0.32% | 95 |
| Phalaris arundinacea | 46 | 84% | 598 | 39% | 214 | 13.84% | 438 | 28.33% | 100 |
| Phleum pratense | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Physocarpus capitatus | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Plagiobothrys | 17 | 31% | 69 | 4% | 3 | 0.19% | 31 | 2.01% | 90 |
| Plantago lanceolata | 10 | 18% | 16 | 1% | 0 | 0.00% | 3 | 0.19% | 20 |
| Plantago major | 5 | 9% | 11 | 1% | 0 | 0.00% | 3 | 0.19% | 15 |
| Poa spp. | 55 | 100% | 137 | 9% | 7 | 0.45% | 40 | 2.59% | 95 |
| Polygonum aviculare | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Polygonum cuspidatum | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Polygonum persicaria | 37 | 67% | 299 | 19% | 44 | 2.85% | 151 | 9.77% | 100 |
| Polypogon monspeliensis | 1 | 2% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Polypogon viridis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Polystichum munitum | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Populus balsamifera | 5 | 9% | 10 | 1% | 0 | 0.00% | 4 | 0.26% | 20 |
| Potamogeton / Stuckenia | 3 | 5% | 13 | 1% | 2 | 0.13% | 10 | 0.65% | 90 |
| Potamogeton foliosus | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 50 |
| Potamogeton gramineus | 3 | 5% | 7 | 0% | 0 | 0.00% | 2 | 0.13% | 25 |
| Potamogeton natans | 8 | 15% | 12 | 1% | 1 | 0.06% | 3 | 0.19% | 80 |
| Potamogeton richarsonii | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Potentilla glaucophylla | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Potentilla norvegica | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Prunella vulgaris | 10 | 18% | 23 | 1% | 0 | 0.00% | 3 | 0.19% | 10 |
| Quercus garryana | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Ranunculus | 4 | 7% | 5 | 0% | 0 | 0.00% | 3 | 0.19% | 20 |
| Ranunculus alismaefolius | 1 | 2% | 1 | 0% | 0 | 0.00% | 1 | 0.06% | 25 |
| Ranunculus aquatilis | 3 | 5% | 4 | 0% | 1 | 0.06% | 1 | 0.06% | 70 |
| Ranunculus flammula | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Ranunculus occidentalis | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Ranunculus orthorhynchus | 9 | 16% | 12 | 1% | 0 | 0.00% | 1 | 0.06% | 15 |
| Ranunculus repens | 10 | 18% | 25 | 2% | 0 | 0.00% | 10 | 0.65% | 45 |
| Ranunculus scleratus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Ranunculus uncinatus | 8 | 15% | 16 | 1% | 0 | 0.00% | 3 | 0.19% | 50 |
| Raphanus sativus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Rhus diversiloba | 3 | 5% | 3 | 0% | 0 | 0.00% | 2 | 0.13% | 15 |
| Ribes | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Ribes bracteosum | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Rorippa curvisiliqua | 25 | 45% | 93 | 6% | 3 | 0.19% | 19 | 1.23% | 90 |
| Rosa eglanteria | 1 | 2% | 1 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Rosa nutkana | 21 | 38% | 67 | 4% | 2 | 0.13% | 25 | 1.62% | 90 |
| Rosa pisocarpa | 8 | 15% | 10 | 1% | 0 | 0.00% | 4 | 0.26% | 40 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Rubus armeniacus | 27 | 49% | 87 | 6% | 1 | 0.06% | 35 | 2.26% | 60 |
| Rubus laciniatus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Rubus spectabilis | 6 | 11% | 14 | 1% | 0 | 0.00% | 3 | 0.19% | 50 |
| Rubus ursinus | 18 | 33% | 91 | 6% | 7 | 0.45% | 49 | 3.17% | 100 |
| Rumex | 8 | 15% | 12 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Rumex acetosella | 3 | 5% | 10 | 1% | 0 | 0.00% | 2 | 0.13% | 15 |
| Rumex conglomeratus | 4 | 7% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Rumex crispus | 21 | 38% | 51 | 3% | 0 | 0.00% | 3 | 0.19% | 20 |
| Rumex obtusifolius | 6 | 11% | 8 | 1% | 0 | 0.00% | 1 | 0.06% | 20 |
| Rumex occidentalis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Rumex salicifolius | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 35 |
| Sagittaria latifolia | 6 | 11% | 35 | 2% | 6 | 0.39% | 21 | 1.36% | 100 |
| Salix | 16 | 29% | 30 | 2% | 1 | 0.06% | 17 | 1.10% | 90 |
| Salix geyeriana | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Salix hookeriana | 4 | 7% | 5 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Salix lucida | 23 | 42% | 83 | 5% | 2 | 0.13% | 32 | 2.07% | 80 |
| Salix scouleriana | 3 | 5% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Salix sitchensis | 15 | 27% | 30 | 2% | 2 | 0.13% | 15 | 0.97% | 80 |
| Sambucus racemosa | 1 | 2% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Schedonorus pratensis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Schoenoplectus acutus | 7 | 13% | 16 | 1% | 1 | 0.06% | 6 | 0.39% | 70 |
| Scirpus microcarpus | 12 | 22% | 40 | 3% | 3 | 0.19% | 27 | 1.75% | 90 |
| Scutellaria lateriflora | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Senecio jacobaea | 3 | 5% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Silene douglasii | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Sisyrinchium angustifolium | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Sisyrinchium bellum | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Solanum americanum | 7 | 13% | 8 | 1% | 0 | 0.00% | 1 | 0.06% | 30 |
| Solanum dulcamara | 26 | 47% | 108 | 7% | 1 | 0.06% | 36 | 2.33% | 70 |
| Solanum nigrum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Sonchus arvensis | 7 | 13% | 12 | 1% | 0 | 0.00% | 1 | 0.06% | 40 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Sonchus asper | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Sonchus oleraceus | 2 | 4% | 3 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Sparganium emersum | 16 | 29% | 77 | 5% | 9 | 0.58% | 41 | 2.65% | 90 |
| Spergularia rubra | 3 | 5% | 10 | 1% | 0 | 0.00% | 3 | 0.19% | 25 |
| Spiraea betulifolia | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Spiraea douglasii | 23 | 42% | 66 | 4% | 1 | 0.06% | 33 | 2.13% | 60 |
| Stachys cooleyae | 9 | 16% | 32 | 2% | 1 | 0.06% | 12 | 0.78% | 70 |
| Stellaria | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Stellaria borealis | 3 | 5% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Stellaria calycantha | 3 | 5% | 5 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Stellaria crispa | 9 | 16% | 19 | 1% | 0 | 0.00% | 3 | 0.19% | 10 |
| Stellaria longifolia | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Stellaria nitens | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Stuckenia pectinata | 5 | 9% | 8 | 1% | 2 | 0.13% | 4 | 0.26% | 90 |
| Symphoricarpos albus | 12 | 22% | 23 | 1% | 2 | 0.13% | 11 | 0.71% | 90 |
| Syringa vulgaris | 1 | 2% | 1 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Taeniatherum caput-medusae | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Tanacetum vulgare | 4 | 7% | 26 | 2% | 1 | 0.06% | 7 | 0.45% | 60 |
| Taraxacum officinale | 6 | 11% | 9 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Tellima grandiflora | 11 | 20% | 23 | 1% | 0 | 0.00% | 8 | 0.52% | 40 |
| Thalictrum occidentale | 2 | 4% | 3 | 0% | 0 | 0.00% | 3 | 0.19% | 25 |
| Tiarella trifoliata | 2 | 4% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Tolmiea menziesii | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Tonella tenella | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Torilis japonica | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Trientalis latifolia | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Trifolium | 7 | 13% | 20 | 1% | 3 | 0.19% | 8 | 0.52% | 100 |
| Trifolium ciliolatum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Trifolium dubium | 10 | 18% | 21 | 1% | 1 | 0.06% | 6 | 0.39% | 80 |
| Trifolium hybridum | 1 | 2% | 9 | 1% | 2 | 0.13% | 8 | 0.52% | 70 |
| Trifolium longipes | 1 | 2% | 6 | 0% | 0 | 0.00% | 2 | 0.13% | 20 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Trifolium pratense | 6 | 11% | 10 | 1% | 1 | 0.06% | 3 | 0.19% | 90 |
| Trifolium repens | 1 | 2% | 2 | 0% | 1 | 0.06% | 1 | 0.06% | 90 |
| Trifolium subterraneum | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Trifolium variegatum | 3 | 5% | 4 | 0% | 0 | 0.00% | 2 | 0.13% | 25 |
| Trifolium vesiculosum | 1 | 2% | 2 | 0% | 0 | 0.00% | 2 | 0.13% | 20 |
| Trisetum cernuum | 1 | 2% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Triteleia hyacinthina | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Triticum aestivum | 2 | 4% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 25 |
| Typha latifolia | 22 | 40% | 98 | 6% | 8 | 0.52% | 42 | 2.72% | 100 |
| Typha latifolia/ Iris | 1 | 2% | 2 | 0% | 0 | 0.00% | 1 | 0.06% | 25 |
| Urtica dioica | 13 | 24% | 31 | 2% | 5 | 0.32% | 21 | 1.36% | 65 |
| Utricularia macrorhiza | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Vaccinium parvifolium | 1 | 2% | 1 | 0% | 0 | 0.00% | 1 | 0.06% | 10 |
| Ventenata dubia | 1 | 2% | 3 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Veratrum californicum | 2 | 4% | 5 | 0% | 0 | 0.00% | 3 | 0.19% | 30 |
| Verbascum thapsus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Veronica | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Veronica americana | 30 | 55% | 161 | 10% | 2 | 0.13% | 46 | 2.98% | 65 |
| Veronica cf.longifolia | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |
| Veronica peregrina | 10 | 18% | 20 | 1% | 0 | 0.00% | 0 | 0.00% | 5 |
| Veronica scutellata | 25 | 45% | 91 | 6% | 4 | 0.26% | 25 | 1.62% | 90 |
| Veronica serpyllifolia | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Veronica/ Myosotis | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Vicia | 12 | 22% | 24 | 2% | 1 | 0.06% | 5 | 0.32% | 70 |
| Vicia americana | 2 | 4% | 4 | 0% | 0 | 0.00% | 1 | 0.06% | 15 |
| Vicia cracca | 2 | 4% | 2 | 0% | 1 | 0.06% | 1 | 0.06% | 90 |
| Vicia hirsuta | 11 | 20% | 29 | 2% | 1 | 0.06% | 4 | 0.26% | 60 |
| Vicia laxiflora | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Vicia sativa | 13 | 24% | 35 | 2% | 2 | 0.13% | 10 | 0.65% | 90 |
| Vicia tetrasperma | 22 | 40% | 75 | 5% | 1 | 0.06% | 16 | 1.03% | 70 |
| Vicia villosa | 2 | 4% | 4 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |

| Plant Taxa | # of sites | % of sites | # of plots | % of plots | Dominant: # of plots | Dominant: % of plots | Co-dominant: # of plots | Co-dominant:: % of plots | Max Cover |
|---|---|---|---|---|---|---|---|---|---|
| Viola orbiculata | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Vulpia bromoides | 4 | 7% | 7 | 0% | 2 | 0.13% | 6 | 0.39% | 95 |
| Vulpia microstachys | 5 | 9% | 8 | 1% | 0 | 0.00% | 1 | 0.06% | 40 |
| WATER | 37 | 67% | 273 | 18% | 161 | 10.41% | 254 | 16.43% | 100 |
| Wyethia angustifolia | 3 | 5% | 8 | 1% | 0 | 0.00% | 5 | 0.32% | 30 |
| Xanthium strumarium | 8 | 15% | 42 | 3% | 1 | 0.06% | 20 | 1.29% | 70 |
| Zannichellia palustris | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Zigadenus venenosus | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Zizania aquatica | 1 | 2% | 1 | 0% | 0 | 0.00% | 0 | 0.00% | 1 |
| Zizania palustris | 2 | 4% | 2 | 0% | 0 | 0.00% | 0 | 0.00% | 5 |

A-5. Frequencies of birds and other animals identified incidental to vegetation surveys of the Willamette Valley study wetlands, May-September 2009 and 2010

"Frequency" is the number of sites times the number of years (of 2).

| **Species** | **Frequency** |
|---|---|
| Song Sparrow | 94 |
| American Goldfinch | 89 |
| Cedar Waxwing | 82 |
| Barn Swallow | 77 |
| American Robin | 72 |
| Common Yellowthroat | 71 |
| Western Scrub-Jay | 70 |
| Black-Capped Chickadee | 68 |
| Bewick's Wren | 63 |
| Spotted Towhee | 62 |
| Black-Headed Grosbeak | 52 |
| House Finch | 52 |
| Northern Flicker | 51 |
| Red-Winged Blackbird | 51 |
| European Starling | 50 |
| Violet-Green Swallow | 45 |
| Western Wood-Pewee | 45 |
| Killdeer | 44 |
| American Crow | 42 |
| bullfrog | 37 |
| Downy Woodpecker | 36 |
| Mallard | 36 |
| Swainson's Thrush | 36 |
| Brown-Headed Cowbird | 33 |
| Mourning Dove | 31 |
| Bushtit | 29 |
| Red-Tailed Hawk | 26 |
| Savannah Sparrow | 25 |
| Steller's Jay | 25 |
| Purple Finch | 24 |
| Great Blue Heron | 23 |
| Canada Goose | 19 |
| Tree Swallow | 19 |
| Brown Creeper | 18 |
| Lazuli Bunting | 18 |
| Belted Kingfisher | 17 |
| Pacific Tree Frog | 15 |
| White-Breasted Nuthatch | 15 |
| Osprey | 14 |

| Species | Frequency |
|---|---|
| Vaux's Swift | 14 |
| Yellow Warbler | 14 |
| Common Raven | 13 |
| House Sparrow | 13 |
| Marsh Wren | 13 |
| Orange-Crowned Warbler | 13 |
| Red-Breasted Nuthatch | 13 |
| Green Heron | 12 |
| Western Tanager | 12 |
| Spotted Sandpiper | 11 |
| Warbling Vireo | 11 |
| nutria | 11 |
| Garter Snake | 10 |
| Turkey Vulture | 10 |
| Brewer's Blackbird | 9 |
| Wood Duck | 9 |
| Ring-Necked Pheasant | 8 |
| Bullock's Oriole | 7 |
| Chestnut-Backed Chickadee | 7 |
| Evening Grosbeak | 7 |
| Greater Yellowlegs | 7 |
| Pacific-slope Flycatcher | 7 |
| White-Crowned Sparrow | 6 |
| Willow Flycatcher | 6 |
| Wilson's Warbler | 6 |
| American Kestrel | 5 |
| Dark-Eyed Junco | 5 |
| House Wren | 5 |
| Purple Martin | 5 |
| Red-Breasted Sapsucker | 5 |
| Rufous Hummingbird | 5 |
| Western Pond Turtle | 5 |
| Wrentit | 5 |
| Black-Throated Gray Warbler | 4 |
| California Quail | 4 |
| Cinnamon Teal | 4 |
| Cliff Swallow | 4 |
| Cooper's Hawk | 4 |
| Hairy Woodpecker | 4 |
| Northern Harrier | 4 |
| Pied-Billed Grebe | 4 |
| Pileated Woodpecker | 4 |
| Wilson's Snipe | 4 |
| Anna's Hummingbird | 3 |
| Gadwall | 3 |

| Species | Frequency |
|---|---|
| Hutton's Vireo | 3 |
| Lesser Goldfinch | 3 |
| Virginia Rail | 3 |
| Western Meadowlark | 3 |
| Western Sandpiper | 3 |
| Winter Wren | 3 |
| American Coot | 2 |
| Bald Eagle | 2 |
| Band-Tailed Pigeon | 2 |
| Cassin's Vireo | 2 |
| Chipping Sparrow | 2 |
| Great Egret | 2 |
| Rough-skinned Newt | 2 |
| Yellow-Breasted Chat | 2 |
| beaver | 2 |
| American Bittern | 1 |
| Dunlin | 1 |
| Hermit Warbler | 1 |
| Horned Lark | 1 |
| Lesser Yellowlegs | 1 |
| Long-billed Dowitcher | 1 |
| Macgillivray's Warbler | 1 |
| Northern Pintail | 1 |
| Olive-Sided Flycatcher | 1 |
| Red Crossbill | 1 |
| Red-Shouldered Hawk | 1 |
| Red-legged Frog | 1 |
| Ruddy Duck | 1 |
| Semipalmated Plover | 1 |
| Sora | 1 |
| Striped Skunk | 1 |
| Western Bluebird | 1 |
| Wilson's Phalarope | 1 |
| turtle sp. | 1 |

A-6. Vegetation metrics that correlated significantly with soil and surface water quality parameters in 2009 survey of Willamette wetlands.

See Data Dictionary (Appendix A-1) for definitions of the vegetation metrics.
**surf**= surface water; all others are from soils.

| A-6 Metric | Ca | Cu | Fe | K | Mg | Mn | Na | NO3 | OM | TP | Zn | pH | pH surf | Cl surf | Conduc surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %Fq12nnGT50 | | | | | -0.3 | | | | | | | | | | |
| %Fq1NnGT50 | | | | | -0.3 | | | | | | | | | | |
| %Rich12FAC | | | | | | -0.3 | | | | | | 0.3 | 0.3 | | |
| %Rich12FACW | 0.4 | 0.4 | | | | | | 0.3 | 0.4 | 0.3 | 0.3 | | | 0.3 | 0.3 |
| %Rich12gram | | | | | -0.3 | | | | | | | | | | |
| %Rich12GT19 | | | | | | | | | | | | | | | 0.3 |
| %Rich12GT9 | | | 0.4 | | | | | | | 0.4 | | | | | 0.3 |
| %Rich12invas | | | | | | | | | 0.3 | 0.3 | 0.3 | | | | |
| %Rich12OBL | | -0.3 | | -0.4 | | | | | | -0.4 | | | -0.3 | | |
| %Rich12shrub | | | | | -0.3 | | | | | | | | | | |
| %Rich12tree | | | | | -0.3 | | | | | | | | | | |
| %Rich12Wet | | | | -0.3 | -0.3 | 0.4 | | | | | | | -0.4 | 0.3 | |
| %Rich1FAC | | | | | | -0.3 | | | | | | 0.3 | 0.3 | | |
| %Rich1FACW | | 0.4 | | | | | | | 0.4 | 0.3 | 0.4 | | | | |
| %Rich1Forb | | | | | 0.3 | -0.3 | 0.4 | | | | | | | | |
| %Rich1Gram | | | | | | 0.3 | | | | -0.3 | | | | | |
| %Rich1GT20 | | | 0.4 | | | | | | | 0.3 | | -0.3 | | | 0.3 |
| %Rich1GT50 | | | 0.3 | | -0.3 | | | | | | | | | | 0.3 |
| %Rich1Invas | | | | | 0.3 | | 0.4 | | | | | | | | |
| %Rich1NN | | | | | | | | | 0.3 | 0.3 | 0.3 | | | | |
| %Rich1OBL | | -0.3 | | -0.3 | | | | | -0.3 | -0.4 | | | | | |
| %Rich1Shrub | | | | | | | | | | 0.5 | 0.5 | | | | |
| %Rich1Tree | | | | | | | | | | | | | -0.3 | | |
| %Rich1Wet | | | | | | 0.4 | | | | | | | -0.4 | 0.4 | |
| Fq12nnGT50 | | | | | -0.3 | | | | | | | | | | |
| Fq1NnGT50 | | | | | -0.3 | | | | | | | | | | |
| FqInvAll | | | | 0.3 | | | | | | | | | | | |
| FqNonWet | | | | | | -0.4 | | | | | | | | | |
| PCavGramQd | | | | | -0.3 | | | | | | | | | | |
| PCavShrQd | | | | | | | | | | 0.4 | | | | | |
| PCinvQdM% | | | | | | | | | | | 0.3 | | | | |
| PCm%Forb | | | | | 0.3 | | | | | | | | | | |
| PCm%Gram | | | | | | | | | | | | | | 0.5 | |
| PCm%Shr | | | | | | | | | | 0.3 | | | | | |
| PCnnQdM% | | | | | | -0.3 | | | | | | | | | |
| QdNonWet | | | | | | -0.4 | | | | | | | | | |
| Rich12Cumu | | | | | 0.3 | | | | | | | | 0.3 | | |
| Rich12FAC | | | | | | | | | | | | 0.4 | 0.4 | | |
| Rich12FACW | | 0.3 | | | 0.3 | | | | | | | | | | |
| Rich12GT19 | | 0.3 | | | | | | | | | | | 0.4 | | 0.3 |

| A-6 Metric | Ca | Cu | Fe | K | Mg | Mn | Na | NO3 | OM | TP | Zn | pH | pH surf | Cl surf | Conduc surface |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rich12GT50 | | | | | | | | | | | | | 0.4 | | |
| Rich12GT9 | | 0.3 | | | | | | | | | | | | | 0.3 |
| Rich12invas | | | | | | | | | | | | | 0.3 | | |
| Rich12NN | | | -0.3 | | | | | | | | | | 0.3 | | |
| Rich12OBL | | | | -0.4 | | | | | | -0.4 | | | | | |
| Rich12QdAvGT9 | | | | | 0.3 | | 0.3 | | | | | | | | |
| Rich12QdAvNN | | | -0.3 | | | | | | | | | | 0.4 | | |
| Rich12QdM%GT9 | | | | | 0.3 | | 0.3 | | | | | | | | |
| Rich12QdM%NN | | | -0.3 | | | | | | | -0.3 | | | | | |
| Rich12Wet | | | | | 0.3 | | | | | | | | | | |
| Rich1Cumu | | | | | 0.3 | | | | | | | | | | |
| Rich1FAC | | | | | | -0.3 | | | | | | 0.3 | 0.4 | | |
| Rich1FACW | | 0.4 | | | 0.3 | | | | | | | | | | |
| Rich1Forb | | | | | 0.4 | | 0.3 | | | | | | | | |
| Rich1Gram | | | -0.4 | | | | | | | -0.4 | -0.3 | | | | |
| Rich1GT20 | | | | | | | | | | | | | 0.3 | | |
| Rich1GT50 | | | | | | | | | | | | | 0.3 | | |
| Rich1GT9 | | 0.4 | | | 0.4 | | | | | | | | | | |
| Rich1Invas | | | | | | | | | | | | | 0.3 | | |
| Rich1NN | | | -0.3 | | | | | | | | | | | | |
| Rich1OBL | | | | -0.4 | | | 0.3 | | | -0.3 | | | | | |
| Rich1QdAvg | | | | | 0.4 | | 0.4 | | | | | | 0.4 | | |
| Rich1QdAvGT9 | | | | | 0.4 | | 0.3 | | | | | | 0.3 | | |
| Rich1QdAvNN | | | -0.3 | | | | | | | | | | 0.4 | -0.3 | |
| Rich1QdM%GT9 | | | | | 0.3 | | 0.3 | | | | | | 0.3 | | |
| Rich1QdM%NN | | | -0.3 | | | | | | | | | | | | |
| Rich1QdMa% | | | | | 0.5 | | 0.3 | | | | | | | | |
| Rich1Shrub | | 0.3 | | | | -0.3 | | | | 0.4 | 0.4 | 0.3 | | | |
| Rich1Wet | | | | | 0.4 | | | | | | | | | | |
| RichAllQdAvg | | | | | 0.4 | | 0.3 | | | | | | 0.4 | | |
| RichAllQdMa% | | | -0.3 | | 0.4 | | | | | | | | | | |
| UbiqWetNtvAv | | 0.5 | | | | | | | 0.3 | 0.5 | 0.3 | | | | 0.4 |
| UbiqWetNtvM% | | | | | | | | | | 0.3 | | | | | |
| WISavg | | | | 0.3 | | -0.3 | | | | | | | | | |
| WISma% | | | | | | -0.3 | | 0.4 | | | | | | | |
| WISmin | | | | 0.4 | | | | | | | | | | | |

A-7. Paired metrics for vegetation and macroinvertebrates that were significantly correlated both years: positive correlations

See Data Dictionary (Appendix A-1) for definitions of the metrics.

| A7. Vegetation Metric | Macroinvertebrate Metric | R max |
|---|---|---|
| %FqInvAll | PctN_ETSD | 0.42 |
| %FqInvAll | PctNmites | 0.38 |
| %FqInvAll | PctNsens | 0.36 |
| %FqInvAll | SensSp | 0.33 |
| %FqInvGT50 | PctN_ETSD | 0.35 |
| %FqInvGT9 | PctN_ETSD | 0.42 |
| %FqInvGT9 | PctNSphaer | 0.37 |
| %FqInvGT9 | PctSpETSD | 0.40 |
| %Rich12FAC | PctNsens | 0.45 |
| %Rich12FAC | PctSpSens | 0.46 |
| %Rich12FACW | PctSpCM | 0.35 |
| %Rich12GT50 | PctNCM | 0.36 |
| %Rich12GT50 | PctNCrus | 0.42 |
| %Rich12GT50 | PctNmicroc | 0.45 |
| %Rich12GT9 | MHBIavWtd | 0.37 |
| %Rich12GT9 | PctNCrus | 0.34 |
| %Rich12GT9 | PctNmicroc | 0.35 |
| %Rich12Wet | MHBIavWtd | 0.39 |
| %Rich12Wet | PctSpTol | 0.36 |
| %Rich1FAC | PctNmites | 0.35 |
| %Rich1FAC | PctNsens | 0.40 |
| %Rich1FAC | PctSpSens | 0.42 |
| %Rich1FAC | SensSp | 0.42 |
| %Rich1FACW | PctSpCM | 0.35 |
| %Rich1Gram | PctNpred | 0.31 |
| %Rich1Gram | PctSpPred | 0.38 |
| %Rich1GT20 | PctNCrus | 0.35 |
| %Rich1GT20 | PctNmicroc | 0.37 |
| %Rich1GT20 | PctSpCrus | 0.36 |
| %Rich1Shrub | ETSDspp | 0.43 |
| %Rich1Shrub | NonInsects | 0.36 |
| %Rich1Shrub | PctN_ETSD | 0.50 |
| %Rich1Shrub | PctNcg | 0.33 |
| %Rich1Shrub | PctNSphaer | 0.47 |
| %Rich1Shrub | PctSpETSD | 0.46 |
| %Rich1Wet | MHBIavWtd | 0.39 |
| %Rich1Wet | PctSpTol | 0.37 |
| %XerRichForb | PctSpColeo | 0.29 |

| A7. Vegetation Metric | Macroinvertebrate Metric | R max |
|---|---|---|
| %XerWet | GenCM | 0.34 |
| FqInvAll | PctN_ETSD | 0.44 |
| FqInvAll | PctNmites | 0.36 |
| FqInvAll | PctNsens | 0.35 |
| FqInvAll | SensSp | 0.32 |
| FqInvGT50 | PctN_ETSD | 0.35 |
| FqInvGT9 | PctN_ETSD | 0.41 |
| FqInvGT9 | PctNSphaer | 0.36 |
| FqInvGT9 | PctSpETSD | 0.39 |
| PCinvQdAv | PctN_ETSD | 0.39 |
| PCinvQdAv | PctNSphaer | 0.38 |
| PCinvQdMx | PctN_ETSD | 0.47 |
| PCinvQdMx | PctSpETSD | 0.29 |
| PCmxForb | PctNCrus | 0.34 |
| PCmxForb | PctNmicroc | 0.31 |
| Rich12Cumu | PctNGas | 0.41 |
| Rich12GT19 | PctNGas | 0.41 |
| Rich12GT50 | PctNCM | 0.42 |
| Rich12GT50 | PctNCrus | 0.38 |
| Rich12GT50 | PctNmicroc | 0.31 |
| Rich12GT9 | PctNGas | 0.39 |
| Rich12invas | PctNmites | 0.34 |
| Rich12invas | PctSpSens | 0.33 |
| Rich12invas | SensSp | 0.34 |
| Rich12OBL | ColeoSpp | 0.48 |
| Rich12OBL | GasGen | 0.31 |
| Rich12OBL | GenECOT | 0.52 |
| Rich12OBL | PctSpColeo | 0.36 |
| Rich12OBL | PredSp | 0.44 |
| Rich12QdAvGT9 | PctNGas | 0.39 |
| Rich12Wet | PctNGas | 0.46 |
| Rich1Cumu | PctNGas | 0.43 |
| Rich1Forb | PctNGas | 0.40 |
| Rich1Gram | ColeoSpp | 0.39 |
| Rich1Gram | GenECOT | 0.40 |
| Rich1Gram | PctNGas | 0.42 |
| Rich1Gram | PctNpred | 0.41 |
| Rich1Gram | PredSp | 0.44 |
| Rich1GT20 | PctNGas | 0.31 |
| Rich1GT50 | PctNCM | 0.36 |
| Rich1GT50 | PctNCrus | 0.31 |
| Rich1GT9 | PctNGas | 0.43 |
| Rich1Invas | PctSpSens | 0.33 |
| Rich1Invas | SensSp | 0.34 |

| A7. Vegetation Metric | Macroinvertebrate Metric | R max |
|---|---|---|
| Rich1OBL | ColeoSpp | 0.48 |
| Rich1OBL | GenECOT | 0.50 |
| Rich1OBL | PctSpColeo | 0.38 |
| Rich1OBL | PctSpPred | 0.37 |
| Rich1OBL | PredSp | 0.45 |
| Rich1QdAvg | GenECOT | 0.44 |
| Rich1QdAvg | PctNGas | 0.46 |
| Rich1QdAvg | PredSp | 0.45 |
| Rich1Shrub | ETSDspp | 0.43 |
| Rich1Shrub | NonInsects | 0.35 |
| Rich1Shrub | PctN_ETSD | 0.49 |
| Rich1Shrub | PctNsens | 0.35 |
| Rich1Shrub | PctNSphaer | 0.42 |
| Rich1Shrub | PctSpETSD | 0.42 |
| Rich1Shrub | PctSpSens | 0.35 |
| Rich1Shrub | SensSp | 0.36 |
| Rich1Tree | PctSpSens | 0.30 |
| Rich1Wet | PctNGas | 0.48 |
| RichAllQdAvg | GenECOT | 0.44 |
| RichAllQdAvg | PctNGas | 0.43 |
| RichAllQdAvg | PredSp | 0.48 |
| XerPCgt9 | PredSp | 0.30 |
| XerRich12 | GenECOT | 0.39 |
| XerRich12 | PctN_Coleo | 0.31 |
| XerRich12 | PctNpred | 0.40 |
| XerRichAll | PctNpred | 0.37 |
| XerRichGram | PctNpred | 0.34 |
| XerRichOBL | GenECOT | 0.46 |
| XerRichOBL | PredSp | 0.38 |
| XerRichShr | GenCM | 0.31 |
| XerShrPC | GenCM | 0.30 |
| XerWaterPC | ETSDspp | 0.37 |
| XerWaterPC | GenCM | 0.31 |
| XerWaterPC | NonInsects | 0.45 |
| XerWaterPC | PctNSphaer | 0.50 |
| XerWaterPC | PctSpETSD | 0.31 |
| XerWaterPC | TolSpp1 | 0.36 |
| XerWet | GenECOT | 0.44 |
| XerWet | PctNpred | 0.41 |

A-8. Paired metrics for vegetation and macroinvertebrates that were significantly correlated both years: negative correlations

See Data Dictionary (Appendix A-1 for definitions of the vegetation metrics.

| A-8. Vegetation Metric | Macroinvertebrate Metric | R max |
|---|---|---|
| FqInvAll | PctSpColeo | -0.30 |
| FqInvGT50 | PctN_Coleo | -0.31 |
| FqInvGT50 | PctSpColeo | -0.32 |
| FqInvGT9 | PctSpColeo | -0.32 |
| PCinvQdAv | ColeoSpp | -0.36 |
| PCinvQdAv | PctN_Coleo | -0.37 |
| PCinvQdAv | PctSpColeo | -0.40 |
| PCinvQdMx | PctN_Coleo | -0.35 |
| PCinvQdMx | PctSpColeo | -0.28 |
| PCinvQdMx | PctSpPred | -0.30 |
| PCmxForb | PctNsens | -0.32 |
| Rich12Cumu | PctMostDom | -0.28 |
| Rich12FAC | MHBIavWtd | -0.29 |
| Rich12NN | PctSpTol | -0.28 |
| Rich12QdAvNN | PctSpTol | -0.29 |
| Rich1Gram | PctNChiro | -0.31 |
| Rich1QdAvGT9 | PctDivCG | -0.28 |
| Rich1Shrub | ColeoSpp | -0.36 |
| Rich1Shrub | PctSpColeo | -0.48 |
| Rich1Shrub | PctSpPred | -0.28 |
| RichAllQdAvg | PctMostDom | -0.28 |
| XerPCgt9 | PctSpOrtho | -0.32 |
| XerRich1 | ChiroPctMidge | -0.29 |
| XerRich1 | MHBIavWtd | -0.28 |
| XerRich12 | MHBIavWtd | -0.29 |
| XerRichAll | MHBIavWtd | -0.34 |
| XerRichGram | ChiroPctMidge | -0.34 |
| XerRichGram | MHBIavWtd | -0.30 |
| XerRichShr | PctSpColeo | -0.29 |
| XerShrPC | PctSpColeo | -0.29 |
| XerWaterPC | PctSpColeo | -0.31 |
| %FqInvAll | PctSpColeo | -0.31 |
| %FqInvGT50 | PctN_Coleo | -0.31 |
| %FqInvGT50 | PctSpColeo | -0.32 |
| %FqInvGT9 | PctSpColeo | -0.32 |
| %Rich12FAC | MIVnum | -0.34 |
| %Rich12FACW | GenECOT | -0.31 |
| %Rich12GT50 | PctNsens | -0.28 |

| A-8. Vegetation Metric | Macroinvertebrate Metric | R max |
|---|---|---|
| %Rich12NN | PctSpTol | -0.31 |
| %Rich12Wet | PctNsens | -0.31 |
| %Rich12Wet | SensSp | -0.29 |
| %Rich1FAC | MIVnum | -0.34 |
| %Rich1FACW | GenECOT | -0.29 |
| %Rich1FACW | PredSp | -0.30 |
| %Rich1OBL | PctNsens | -0.32 |
| %Rich1OBL | PctSpSens | -0.28 |
| %Rich1Shrub | ColeoSpp | -0.47 |
| %Rich1Shrub | GenECOT | -0.30 |
| %Rich1Shrub | PctN_Coleo | -0.33 |
| %Rich1Shrub | PctSpColeo | -0.56 |
| %Rich1Shrub | PctSpPred | -0.40 |
| %XerRichShr | PctSpColeo | -0.30 |